Revised
Notice of Construction Application Supporting Information Report
Pasco Sanitary Landfill
Pasco, Washington

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Prepared for

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TABLE OF CONTENTS

Page

FIGURES

TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

°K	Degrees Kelvin
$\mu g/m^3$	Microgram per Cubic Meter
AERMAP	AMS/EPA Regulatory Model Terrain Pre-Processor
AERMET	AERMOD Meteorological Pre-Processor
AERMOD	AMS/EPA Regulatory Model
AMS	American Meteorological Society
ASIL	Acceptable Source Impact Level
BACT	Best Available Control Technology
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DRE	Destruction and Removal Efficiency
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	Foot
ft/sec	Feet per second
GAC	Granular-Activated Carbon
GCE	Gulf Coast Environmental Systems
GEP	Good Engineering Practice
HAP	Hazardous Air Pollutant
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
ICE	Internal Combustion Engine
IWAG	Industrial Waste Area Generators
lbs/day	Pounds per Day
lbs/hr	Pounds per Hour
LFG	Landfill Gas
m	Meter
m/sec	Meters per Second
MSW	Municipal Solid Waste
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrogen Dioxide
NOC	Notice of Construction
NO_x	Nitrogen Oxides
NSR	New Source Review
NWS	National Weather Service
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with an Aerodynamic Diameter Less Than or Equal to 2.5 Microns
PM_{10}	Particulate Matter with an Aerodynamic Diameter Less Than or Equal to 10 Microns
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Reaction Model
RCW	Revised Code of Washington
RTO	Regenerative Thermal Oxidizer
scfh	Standard Cubic Feet per Hour
scfm	Standard Cubic Feet per Minute
SO_2	Sulfur Dioxide

LIST OF ABBREVIATIONS AND ACRONYMS (Con't)

SQER	Small-Quantity Emission Rate
SRTM	Shuttle Radar Topography Mission
SVE	Soil Vapor Extraction
TAP	Toxic Air Pollutant
tBACT	Best Available Control Technology for Toxic Air Pollutants
VOC	Volatile Organic Compound
WAAQS	Washington Ambient Air Quality Standards
WAC	Washington Administrative Code
WSU	Washington State University

1.0 PROJECT DESCRIPTION
(SECTION III OF NOC APPLICATION FORM)

1.1 FACILITY DESCRIPTION

The Industrial Waste Area Generators Group III (IWAG) proposes to install a regenerative thermal oxidizer (RTO) at the Pasco Sanitary Landfill Site in Pasco, Washington ("Site"; Figure 1). The site layout and nearby adjacent properties are shown on Figure 2. The proposed RTO will be designed to control volatile organic compound (VOC) emissions generated from a soil vapor extraction (SVE) system that removes VOCs from Zone A of the Site (Figure 3). The SVE system is currently being operated, and the proposed RTO will be operated, as components of IWAG's ongoing compliance with the requirements of Agreed Order No. DE 9240 (the Order). The proposed location of the RTO will be within a fenced area to the west of Dietrich Road (Figure 2).

Development in the area surrounding the landfill is primarily agricultural or industrial/ commercial.

1.2 PROPOSED NEW EQUIPMENT

This proposed project would route the Zone A SVE stream to an RTO. The proposed RTO would be designed to accommodate a maximum inlet flow rate of 1,000 standard cubic feet per minute (scfm) from the SVE conveyance pipeline and 1,000 scfm of dilution air. Additionally, the RTO would be designed to process up to 12 gallons per hour of process condensate generated within the SVE condensate knockout system. The 2,000-scfm RTO system would be manufactured and installed by Gulf Coast Environmental Systems (GCE). The total VOC destruction and removal efficiency (DRE) for the RTO is estimated at 98 percent.

The fuel usage rate for the RTO during startup would be 750 standard cubic feet per hour (scfh) of natural gas (or the equivalent amount of propane based on heating value); however, the duration that fuel would be used at that rate is only 45 minutes per startup. It is anticipated that the RTO will be in startup mode no more than 24 times per year. The fuel usage rate during loading conditions is about $^1/_{10}$ of the fuel usage rate during startup (i.e., 75 scfh). Specifications from GCE on the proposed RTO are provided in Appendix A.

1.3 COMPLIANCE WITH STATE AND FEDERAL REGULATIONS

The operation of the proposed RTO will comply with the following applicable state and federal air regulations:

- Chapter 70.94 Revised Code of Washington (RCW) (Washington Clean Air Act)

- Chapter 173-400 Washington Administrative Code (WAC) (General Regulations for Air Pollution Sources)
- Chapter 173-460 WAC (Controls for New Sources of Toxic Air Pollutants).

Specifically, the proposed project includes a source of air contaminants and will follow applicable air contaminant regulations as listed in:

- RCW 70.94.152
- WAC 173-400-113

The facility is located in an attainment area; therefore, the permittee is applying for an NOC permit to meet minor New Source Review (NSR) requirements. A non-attainment NSR permit is not required. Facilities that produce more than 100 tons per year of any criteria pollutant are considered major sources, and those that produce less than 100 tons per year are considered minor sources. Potential-to-emit estimates provided in Section 2.0 demonstrate that the facility will emit:

- Less than 100 tons per year of any criteria pollutant [particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone, and lead]
- Less than 10 tons per year of any Washington State toxic air pollutant (TAP) or U.S. Environmental Protection Agency (EPA) hazardous air pollutant (HAP)
- Less than 25 tons per year of total TAPs/HAPs.

As a result, neither a Prevention of Significant Deterioration (PSD) NSR pre-construction permit nor a Title V operating permit is required. Due to the minor source status of the proposed construction and operating activities at the facility, a comparison of estimated maximum ambient air contaminant concentrations to PSD Class II increment levels is not required.

2.0 AIR POLLUTANT EMISSION ESTIMATES (SECTIONS V AND VI OF NOC APPLICATION FORM)

Air pollutant emission rates were calculated for the proposed RTO per the requirements of WAC 173-400-103. Additionally, at the request of the Washington State Department of Ecology (Ecology), TAP emission rates were quantified to demonstrate that the project meets the substantive requirements of Chapter 173-460 WAC. Conservatively high emission rates were quantified for criteria pollutants and TAPs. The basis for emission calculations is described in the following sections. Detailed emission calculation spreadsheets are provided in Microsoft® Excel® format in Appendix B. Tabulated SVE vapor and condensate analytical results used as the basis for calculating the VOC inlet mass loading rates are provided in Appendix B.

2.1 EMISSION CALCULATIONS

RTO outlet emission rates were estimated based on contaminant mass loading to the RTO inlet, DRE of the RTO and estimated fuel usage. The emission rates for criteria pollutants and TAPs, and the calculation methodologies are provided in the following sections.

2.1.1 REGENERATIVE THERMAL OXIDIZER PROCESS STREAM

Maximum RTO outlet emissions resulting from contaminant loading from the SVE conveyance line were calculated based on the analytical results of SVE vapor samples collected by Environmental Partners Inc. (EPI) from the SVE effluent from Zone A of the landfill. Emission rates for VOCs and hydrogen chloride (HCl) were conservatively calculated based on the maximum designed influent flow rate to the system (i.e., 1,000 scfm), the maximum concentrations observed in SVE vapor analytical result and the proposed combustion of the liquid condensate stream. The highest VOC mass loading rates observed to date from the SVE system occurred in late 2012 (approximately June through November 2012). Tabulated SVE vapor and condensate analytical results for the approximately 6-month period are provided in Appendix B. Additionally, a laboratory analytical data package for the October 1, 2012 sampling event—the highest VOC concentrations ever observed in the SVE vapors—is provided in Appendix B. Considering that concentrations at these levels have not since been observed in the SVE system influent, this approach provides an extremely conservative estimate of long-term VOC influent concentrations to the RTO.

GCE has stated that the RTO will achieve at least a 98 percent DRE for VOCs with normal inlet concentrations or a maximum of 20 parts per million by volume (ppmv) total VOCs at the stack outlet when a 98 percent DRE may not be achievable due to low inlet concentrations. RTO emission rates for

VOCs calculated based on a vendor-specified DRE of 98 percent are presented in Table 1. Emission rates for HCl and hydrogen fluoride (HF) as presented in Table 1 were calculated based on the assumption that all of the chlorine and fluorine from influent solvents would react with the available hydrogen and exit the RTO in gaseous form as HCl or HF.

Trichloroethene and methylene chloride are the two most abundant sources of elemental chlorine in the untreated soil vapor, representing more than 85 percent of the chlorinated compounds by mass in the average untreated SVE vapors, and providing a combined 97.9 pounds of chlorine per day (lbs/day) at the conservatively high estimate. After combining with hydrogen, the HCl gas emissions from these two contributors are estimated to be 100.7 lbs/day. Stoichiometric calculations were simplified by using the two most abundant contributors, then scaled up to account for the presence of the other potential sources of chlorine in the soil vapor [100.7 x (100% / 85%)], resulting in the final estimate of 118 lbs/day of HCl gas, as indicated in Table 1.

Dichlorodifluoromethane (CFC-12) and trichlorofluoromethane (CFC-11) are the only two available fluorine sources in the untreated soil vapor, so direct stoichiometric conversions established an estimate for HF. The estimated HF gas emission rate is 2.9 lbs/day (also shown in Table 1).

These maximum design assumptions were used to calculate worst-case 1-hour, daily, and annual emission rates for VOCs, HCl, and HF assuming that the RTO would operate at its design capacity 24 hours per day, 365 days per year at the highest concentrations ever observed in the SVE effluent. Worst-case emission rates and example calculations for VOCs, HCl, and HF are provided in Table 1.

Estimated VOC emission rates based on a stack outlet concentration of 20 ppmv are presented in Table 2, and were calculated assuming an average ratio between each compound based on previously collected analytical data. As shown in Tables 1 and 2, the emission rates calculated based on maximum anticipated loading rates to the RTO assuming a 98 percent DRE are higher than the emission rates estimated when a 98 percent DRE for every compound may not be achievable, but the total VOC concentration at the stack outlet does not exceed 20 ppmv.

2.1.2 FUEL COMBUSTION

The proposed RTO will be either natural gas or propane-fired. The quantity of fuel required for RTO operation will vary depending on the VOC mass loading to the inlet of the RTO. The fuel usage estimates provided below are based on the heating value for natural gas; however, an equivalent amount of propane fuel (based on heating value) may be substituted. During startup, the RTO will use 750 scfh of natural gas until the unit is up to operating temperature at which point the temperature will be self-sustaining and little to no fuel will be required. The average VOC mass loading to the inlet of the RTO will be approximately 480 lbs/day, during which time natural gas usage would be an estimated 75 scfh.

The natural gas usage during periods of steady-state high VOC mass loading to the inlet of the RTO (i.e., 1,500 lbs/day or more) will be nearly zero (less than 75 scfh). For the purposes of calculating the maximum 1-hour emission rates, it was conservatively assumed that the RTO would be in startup mode and would use 750 scfh of natural gas for 1 full hour. For the purposes of calculating the maximum daily emission rates, it was conservatively assumed the RTO would operate for 1 hour in startup mode with a natural gas fuel use rate of 750 scfh and 23 hours with a fuel usage rate of 75 scfh. For the purposes of calculating the maximum annual emission rates, it was conservatively assumed that the RTO would operate in startup mode for 24 cumulative hours per year and normal operation would occur for the remainder of the year.

At Ecology's request, RTO outlet emission rates for criteria pollutants and TAPs associated with natural gas were calculated based on emission factors presented in the Ventura County Air Pollution Control District document titled *AB 2588 Combustion Emission Factors* (VCAPCD 2001) and Volume I, Chapter 1.4 ("Natural Gas Combustion") of the EPA's *Compilation of Air Pollutant Emission Factors* (EPA 1995). Additionally, RTO outlet emission rates for criteria pollutants and TAPs associated with propane combustion were calculated based on emission factors in Volume I, Chapter 1.5 ("Liquefied Petroleum Gas Combustion"). These fuel emission rates are presented with example calculations in Table 3. Emission rates for each criteria pollutant or TAP were calculated using the emission factors for natural gas or propane, whichever was highest.

2.1.3 DIOXINS AND FURANS (PCDD/FS)

As described below, the RTO is not expected to emit significant amounts of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), collectively referred to as PCDD/Fs.

An evaluation was completed to determine whether operation of the RTO is likely to result in formation of PCDD/Fs. PCDD/Fs are indirect byproducts of incomplete combustion. Studies have shown that without proper design and control of certain types of oxidation technologies, PCDD/F-precursor compounds (e.g., chlorophenols, chlorobenzenes, polychlorinated biphenyls, and polychlorinated naphthalenes) could be formed. In some situations, these precursor compounds may progress to form PCDD/Fs in the "post-combustion zone" (Wielgosinski 2010).

PCDD/F formation is a well-documented issue with large-scale waste incinerators, although specific information on SVE off-gas thermal oxidizer systems is limited. There are three known pathways for PCDD/F formation by combustion. All are minimized by good combustion control, adequate oxygen supply, and temperature control with proper residence time (EPA 2005a; Wielgosinski 2010). A description of the three known pathways for PCDD/F formation and a discussion of why the expected conditions at the Site would not be conducive to each PCDD/F formation pathway are presented below.

Scenario 1: Pass-Through

As described below, PCDD/F emissions from the proposed RTO is not expected to occur under this scenario. This scenario involves incomplete breakdown and pass-through of PCDD/Fs already present, either as contaminants in the fuel, ambient air supply, or waste (Environment Australia 1999; EPA 2005a; Wielgosinski 2010). Even if PCDD/Fs were somehow present in the solids and containerized liquids within Zone A of the landfill, there is no reason to believe the PCDD/Fs would volatilize into the vapors pulled into the RTO due to the low vapor pressure for PCDD/F.

For a PCDD/F emission concentration of parts per trillion or even parts per billion, a feed stream concentration would have to be on the order of parts per million (Shaub and Tsang 1983). Additionally, effective degradation of PCDD/F can be achieved at temperatures above 1,100°F (600°C) (Lundin and Marklund 2005). The operating temperature of the RTO will be a minimum of 1,600°F; at that temperature, it is expected that any potential PCDD/Fs in the feed stream would be efficiently broken down. Therefore, PCDD/F formation as a result of incomplete breakdown and pass-through is not a concern for the proposed RTO.

Scenario 2: Precursor

As described below, PCDD/F formation from the proposed RTO is not expected to occur under this scenario. This scenario involves incomplete breakdown of aromatic precursor compounds and rearrangement reactions with chlorine radicals. This mechanism is catalyzed in the presence of transition metals, particularly copper, and can progress in the gas phase while reactants adsorb to fly ash. The optimal temperatures for this mechanism most commonly occur in the post-combustion zone unless the stack gas is rapidly cooled from above 930°F to less than 400°F (500°C to 200°C) (Environment Australia 1999; EPA 2005a; Wielgosinski 2010).

In its report titled, *Off-Gas Treatment Technologies for Soil Vapor Extraction Systems: State of the Practice*, the EPA indicates that the most common precursor compounds (which undertake the initial rearrangement step) are not typically extracted by SVE systems due to their low volatility (EPA 2006). Some aliphatic compounds with lower molecular weight may act as potential PCDD/F precursors (EPA 2006); however, these compounds would be expected to combust with a greater than 98 percent DRE before entering the post-combustion zone in the proposed RTO. Additionally, the post-combustion system for the proposed RTO contains a ceramic heat exchange bed that rapidly cools the post-combustion exhaust stream from 1,600°F to less than 480°F in less than ¼ second, which will minimize the opportunity for PCDD/F formation under this scenario.

Scenario 3: *De Novo* Synthesis

As described below, PCDD/F formation from the proposed RTO is not expected to occur under this scenario. This scenario, commonly referred to as "*de novo*" synthesis, is the only conceivable mechanism for PCDD/F formation from thermally oxidized effluent from SVE systems. It can occur when chlorinated aliphatics react with simple organic compounds in the presence of a metal catalyst. This theory suggests that PCDD/F can be formed in the presence of fly ash containing chemically unrelated, unburnt aromatics and metal catalysts (Environment Australia 1999; EPA 2005a; Wielgosinski 2010). This scenario is typically associated with solid waste combustion systems that exhibit high concentrations of metal-containing fly ash, but could conceivably also occur in thermal oxidation systems that use a metal catalyst, such as a catalytic oxidizer. Similar to the second scenario, the *de novo* synthesis occurs in the post-combustion zone and is best controlled by increased operation temperature, residence time, and minimizing time spent within the temperature range of 400°F to 840°F (200°C to 450°C) (Environment Australia 1999; EPA 2005a; Wielgosinski 2010).

This scenario is not a concern for the Site because the proposed RTO will not use a metal catalyst, the RTO will not combust solid waste that forms metal-containing fly ash, and there is no metal catalyst in the SVE effluent. Additionally, as discussed above, the post-combustion exhaust stream for the RTO will cool from 1,600°F to less than 480°F in only a fraction of a second which will result in an exhaust temperature at the low end of where PCDD/F formation can occur, thereby minimizing the opportunity for PCDD/F formation.

Case Study Comparison

In 1998, the McClellan Air Force Base (MAFB) in Sacramento, California released a report on its pilot-scale study on soil remediation of VOCs (CH2M HILL 1998). Similar to the Pasco Sanitary Landfill, the MAFB system extracted VOCs with an SVE system, and the SVE vapor effluent was routed to a thermal combustion unit to control VOC air emissions. However, the thermal combustion unit used at the MAFB site was a catalytic oxidizer. PCDD/F formation was found to be an issue for the MAFB site, which required installation of a wet scrubber and a vapor-phase granular-activated carbon treatment system. The pilot-scale study at MAFB tested two different operating temperatures and demonstrated that by simply increasing the outlet stack temperature from 725°F to 1,112°F, PCDD/F emission levels decreased by 70 percent.

There are a number of factors that likely contributed to PCDD/F formation at the MAFB site that do not apply to the Pasco Sanitary Landfill Site, including: 1) the thermal oxidation technology used at the MAFB site was a catalytic oxidizer that uses a metal catalyst, a known contributor to PCDD/F formation; 2) the catalytic oxidizer at the MAFB site operated at temperatures between 400°F and 840°F, which is within the range where PCDD/F formation has been noted to occur; 3) the soil at the MAFB site was contaminated with PCDD/Fs, suggesting that pass-through of PCDD/F may have contributed to the presence of PCDD/F at the stack outlet. As described above, the three likely contributors to PCDD/F formation at the MAFB site have been ruled out as potential factors at Zone A. Additionally, when the exhaust temperature at the MAFB site was increased to 1,100°F, PCDD/F emissions decreased significantly. Further, the proposed RTO will operate at a much higher temperature (1,600°F) than the MAFB catalytic oxidizer.

Conclusion

In its 2006 report, the EPA indicates that "to minimize the formation of Products of Incomplete Combustion [such as PCDD/F], most commercial thermal oxidation systems are designed to have sufficient fuel/air mixing processes and operate at high temperatures" (EPA 2006). Chad Clark, technical director of GCE, has indicated that PCDD/F will not be a concern for the proposed RTO because the contributing factors associated with PCDD/F formation in catalytic oxidizers and solid waste incinerators are not a factor when oxidizing a vapor stream with an RTO (Clark 2014).

In summary, PCDD/F formation resulting from operation of the proposed RTO at the Site is not anticipated because the requisite transition metal catalyst is absent, combustion temperatures above 840°F will be achieved, and rapid cool-down by the ceramic heat exchange bed would prevent PCDD/F generation in the post-combustion zone. The use of such engineering controls is expected to negate any potential formation of PCDD/F due to VOC combustion with the proposed RTO.

Additionally, at Ecology's request we contacted the U.S. EPA Office of Research and Development to discuss the potential of the proposed RTO to result in PCDD/F emissions. According to Mr. Brian Gullett, who is an international expert on PCDD/F formation from combustion, the potential for PCDD/F formation is low for this project (Gullett, B., 2014, personal communication).

Based on the available literature on PCDD/F formation and discussions with GCE and Mr. Gullett, there is no indication that PCDD/F formation would be a concern for the proposed RTO; therefore, we conclude that a requirement to test the RTO exhaust gas for PCDD/Fs is not warranted.

2.2 EMISSION-BASED EXEMPTION EVALUATION

Emission rates are described and provided in Section 2.1, Tables 1, 2, 3, and 4 and Appendix B. The RTO emission rates shown in Table 4 account for unburned TAP constituents from the SVE stream and fuel combustion byproducts. WAC 173-400-110 allows for exemptions from NSR based on emissions thresholds. The NSR exemption threshold levels for criteria pollutants are identified in WAC 173-400-110(5). Additionally, the exemption threshold levels for TAPs are the *de minimis* emission rates specified in WAC 173-460-150.

The calculated RTO emission rates that include the SVE process stream and fuel combustion have been calculated and compared to registration program exemption thresholds (Table 4). RTO emission rates exceeded the registration program exemption thresholds for one criteria pollutant (total VOCs as a precursor to ozone formation) and 13 TAPs [1,1-dichloroethane; 1,2-dichloroethane; 1,4-dichlorobenzene; benzene; ethylbenzene; acrolein; m,p-xylene; methylene chloride; naphthalene; tetrachloroethene; total xylenes; trichloroethene; vinyl chloride; HCl; and HF]. Based on these emissions, the proposed project does not qualify for an exemption from registration program requirements.

3.0 EMISSION STANDARD COMPLIANCE (SECTION VII OF NOC APPLICATION FORM

Standards of performance for new stationary sources are specified in Part 40, Subpart 60 of the Code of Federal Regulations (40 CFR Part 60). The requirements of 40 CFR Part 60 are applicable only to certain source groups with new, modified, and reconstructed sources of criteria pollutants.

Standards of performance for municipal solid waste (MSW) landfills are specified in 40 CFR Part 60 Subpart Cc; however, this rule is not applicable to the proposed project because it applies to landfills for which construction, reconstruction, or modification was commenced before May 30, 1991. Modifications to the Pasco Landfill were commenced after 1991.

40 CFR Part 60 Subpart WWW provides standards of performance for MSW landfills for which construction, reconstruction, or modification was commenced on or after May 30, 1991. It is noted that Zone A of the Site was closed in 1974 and was not then, nor is it now, an MSW landfill. However, for the purposes of this NOC application, this regulation is considered an applicable relevant and appropriate regulation for the RTO. Modifications to Zone A, including construction of an impermeable cover system and installation of an SVE system, were commenced after May 30, 1991; therefore, the operator of Zone A will comply with the standards, recordkeeping, and reporting requirements presented in 40 CFR Part 60 Subpart WWW.

The National Emission Standards for Hazardous Air Pollutants (NESHAP) are specified in 40 CFR Part 63. The requirements of 40 CFR Part 63 are applicable only to certain source groups with new and existing sources of HAPs. 40 CFR Part 63 Subpart AAAA presents the NESHAP for MSW landfills; however, this rule is not applicable to the proposed project because Zone A was never an MSW landfill, it is not a major source of HAPs, and the design capacity is less than 2.5 million megagrams.

4.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS (SECTION VIII OF NOC APPLICATION FORM)

4.1 GENERAL APPROACH FOR BEST AVAILABLE CONTROL TECHNOLOGY ASSESSMENT

Best available control technology (BACT) is an emission limitation based on the maximum degree of reduction that can be feasibly achieved for each air pollutant emitted from any new or modified stationary source. Ecology permit writers determine BACT using a "top-down" approach as described in the EPA's draft *New Source Review Workshop Manual: Prevention of Significant Deterioration and Non-Attainment Area Permitting* (EPA 1990). The following five steps are involved in the top-down process:

- The first step in the top-down analysis is to identify all available control technologies that can be practicably applied for each emission unit.
- The second step is to determine the technical feasibility of potential control options and to eliminate options that are demonstrated to be technically infeasible.
- The third step is to rank all remaining options based on control effectiveness, with the most effective control alternative at the top.
- The fourth step is to evaluate the remaining control alternatives. If the top-ranked control alternative is considered unacceptable based on disproportionate economic, environmental, and/or energy impacts, it is discarded. Justifications for discarding top-ranked control options must be approved by Ecology.
- The fifth and final step is to choose the top-ranked alternative from the list of control options remaining after applying Steps 1 through 4. This option is then required as BACT and the maximum resulting emission rate becomes the emission limitation.

In Washington State, the term BACT refers to the control technology applied to achieve reductions in criteria pollutant emission rates as defined in WAC 173-400-030. This section summarizes the findings and recommended BACT determination.

4.2 STEP 1 AND STEP 2: IDENTIFY FEASIBLE CONTROL TECHNOLOGIES

Commercially available technologies were evaluated for the control of VOCs from the SVE system at Zone A of the Pasco Landfill. Potential VOC control technology options for use at the site were identified by Landau Associates and Ecology as part of an assessment conducted in 2012. VOC control alternatives were evaluated in a report prepared by Landau Associates, titled Final Draft Report: *Soil Vapor Extraction Off-Gas Treatment Assessment, Pasco Landfill – Zone A, Pasco, Washington* (Landau Associates 2012). Landau Associates identified the commercially available technologies in the following sections for use at the site.

4.2.1 DESTRUCTION TECHNOLOGIES

- An LFG flare destroys a significant portion of gaseous VOCs through combustion. However, management of Zone A liquid condensate using an LFG flare has not been demonstrated to be effective and has been disallowed by Ecology; therefore, this option has been ruled out for further use on this project.
- A thermal oxidizer would treat the off-gas from Zone A by heating the process stream for a period of time resulting in VOC destruction. The types of thermal oxidizers considered include: straight thermal oxidizer; recuperative thermal oxidizer; catalytic thermal oxidizer; and regenerative thermal oxidizer (RTO). The presence of chlorinated compounds in the SVE off-gas would quickly contaminate the catalysts in a catalytic thermal oxidizer, which would require frequent change-outs of the catalysts; therefore, this technology is not recommended for this project. Additionally, a recuperative thermal oxidizer is not recommended for this project because the HCl that would be produced would corrode the metal surfaces of the heat exchanger. A straight thermal oxidation unit would result in excessively high utility costs because it would not include heat recovery or the use of catalysts to lower the required oxidation temperature. Of the types of thermal oxidizers available, an RTO would be the most appropriate for controlling VOC emissions from the Zone A SVE system due to its improved thermal efficiency, reduced utility costs, and relative resistance to HCl corrosion.
- Internal combustion engines (ICEs) provide an option to combust gas streams with a high concentration of petroleum-based VOCs. In addition to treating the gas streams, ICEs can be used to generate electrical power. However, these systems are not typically used for an off-gas stream with a significant concentration of chlorinated compounds. Pretreatment of the gas stream prior to introduction to the ICE would be expensive, and is likely to remove components that would provide significant heat to fuel the combustion reaction. Therefore, this technology has been ruled out for use on this project.

4.2.2 SEQUESTRATION TECHNOLOGIES

- Granular-activated carbon (GAC) systems provide VOC treatment by adsorbing contaminants onto GAC media. The available surface area for active adsorption typically ranges from 5 to 10 acres per ounce of GAC media. This large surface area allows GAC systems to effectively remove a mass of up to 20 percent of its weight in contamination. GAC systems are appropriate for removing a wide range of VOCs from a vapor stream, and are considered a technically feasible control technology for the site. The high concentrations of ketones in the SVE gases, however, would limit their effectiveness since ketones are not readily adsorbed by GAC.

4.2.3 EMERGING TECHNOLOGIES

- Biofiltration involves passing the off-gas through a wet biologically active filter bed. When the vapor stream passes through the filter, contaminants are retained for degradation by micro-organisms such as bacteria, heterotrophs, oligotrophs, and fungi. Prior to biofiltration, the waste stream would go through a number of pre-treatment processes to remove particulates, equalize the flow, and adjust the humidity and temperature to maintain the optimum conditions for the micro-organisms. The treatment process generally produces end products of carbon dioxide, water, and mineral salts. Biofiltration can treat a variety of VOCs, but are of particular relevance to the treatment of benzene, toluene, ethylbenzene, and xylene compounds. However, achieving reliable removal efficiencies can be problematic due to the variable nature of biological systems. Also, high contaminant concentrations and the presence of chlorinated solvents can be toxic to micro-organisms. Therefore, this technology has been ruled out for use on this project.

- Non-thermal plasma technology is another treatment option for this site. A number of non-thermal plasma technologies are available and can provide treatment for a wide variety of pollutants, and generally achieve high DREs. Non-thermal plasma, photolytic, and photocatalytic technologies break down contaminants into free radicals, which re-form principally into carbon dioxide, water vapor, and small amounts of nitrous oxide (N_2O) and nitrogen dioxide (NO_2). The technology uses electrical fields and energetic beams. Similarly, photolytic and photocatalytic technologies use ultraviolet light to break down contaminants. However, because non-thermal plasma technologies are not widely used in large-scale treatment, these technologies are considered emerging and too experimental for application at this site. This technology has been ruled out for use on this project.
- Membrane separation involves passing the vapor stream through a membrane that allows organic vapors to pass through while largely rejecting air molecules. The organic vapors are then condensed and collected in liquid form. Membrane separation is considered a technically feasible control technology for the site.
- Vapor condensation involves cooling the off-gas to condense the contaminants into liquid form. Vapor condensation is considered a technically feasible control technology for the site.

4.3 STEPS 3, 4, AND 5: RANK AND EVALUATE TECHNICALLY FEASIBLE CONTROL TECHNOLOGIES AND RECOMMEND BACT

The commercially available control technologies identified in Section 4.2 as feasible for use on this project are ranked below based on their effectiveness for controlling VOCs.

1. An RTO would provide a VOC DRE of at least 98 percent as guaranteed by GCE.
2. A GAC system could provide a VOC control effectiveness of at least 98 percent. However, GAC does not remove ketones from vapor streams as effectively as other VOCs. Several ketones are present in the off-gas from Zone A including methyl ethyl ketone, methyl isobutyl ketone, and acetone. Acetone, for example, adsorbs to activated carbon at only 4 percent the rate of toluene based on adsorption isotherms presented by a manufacturer of activated carbon filters (Shepherd 2001). Additionally, since this is a sequestration technology, the contaminants are not destroyed, simply bound to the GAC media and would require subsequent treatment.
3. Membrane separation or vapor condensation could provide a VOC control effectiveness of at least 98 percent. However, these technologies do not destroy the contaminants, and no end-use has been identified. Therefore, the collected contamination would likely be transported off site for treatment as a hazardous waste. Also, because the technologies are relatively new, and not often used in similar processes, there is risk that treatment will not reliably achieve the DREs observed with other options.

While all of the control technologies presented above generally provide high removal efficiencies (98 percent or greater), an RTO is the only technology that has been proven to provide a consistently high DRE for all contaminants identified in the Zone A SVE stream. Additionally, GAC, membrane separation, and vapor condensation systems do not destroy the contaminants and would require subsequent treatment and/or disposal options.

Based on the information presented in Sections 4.2 and 4.3, an RTO is recommended for implementation as BACT.

4.4 TBACT FOR ACID GAS

TAPs other than VOCs emitted by the RTO at rates exceeding the SQERs include HCl and HF, collectively referred to as acid gas. Control of acid gas from the RTO would require the use of a wet scrubber. An economic evaluation was conducted to determine whether installing a wet scrubber would be cost-prohibitive based on the Hanford Method.[1] Air toxics BACT (tBACT) cost-effectiveness calculation tables were provided to Ecology on July 2, 2014 (Brunner 2014).

Using the Hanford Method, the economic evaluation determined that the cost for removing acid gas based on an average VOC mass loading to the inlet of the RTO would be approximately $42,700 per ton of acid gas removed. Using the Hanford Method, the calculated "ceiling" cost for removing acid gas is $36,500. Ecology typically considers costs greater than the Hanford ceiling cost to be disproportionately expensive. The treatment cost of $42,700 exceeds the cost-effectiveness threshold; therefore, a wet scrubber is rejected as tBACT on the basis of the disproportionate cost analysis.

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[1] The Hanford Method for evaluating cost effectiveness of control technologies is documented in a report titled, *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (Haass et al. 2010).

5.0 AMBIENT AIR QUALITY IMPACT ANALYSIS (SECTION IX OF NOC APPLICATION FORM)

This section presents the air dispersion modeling results and provides a comparison of the results to the National Ambient Air Quality Standards (NAAQS) and Washington Ambient Air Quality Standards (WAAQS) for criteria pollutants and the Washington State Acceptable Source Impact Levels (ASILs) for TAPs. Air dispersion model input and output files are provided in electronic format in Appendix B.

5.1 FIRST-TIER COMPARISON OF TOXIC AIR POLLUTANT EMISSION RATES TO SMALL-QUANTITY EMISSION RATE EXEMPTION THRESHOLDS

As an alternative to atmospheric dispersion modeling, compliance with ASILs—the ambient air quality standards for TAPs under Washington State regulations—may be demonstrated by comparing air pollutant emission rates with screening thresholds [small-quantity emission rates (SQERs)] that Ecology has determined to be protective of ambient air quality. The provision for demonstration of compliance with ASILs for TAP emissions through a comparison to SQERs is described in WAC 173-460-080(2)(b). Some TAPs (CO, SO_2, and NO_2) also have corresponding NAAQS and/or WAAQS values and, therefore, require air dispersion modeling to demonstrate compliance with ambient air quality standards regardless of whether they exceed the SQER values.

Table 4 provides a comparison between the RTO emission rates for TAPs and the SQERs identified in WAC 173-460-150. As shown in Table 4, benzene, ethylbenzene, methylene chloride, trichloroethene, vinyl chloride, HCl, HF, and 1,2-dichloroethane are the only TAPs to exceed their SQER and will therefore require an evaluation of ambient impacts using air dispersion modeling. All other TAPs have emission rates that are less than the SQER values, demonstrating compliance with ambient air impact demonstration requirements for TAPs under WAC 173-460-080(2)(b).

5.2 AIR DISPERSION MODELING – MODEL AND MODEL ASSUMPTIONS

Table 4 presents the emission rates for the criteria pollutants. As indicated in Section 2.2 and shown in Table 4, the emission rate for VOCs exceeds the *de minimis* threshold of 2.0 tons per year. Therefore, air dispersion modeling to demonstrate compliance with ambient air quality standards is required for criteria pollutants CO, SO_2, NO_2, PM_{10}, and $PM_{2.5}$.[2]

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[2] PM_{10} and $PM_{2.5}$ are particulate matter with an aerodynamic diameter less than or equal to 10 microns and less than or equal to 2.5 microns, respectively.

Air dispersion modeling was conducted in general accordance with the EPA's *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions* (EPA 2005b). The American Meteorological Society (AMS)/EPA Regulatory Model (AERMOD) Version 14134 was used to estimate ambient pollutant concentrations at the facility's fenceline associated with emissions from the facility. AERMOD was used to calculate maximum ambient impact concentrations of criteria pollutants (CO, SO_2, NO_2, PM_{10}, and $PM_{2.5}$) and TAPs (benzene, ethylbenzene, methylene chloride, trichloroethene, vinyl chloride, HCl and 1,2-dichloroethane) that exceeded the SQERs. Note, the maximum ambient impact concentration for HF was calculated using a dispersion factor based on the air dispersion model run for HCl. AERMOD requires input from several models in order to process meteorological parameters, downwash parameters, and terrain heights. The following sections describe these modeling inputs.

5.2.1 STACK PARAMETERS AND PLUME VOLUME MOLAR REACTION MODEL

Emissions from the RTO were modeled as a point source with a stack release height of 20 feet (ft) [6.1 meters (m)]. The stationary stack was modeled with a stack diameter of 1 ft (0.305 m).

Emissions from the RTO were modeled using one of two scenarios depending on the pollutant. Maximum RTO emission rates for PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO will occur when the inlet VOC mass loading rate is lowest and fuel combustion rate is highest. During periods with low inlet VOC mass loading and high fuel usage rates, the stack exit temperature is 150°F [338.7 degrees Kelvin (°K)] and the exit velocity is 33.33 feet per second (ft/sec) [10.16 meters per second (m/sec)]. Maximum RTO emission rates for VOCs and HCl will occur when the inlet VOC mass loading rate is highest. During periods with high inlet VOC mass loading rates, the stack exit temperature is 450°K and the exit velocity is 66.66 ft/sec (20.32 m/sec). Stack parameters are summarized in Table 5.

Ambient NO_2 concentrations caused by the combustion of fuel were modeled using the Plume Volume Molar Reaction Model (PVMRM) module of AERMOD. It was assumed that the primary NO_2 emission rate was 10 percent of the primary emission rate for nitrogen oxides (NO_x), which is the same assumption that Ecology has required for PVMRM modeling for other industrial facilities in Washington. Site-specific coordinates were used to obtain an ambient ozone concentration of 51 parts per billion from Washington State University's (WSU) NW Airquest webpage (WSU website 2014).

5.2.2 STACK HEIGHTS AND BUILDING DOWNWASH INPUT PARAMETER MODELING

All existing and proposed structures within the fenceline surrounding the RTO were input to the AERMOD model to account for potential building downwash. Building downwash occurs when the aerodynamic turbulence induced by nearby buildings causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground-level concentrations. Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) was used to determine if exhaust from emission units would be affected by nearby building structures. In general, these determinations are made if a stack's height is less than the height defined by the EPA's Good Engineering Practice (GEP) stack height. GEP stack height is defined as the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack, plus 1.5 times the lesser dimension, height, or projected width of the nearby structure(s). The proposed stack height is lower than GEP stack height.

5.2.3 RECEPTOR GRID SPACING AND TERRAIN HEIGHT INPUT MODELING

The air quality compliance boundary was set at the fenceline surrounding the RTO. This compliance boundary represents the closest location where passersby could conceivably be exposed to emissions from the proposed RTO.

Receptor heights for receptors at or beyond the air quality compliance boundary were set at 4.9 ft (1.5 m) above ground height to approximate the human breathing zone height. To model complex terrain, AERMOD requires information about the surrounding terrain. This information includes a height and a base elevation for each receptor. The AMS/EPA Regulatory Model Terrain Pre-processor (AERMAP) was used to obtain a height scale and the base elevation for a receptor, and to develop receptor grids with terrain effects.

The general approach to the Cartesian receptor grid placement was as follows:

- 33-ft (10-m) spacing from emission source to 1,148 ft (350 m)
- 82-ft (25-m) spacing from 1,148 ft (350 m) to 2,625 ft (800 m)
- 164-ft (50-m) spacing from 2,625 ft (800 m) to 13,123 ft (4,000 m).

AERMAP requires the use of topographic data to estimate surface elevations above mean sea level. For the Pasco Landfill, Shuttle Radar Topography Mission (SRTM) data were downloaded from the Web-GIS website (http://www.webgis.com/). The SRTM data used for this project have a resolution of approximately 98 ft (30 m; 1 arc-second).

AERMAP produces a Receptor Output File (*.rou) containing the calculated terrain elevations and scale height for each receptor. The *.rou file was used as an input runstream file (AERMOD Input File) for the Receptor Pathway in the Terrain Options page of the Control Pathway. AERMAP also produces a Source Output File (*.sou). This file contains the calculated base elevations for all sources.

5.2.4 METEOROLOGICAL INPUT PARAMETER MODELING

The AERMOD Meteorological Pre-processor (AERMET) is the pre-processor model that estimates boundary layer parameters for use in AERMOD. AERMET processes three types of meteorological input data in three stages, and from this process it generates two input files for the AERMOD model. The two AERMOD input files produced by AERMET are the Surface File with hourly boundary layer parameter estimates and the Profile File with multi-level observations of wind speed, wind direction, temperature, and standard deviations of fluctuating wind components. The three types of AERMET input data are described below and consist of surface observations, upper air soundings, and site-specific data.

Five years of hourly surface data were used for AERMET from the National Weather Service (NWS) hourly surface observations, taken from Tri-Cities Airport, which is located approximately 2.5 miles west of the Pasco Landfill. The 5 years of data processed cover the period 2007 to 2011.

Five years of upper air data were used for AERMET from the NWS twice-daily upper air soundings from Spokane, Washington. The 5 years of data processed cover the period 2007 to 2011.

The site-specific data required for AERMET include albedo, Bowen ratio, and surface roughness. Albedo is a measure of the solar radiation reflected back from earth into space. The Bowen ratio is an evaporation-related measurement and is defined as the ratio of sensible heat to latent heat. The surface roughness length is the theoretical height above ground where the wind speed becomes zero. Source information for the hourly surface air, upper air, and site-specific meteorological data is summarized in Table 6.

The facility does not have an instrumentation tower to record site-specific meteorological parameters for use in AERMET. Therefore, site-specific data were approximated based on the surface data meteorological tower at Tri-Cities Airport. Land use conditions at Tri-Cities Airport are similar to the area surrounding the Pasco Landfill, which is approximately 2.5 miles away. The Pasco Landfill and the Tri-Cities Airport are within close proximity, they are at approximately the same elevation, and areas to the north of both sites are dominated by agriculture. Therefore, surface roughness, albedo, and Bowen ratio are assumed to be sufficiently similar for modeling purposes.

AERSURFACE was used to approximate the albedo, Bowen ratio, and surface roughness within 12 equal sectors of a circle that has a 0.62-mile (1-kilometer) radius and is centered on the surface station tower at the Tri-Cities Airport. Looking at each sector individually, AERSURFACE determined the percentage of land-use type within each sector. Land cover data from the U.S. Geological Survey National Land Cover Data 1992 archives were used as an input to AERSURFACE (USGS 1992). Default seasonal categories were used in AERSURFACE to represent the four seasonal categories as follows: 1) midsummer with lush vegetation; 2) autumn with unharvested cropland; 3) late autumn after frost and harvest, or winter with no continuous snow; and 4) transitional spring with partial green coverage or short annuals.

5.3 CRITERIA AIR POLLUTANT IMPACTS

NAAQS set by the EPA include both primary and secondary standards for criteria pollutants. Primary standards are designed to establish limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Air dispersion modeling was conducted using emissions from the proposed RTO to show compliance with the NAAQS and WAAQS. To estimate worst-case ambient impacts of criteria pollutants, it was conservatively assumed that the new emission source would operate at its maximum emission rate 24 hours per day, 365 days per year, and the AERMOD model automatically selected the maximum impact.

The 24-hour average $PM_{2.5}$ NAAQS is based on the 3-year rolling average of the 98th-percentile daily average impact in each year. Demonstration with the 24-hour average $PM_{2.5}$ NAAQS is typically accomplished by modeling the 8th highest impact for each year of meteorological data and calculating the highest 3-year rolling average. However, for this project the 1st highest 24-hour average $PM_{2.5}$ impact was conservatively modeled for each year of meteorological data and the highest 3-year rolling average was calculated. The results for each model and the calculated 3-year rolling average are provided in Microsoft Excel format in Appendix B.

The 1-hour average NO_2 NAAQS is based on the 3-year rolling average of the 98th-percentile of the highest daily 1-hour average NO_2 impact in each year. Demonstration with the 1-hour average NO_2 NAAQS is typically accomplished by modeling the 8th highest impact for each year of meteorological data and calculating the highest 3-year rolling average. However, for this project the 1st highest 1-hour average NO_2 impact from the PVMRM model was conservatively modeled for each year of meteorological data and the highest 3-year rolling average was calculated. The results for each model and the calculated 3-year rolling average are presented in Excel format in Appendix B.

A summary of NAAQS compliance modeling is provided in Table 7. The listed ambient impacts include the emissions from the proposed RTO and "regional background" levels. In all cases, the modeled ambient impacts caused by emissions of criteria air pollutants are well below the NAAQS limits. Detailed descriptions of the ambient impact assessments for the key criteria air pollutants are provided in the following sections.

5.3.1 REGIONAL BACKGROUND VALUES

This evaluation included "regional background" values contributed by existing regional emission sources in the project vicinity (e.g., permitted sources, highway vehicles, area sources). Regional background values were obtained from WSU's NW Airquest webpage (WSU website 2014) based on state-wide grid modeling of all identified sources in the state. The reported regional background values are as follows:

NO_2 (1-hour average)	43 micrograms per cubic meter ($\mu g/m^3$)
NO_2 (annual average)	8.1 $\mu g/m^3$
CO (1-hour average)	1,358 $\mu g/m^3$
CO (8-hour average)	846 $\mu g/m^3$
SO_2 (1-hour average)	12 $\mu g/m^3$
SO_2 (3-hour average)	10 $\mu g/m^3$
SO_2 (24-hour average)	3.9 $\mu g/m^3$
SO_2 (annual average)	1.3 $\mu g/m^3$
$PM_{2.5}$ (24-hour average)	19 $\mu g/m^3$
$PM_{2.5}$ (annual average)	6.5 $\mu g/m^3$
PM_{10} (24-hour average)	111 $\mu g/m^3$.

5.3.2 NAAQS COMPLIANCE

Maximum ambient impacts for the following criteria pollutants are presented in Table 7:

- CO (1-hour and 8-hour averaging periods)
- NO_2 (1-hour and annual averaging periods)
- SO_2 (1-hour, 3-hour, 24-hour, and annual averaging periods)
- Total suspended particulates (24-hour and annual averaging periods)
- PM_{10} (24-hour and annual averaging periods)
- $PM_{2.5}$ (24-hour and annual averaging periods).

The criteria pollutant impacts presented in Table 7 include the contributions from the proposed RTO and regional background levels. As shown in Table 7, the modeled criteria pollutant impacts are below the NAAQS and WAAQS limits.

5.4 TOXIC AIR POLLUTANT IMPACTS

The AERMOD dispersion model was used to model the impacts for TAPs with estimated emission rates that would be above the SQERs. The maximum ambient impact concentration for HF was derived using a dispersion factor derived from the HCL modeling[3] and is presented in Table 7 (see Table 8 for calculations). The maximum ambient impact concentration for individual VOCs with emission rates that exceeded the SQERs are presented in Table 7 and to provide an operational safety factor are based on emission rates that are double the emission rates presented in Table 4. As presented in Table 7, the maximum modeled ambient impact concentrations of HF, benzene, 1,2-dichloroethane, ethylbenzene, methylene chloride, trichloroethene, and vinyl chloride at all points at or beyond the air quality compliance boundary are less than the ASIL; therefore, the proposed RTO satisfies the first-tier requirements for those TAPs. However, the maximum modeled 24-hour average ambient concentration of HCl exceeds the ASIL; therefore, a second-tier risk review is required for the proposed action.

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[3] When stack parameters (i.e., exhaust exit velocity, temperature, and stack diameter and height) and meteorological inputs in an air dispersion model remain unchanged, changes to the maximum modeled ambient concentrations for non-reactive compounds are directly proportional to changes to the emission rate input for a specific time-weighted average. For example, ambient impacts for HF and HCl both require comparison to an ASIL developed based on a 24-hour time-weighted average; therefore, because ambient impacts for HCl have already been modeled and there are no differences between the stack parameters and meteorological inputs, a dispersion factor (based on the HCl model run) can be used to calculate the maximum HF impact without running a separate model for HF.

6.0 PROPOSED EMISSION LIMITS

As discussed with Ecology during a teleconference on September 15, 2014, the IWAG proposes emission limits that are considered protective of human health and the environment and will also allow for operational flexibility of the RTO over a range of mass loading scenarios. The proposed emission limits are presented in Table 9 and a description of how each emission limit was derived is provided below.

For all criteria pollutants—except for VOCs (ozone precursor)—emission limits equal to the NSR exemption level in Table 110(5) of WAC 173-400 are proposed. For all TAPs with maximum calculated emission rates that are below the SQER, emission limits equal to the SQER are proposed.

For total VOCs and individual VOCs with emission rates that exceed the SQERs, the emission limits proposed are equal to the maximum calculated emission rate presented in Table 4 multiplied by a safety factor of two. To demonstrate that the maximum ambient concentrations for those TAPs (with doubled emission rates) are below ASILs, recalculated maximum ambient impacts are presented in Table 8. Maximum ambient impacts were recalculated using a dispersion factor.[4]

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[4] When stack parameters (i.e., exhaust exit velocity, temperature, and stack diameter and height) and meteorological inputs in an air dispersion model remain unchanged, changes to the maximum modeled ambient concentrations are directly proportional to changes to the emission rate input. Therefore, when an emission rate for a TAP changes, the TAP has already been modeled, and there are no changes to the stack parameters in the model, a dispersion factor can be calculated to estimate ambient impacts without re-running the air dispersion model.

7.0 USE OF THIS REPORT

This Notice of Construction Application Supporting Information Report has been prepared for the exclusive use of the IWAG and applicable regulatory agencies for specific application to the proposed RTO installation at the Pasco Sanitary Landfill in Pasco, Washington. The reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

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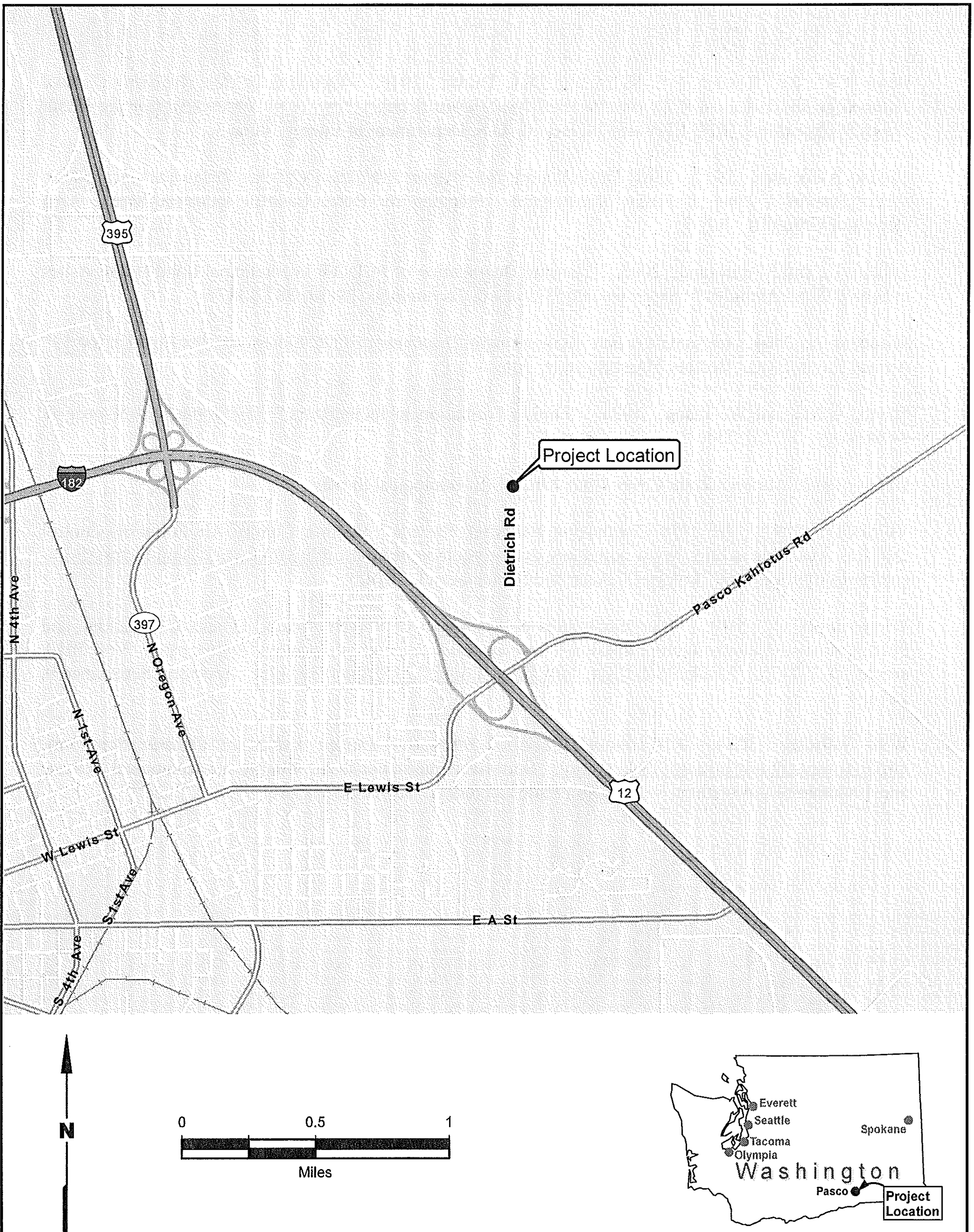

Data Source: Esri 2012

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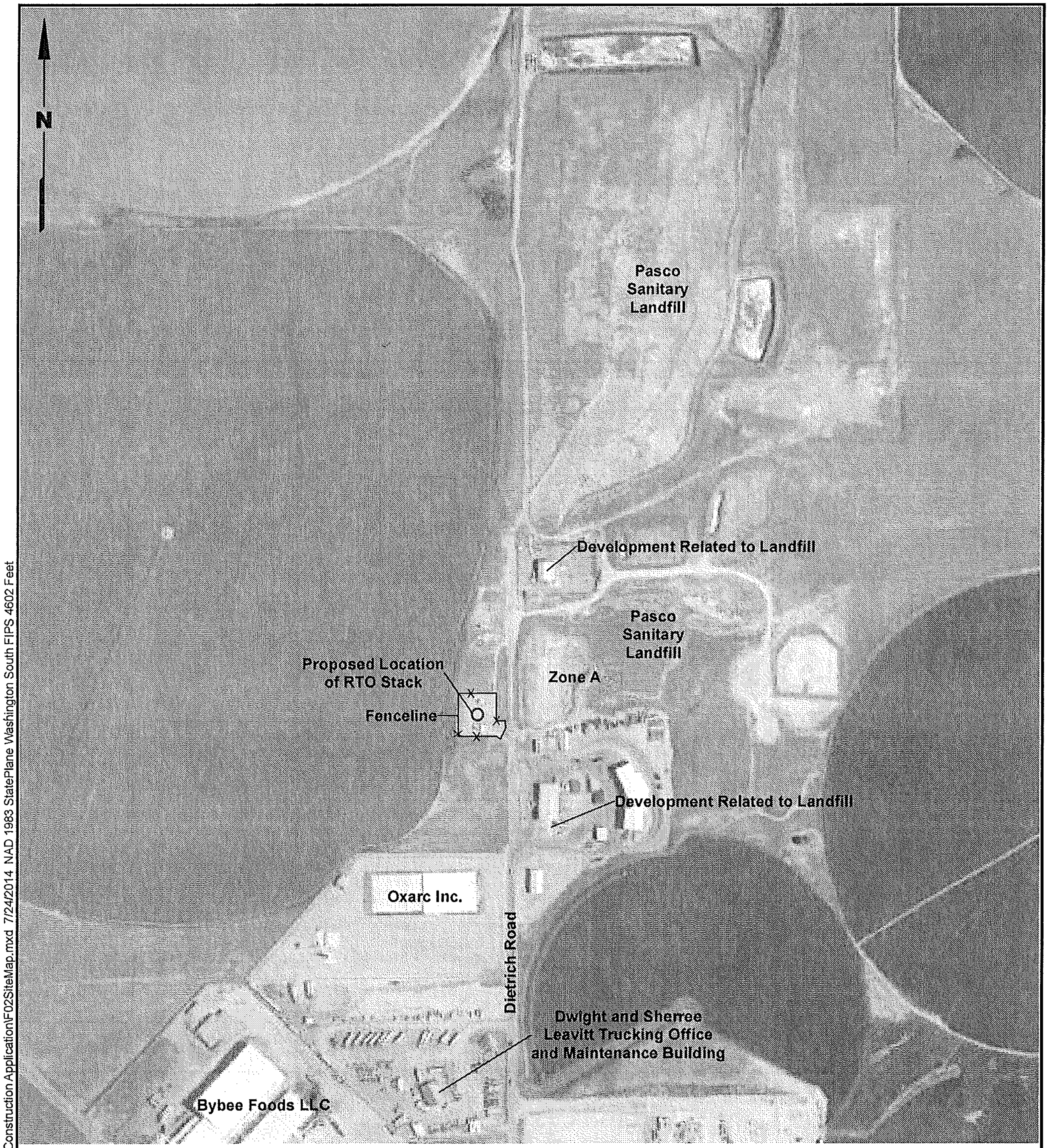
Landau Associates

Pasco Sanitary Landfill
Pasco, Washington

Vicinity Map

Figure
1



Legend

○ Proposed Location of RTO Stack

×— Fenceline

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 600 1,200

Scale in Feet

Data Source: 2014 Google © USGS

G:\Projects\1295\001\010\014\Notice of Construction Application\F02SiteMap.mxd 7/24/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

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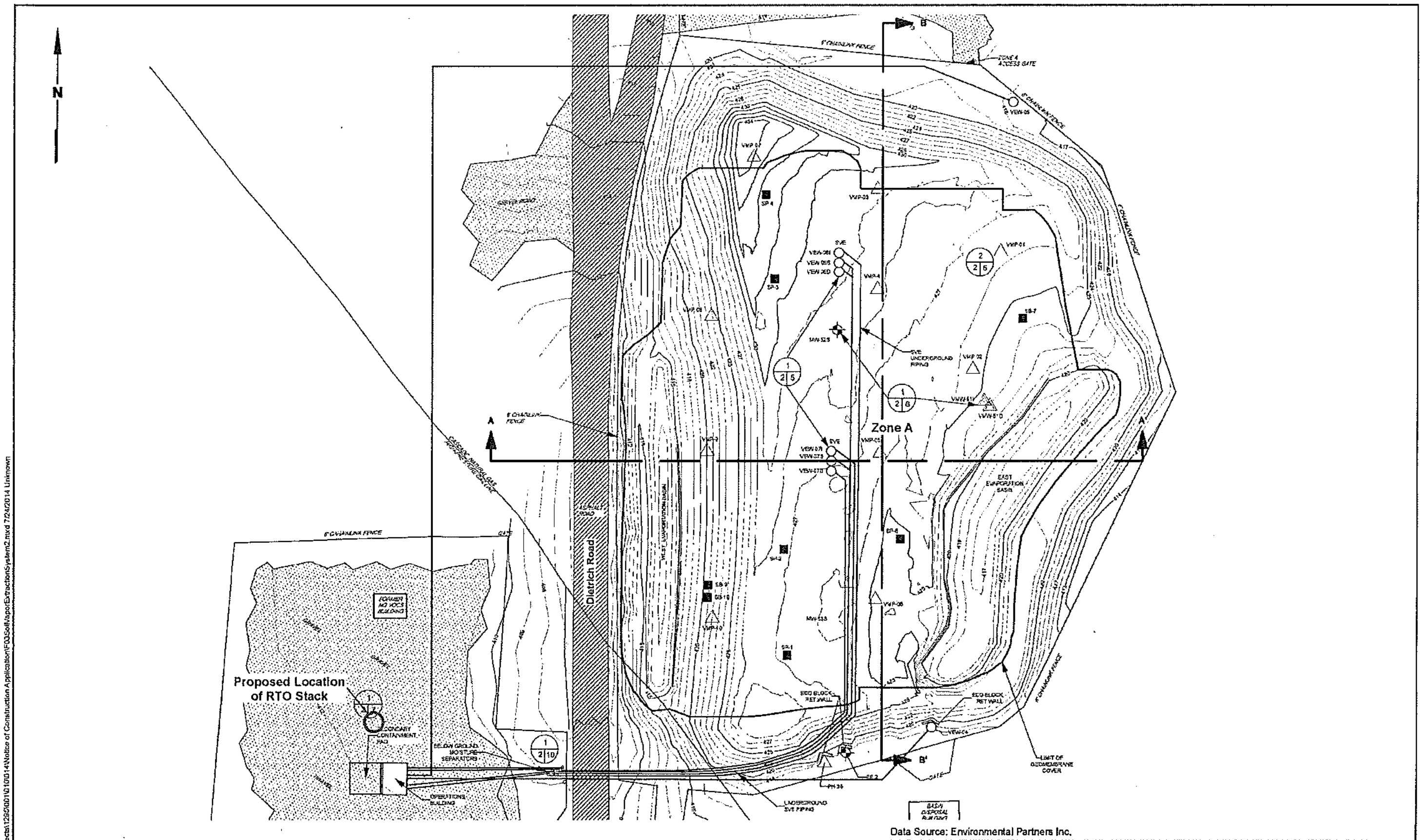
Pasco Sanitary Landfill Pasco, Washington	**Site Map**	Figure 2



Data Source: Environmental Partners Inc.

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Pasco Sanitary Landfill
Pasco, Washington

Soil Vapor Extraction System

Figure
3

TABLE 1
EMISSION RATES FOR REGENERATIVE THERMAL OXIDIZER PROCESS STREAM
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

SVE Vapor Analytical Data			Untreated Emissions		Condensate		RTO Outlet (98% DRE)	
VOC Compounds	Average Concentration (µg/L)	Maximum Concentration (µg/L)	Emissions Rate (lbs/day)	Emissions Rate (lbs/year)	Contribution from Condensate µg/L (cond)	Contribution from Condensate (lbs/day)	Emissions Rate (lbs/day)	Emissions Rate (lbs/year)
1,1,1-Trichloroethane	47	200	17.98	6,568.08	180	0.0004	0.36	131.36
1,1-Dichloroethane	32	46	4.14	1,510.66	190	0.0005	0.08	30.22
1,1-Dichloroethene	1.6	18	1.62	591.13	3	0.0000	0.03	11.82
1,2,4-Trimethylbenzene	65	110	9.89	3,612.44	18	0.0000	0.20	72.25
1,2-Dichlorobenzene	3.3	17	1.53	558.29	260	0.0006	0.03	11.17
1,2-Dichloroethane	31	55	4.95	1,806.22	680	0.0016	0.10	36.14
1,2-Dichloropropane	1.1	1.1	0.10	36.12			0.002	0.72
1,3,5-Trimethylbenzene	39	54	4.86	1,773.38	630	0.0015	0.10	35.48
1,4-Dichlorobenzene	0.4	2	0.18	65.68	24	0.0001	0.004	1.31
2-butanone (MEK)	3,458	9,300	836.18	305,415.80	720,000	1.7306	16.76	6,120.96
2-Hexanone (MBK)	22	28	2.52	919.53	18,000	0.0433	0.05	18.71
4-Methyl-2-pentanone (MIBK)	758	1,100	98.90	36,124.45	150,000	0.3605	1.99	725.12
Acetone	2,539	9,700	872.15	318,551.96	720,000	1.7306	17.48	6,383.68
Benzene	4.1	22	1.98	722.49	25	0.0001	0.04	14.45
Carbon disulfide	0.30	0.39	0.04	12.81			0.001	0.26
Chlorobenzene	0.7	4.1	0.37	134.65	7	0.0000	0.007	2.69
Chloroethane	2.6	15	1.35	492.61	11	0.0000	0.03	9.85
Chloroform	2.1	8.9	0.80	292.28	9	0.0000	0.02	5.85
Chloromethane	2.2	12	1.08	394.08	5	0.0000	0.02	7.88
cis-1,2-Dichloroethene	7.0	36	3.24	1,182.25	46	0.0001	0.06	23.65
Dichlorodifluoromethane (CFC-12)	2.2	7.7	0.69	252.87			0.01	5.06
Ethanol	1,046.2	7,000	629.38	229,882.86	3,300,000	7.9319	12.75	4,655.60
Ethylbenzene	396	550	49.45	18,062.22	2,500	0.0060	0.99	361.29
Isopropylbenzene	13	77	6.92	2,528.71	140	0.0003	0.14	50.58
m,p-Xylene	1,221	1,700	152.85	55,828.69	9,200	0.0221	3.06	1,116.74
Methylene chloride	535	820	73.73	26,929.14			1.47	538.58
Naphthalene	1.1	7.4	0.67	243.02	1,200	0.0029	0.01	4.88
n-butylBenzene	2.0	7.4	0.67	243.02	57	0.0001	0.01	4.86
n-propylbenzene	24	98	8.81	3,218.36	300	0.0007	0.18	64.37
o-Xylene	340	460	41.36	15,106.59	3,900	0.0094	0.83	302.20
p-Isopropyltoluene	1.2	4.9	0.44	160.92	26	0.0001	0.009	3.22
Tetrachloroethene	31	39	3.51	1,280.78	140	0.0003	0.07	25.62
Toluene	5,796	9,600	863.16	315,267.92	21,000	0.0505	17.26	6,305.73
Total Xylenes	1,561	2,160	194.21	70,935.28	13,100	0.0315	3.88	1,418.94
trans-1,2-Dichloroethene	0.2	0.32	0.03	10.51			0.001	0.21
Trichloroethene	327	500	44.96	16,420.20	1,400	0.2019	0.90	329.88
Trichlorofluoromethane (CFC-11)	23	69	6.20	2,265.99	2	0.0003	0.12	45.32
Vinyl chloride	1.0	5.1	0.46	167.49	1	0.0001	0.009	3.35
Acid Gas (HCl)	-	-	-	-			118.05	43,116.85
Acid Gas (HF)	-	-	-	-			2.940	1,073.84
Total VOC Emissions			3,941	1,439,326			79	28,875

Notes:

Loading in lbs/day = (X) µg/L x 28.32 L/cubit foot x (Y) cubic feet/min x 0.002205 lbs/gram / 1,000,000 µg/gram x 1,440 minutes/day

--	Not applicable
lbs	Pounds
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
VOC	Volatile organic compound

Flow rate:

1,000.00	cubic feet / min
12.00	gallons / hr

Acid Gas Influent:	Total lb/day	Elemental Cl lb/day
TCE	45.16	36.55
Methylene Chloride	73.73	61.55
	Sum Cl = >	98.1
	HCl in Effluent (preliminary)= >	100.9
HCl in effluent (scaled-up for other contributors)		118
Dichlorodifluoromethane (CFC-12)	0.69	0.22
Trichlorofluoromethane (CFC-11)	6.20	2.57
	Sum F = >	2.8
	HF in Effluent (preliminary)= >	2.9

Acid gas emissions calculations assume all influent elemental chlorine/fluorine combines with hydrogen, which is assumed to be present in excess of the stoichiometric requirement for complete conversion.
Scale-up factor based on TCE and methylene chloride making up 85% of chlorinated compounds.

TABLE 2
REPRESENTATIVE EMISSION RATES BASED ON 20 PPMV TOTAL VOCs AT STACK OUTLET
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Avagadros number	6.023E+23
10^6 molecules of air (moles)	1.6603E-18
R (L atm/ K mol)	0.0821
Temp (K)	298.15
Pressure (atm)	1

VOC Compounds	Molecular Weight	Normalized ratio of average VOCs (a)	RTO Outlet Concentration (b)		RTO Outlet Emission Rate (b)	
			PPMv	µg/L	lb/day	lbs/year
1,1,1-Trichloroethane	133.40	0.0026	0.051	0.28	0.000025	0.0091
1,1-Dichloroethane	98.96	0.0017	0.035	0.14	0.000013	0.0046
1,1-Dichloroethene	96.94	0.000087	0.0017	0.0069	0.00000062	0.00023
1,2,4-Trimethylbenzene	120.20	0.0036	0.071	0.35	0.000031	0.011
1,2-Dichlorobenzene	147.00	0.00018	0.0036	0.022	0.0000019	0.00071
1,2-Dichloroethane	98.96	0.0017	0.034	0.14	0.000012	0.0045
1,2-Dichloropropane	113.00	0.000060	0.0012	0.0055	0.00000050	0.00018
1,3,5-Trimethylbenzene	120.20	0.0021	0.042	0.21	0.000019	0.0068
1,4-Dichlorobenzene	147.00	0.000021	0.00041	0.0025	0.00000022	0.000082
2-butanone (MEK)	72.10	0.19	3.8	11	0.0010	0.36
2-Hexanone (MBK)	100.10	0.0012	0.024	0.10	0.0000090	0.0033
4-Methyl-2-pentanone (MIBK)	100.20	0.041	0.83	3.4	0.00030	0.11
Acetone	58.08	0.14	2.8	6.6	0.00059	0.22
Benzene	78.11	0.00022	0.0045	0.014	0.0000013	0.00047
Carbon disulfide	76.14	0.000016	0.00033	0.0010	0.000000091	0.000033
Chlorobenzene	112.60	0.000039	0.00079	0.0036	0.00000032	0.00012
Chloroethane	64.52	0.00014	0.0028	0.0075	0.00000067	0.00025
Chloroform	119.40	0.00011	0.0023	0.011	0.0000010	0.00037
Chloromethane	50.49	0.00012	0.0024	0.0049	0.00000044	0.00016
cis-1,2-Dichloroethene	96.94	0.00038	0.0076	0.030	0.0000027	0.00099
Dichlorodifluoromethane (CFC-12)	120.90	0.00012	0.0024	0.012	0.0000011	0.00039
Ethanol	46.07	0.057	1.1	2.1	0.00019	0.070
Ethylbenzene	106.20	0.022	0.43	1.9	0.00017	0.061
Isopropylbenzene	120.19	0.00068	0.014	0.067	0.0000060	0.0022
m,p-Xylene	106.20	0.067	1.3	5.8	0.00052	0.19
Methylene chloride	84.94	0.029	0.58	2.0	0.00018	0.066
Naphthalene	128.17	0.000060	0.0012	0.0063	0.00000056	0.00021
n-butylBenzene	134.22	0.00011	0.0022	0.012	0.0000011	0.00039
n-propylbenzene	120.19	0.0013	0.026	0.13	0.000012	0.0042
o-Xylene	106.20	0.019	0.37	1.6	0.00014	0.053
p-Isopropyltoluene	134.22	0.000065	0.0013	0.0072	0.00000065	0.00024
Tetrachloroethene	165.80	0.0017	0.034	0.23	0.000020	0.0075
Toluene	92.14	0.32	6.3	24	0.0021	0.78
Total Xylenes	106.17	0.085	1.7	7.4	0.00066	0.24
trans-1,2-Dichloroethene	96.94	0.000013	0.00026	0.0010	0.000000093	0.000034
Trichloroethene	131.39	0.018	0.36	1.9	0.00017	0.063
Trichlorofluoromethane (CFC-11)	137.40	0.0013	0.025	0.14	0.000013	0.0046
Vinyl chloride	62.50	0.000055	0.0011	0.0028	0.00000025	0.000091
Total VOC Emissions			20	70	0.0062	2.3

Notes:

ppmV = Parts per million by volume

µq/L = Micrograms per liter

lbs/day = Pounds per day

lbs/year = Pounds per year

RTO = Regenerative Thermal Oxidizer

(a) Normalized ratio for each compound based on average soil vapor analytical results from Zone A of landfill.

(b) Estimated concentrations and emission rates assume that all compounds have an equal destruction and removal efficiency.

TABLE 3
EMISSION RATES FOR REGENERATIVE THERMAL OXIDIZER FUEL COMBUSTION
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Natural Gas Usage During Start-up (scfh)	750
Natural Gas Heat Input During Start-up (MMBTU/ hour)	0.765
Natural Gas Heat Input During Start-up (MMBTU/year)	18
RTO Operating in Start-up Condition (hours/year)	24
Natural Gas Usage During Regular Operation (scfh)	75
Natural Gas Heat Input During Regular Operation (MMBTU/ hour)	0.077
Natural Gas Heat Input During Regular Operation (MMBTU/year)	668
RTO Operating in Regular Operating Condition (hours/year)	8,736
Heat Value of Natural Gas (BTU/cf Natural Gas)	1020

			RTO Emissions Natural Gas or Propane Combustion			
Pollutants	Natural Gas or Propane-Fired Emission Factors (lb/MMBTU)(f)	Emission Factor Source	lb/hr	lbs/day	lb/yr	tons/yr
Sulfur Dioxide (SO_2)	5.9E-04	(a)	4.5E-04	1.5E-03	4.0E-01	0.0002
Nitrogen Oxides (NO_x)	2.7E-01	(a)	2.1E-01	6.9E-01	1.9E+02	0.09
Carbon Monoxide (CO)	--	(d)	1.0E-01	2.4E+00	8.8E+02	0.44
PM10/ PM2.5 (e)	7.7E-03	(b)	5.9E-03	1.9E-02	5.3E+00	0.003
HC/VOCs	5.4E-03	(a)	4.1E-03	1.4E-02	3.7E+00	0.002
Acetaldehyde	4.2E-05	(c)	3.2E-05	1.1E-04	2.9E-02	0.000014
Acrolein	9.8E-06	(c)	7.5E-06	2.5E-05	6.7E-03	0.0000
Benzene	1.6E-04	(c)	1.2E-04	3.9E-04	1.1E-01	0.00005
Ethylbenzene	1.4E-03	(c)	1.1E-03	3.6E-03	9.7E-01	0.0005
Formaldehyde	1.1E-03	(c)	8.8E-04	2.9E-03	7.9E-01	0.000393
Hexane	2.8E-05	(c)	2.2E-05	7.2E-05	2.0E-02	0.00001
Naphthalene	1.1E-05	(c)	8.3E-06	2.7E-05	7.4E-03	0.00000
Nitrogen Dioxide (NO_2)	2.7E-02	(a)	2.1E-02	6.9E-02	1.9E+01	0.009
Propylene	2.4E-03	(c)	1.8E-03	6.0E-03	1.6E+00	0.00082
Toluene	5.7E-05	(c)	4.4E-05	1.4E-04	3.9E-02	0.0000
Total Xylenes	2.8E-05	(c)	2.2E-05	7.2E-05	2.0E-02	0.00001

Notes:
(a) Emission factors from EPA's AP-42, Volume I, Chapter 1.4, which provides pollutant emission factors for natural gas combustion (EPA 1995).
(b) Emission factors from EPA's AP-42, Volume I, Chapter 1.5, which provides pollutant emission factors for propane combustion (EPA 1995).
(c) Emission factors from Ventura County Air Pollution Control District's AB 2588, Combustion Emission Factors for Natural Gas Fired External Combustion Flare.
(d) The maximum hourly CO emission rate associated with natural gas combustion provided by GCE.
(e) For the purposes of this evaluation, the PM2.5 emission factor was conservatively assumed to be equal to the emission factor for PM10.
(f) The highest emission factor was chosen for each compound between natural gas and propane emission factors.
scfh = Standard cubic feet per hour

Example Calculation for SO2 Emission Rates:

$$750\ SCFH \times 1020\ \frac{BTU}{ft^3\ Nat\ Gas} \div 1{,}000{,}000\ \frac{BTU}{MMBTU} \times 0.000588\ \frac{lbs\ SO2}{MMBTU} = 0.00045\ \frac{lbs\ SO2}{hour}$$

$$0.00045\ \frac{lbs\ SO2}{hour} \times 8{,}760\ \frac{hours}{year} = 3.9\ \frac{lbs}{year}$$

$$3.9\ \frac{lbs}{year} \times 2{,}000\ \frac{lbs}{ton} = 0.0020\ \frac{tons}{year}$$

TABLE 4
EMISSION-BASED EXEMPTION EVALUATION
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Pollutant	Maximum Pollutant Emission Totals				Registration Program Exemption Threshold						Modeling Reqd? (Y/N) (b)
	Max Hourly (lbs/hr)	Max Daily (lbs/day)	Annual (tons/yr)	Annual (lbs/yr)	Criteria Pollutants (a)		TAPs (b)		TAP SQER (c)		
PM (Total)	5.9E-03	1.9E-02	2.6E-03	5.3E+00	1.25	tons/yr	--		--		Y (Criteria)
PM_{10}	5.9E-03	1.9E-02	2.6E-03	5.3E+00	0.75	tons/yr	--		--		Y (Criteria)
$PM_{2.5}$	5.9E-03	1.9E-02	2.6E-03	5.3E+00	0.5	tons/yr	--		--		Y (Criteria)
Nitrogen Oxides (NO_x)	2.1E-01	6.9E-01	9.4E-02	1.9E+02	2	tons/yr	--		--		Y (Criteria)
Carbon Monoxide (CO)	1.0E-01	2.4E+00	4.4E-01	8.8E+02	5	tons/yr	1.14	lbs/hr	50.4	lbs/hr	Y (Criteria)
Volatile Organic Compounds (VOC)	3.3E+00	7.9E+01	**1.4E+01**	2.9E+04	2	tons/yr	--		--		N
Sulfur Dioxide (SO_2)	4.5E-04	1.5E-03	2.0E-04	4.0E-01	2	tons/yr	0.457	lbs/hr	1.45	lbs/hr	Y (Criteria)
1,1,1-Trichloroethane	1.5E-02	3.6E-01	6.6E-02	1.3E+02	--		6.57	lbs/day	131	lbs/day	N
1,1-Dichloroethane	3.4E-03	8.3E-02	1.5E-02	**3.0E+01**	--		6	lbs/yr	120	lbs/yr	N
1,1-Dichloroethene	1.3E-03	3.2E-02	5.9E-03	1.2E+01	--		1.31	lbs/day	26.3	lbs/day	N
1,2-Dichloroethane	4.1E-03	9.9E-02	1.8E-02	**3.61E+01**	--		0.369	lbs/yr	7.39	lbs/yr	Y
1,2-Dichloropropane	8.2E-05	2.0E-03	3.6E-04	7.2E-01	--		0.959	lbs/yr	19.2	lbs/yr	N
1,4-Dichlorobenzene	1.5E-04	3.6E-03	6.6E-04	**1.3E+00**	--		0.872	lbs/yr	17.4	lbs/yr	N
2-butanone (MEK)	7.0E-01	1.7E+01	3.1E+00	6.1E+03	--		32.9	lbs/day	657	lbs/day	N
4-Methyl-2-pentanone (MIBK)	8.3E-02	2.0E+00	3.6E-01	7.3E+02	--		19.7	lbs/day	394	lbs/day	N
Acetaldehyde	3.2E-05	1.1E-04	1.4E-05	2.9E-02	--		3.55	lbs/yr	71	lbs/yr	N
Acrolein	7.5E-06	**2.5E-05**	3.4E-06	6.7E-03	--		0.000394	lbs/day	0.00789	lbs/day	N
Benzene	1.8E-03	4.0E-02	7.3E-03	**1.46E+01**	--		0.331	lbs/yr	6.62	lbs/yr	Y
Carbon disulfide	2.9E-05	7.0E-04	1.3E-04	2.6E-01	--		5.26	lbs/day	105	lbs/day	N
Chlorobenzene	3.1E-04	7.4E-03	1.3E-03	2.7E+00	--		6.57	lbs/day	131	lbs/day	N
Chloroform	6.7E-04	1.6E-02	2.9E-03	**5.8E+00**	--		0.417	lbs/yr	8.35	lbs/yr	N
Ethylbenzene	4.2E-02	9.9E-01	1.8E-01	**3.62E+02**	--		3.84	lbs/yr	76.8	lbs/yr	Y
Formaldehyde	8.8E-04	2.9E-03	3.9E-04	7.9E-01	--		1.6	lbs/yr	32	lbs/yr	N
Hexane	2.2E-05	7.2E-05	9.8E-06	2.0E-02	--		4.6	lbs/day	92	lbs/day	N
Isopropylbenzene	5.8E-03	1.4E-01	2.5E-02	5.1E+01	--		2.63	lbs/day	52.6	lbs/day	N
m,p-Xylene	1.3E-01	**3.1E+00**	5.6E-01	1.1E+03	--		1.45	lbs/day	29	lbs/day	N
Methylene chloride	6.1E-02	1.5E+00	2.7E-01	**5.39E+02**	--		9.59	lbs/yr	192	lbs/yr	Y
Naphthalene	5.7E-04	1.3E-02	2.4E-03	**4.9E+00**	--		0.282	lbs/yr	5.64	lbs/yr	N
Nitrogen Dioxide (NO_2)	2.1E-01	6.9E-01	9.4E-02	1.9E+02	--		0.457	lbs/hr	1.03	lbs/hr	N
o-Xylene	3.4E-02	8.3E-01	1.5E-01	3.0E+02	--		1.45	lbs/day	29	lbs/day	N
Propylene	1.8E-03	6.0E-03	8.2E-04	1.6E+00	--		19.7	lbs/day	394	lbs/day	N
Tetrachloroethene	2.9E-03	7.0E-02	1.3E-02	**2.6E+01**	--		1.62	lbs/yr	32.4	lbs/yr	N
Toluene	7.2E-01	1.7E+01	3.2E+00	6.3E+03	--		32.9	lbs/day	657	lbs/day	N
Total Xylenes	1.6E-01	**3.9E+00**	7.1E-01	1.4E+03	--		1.45	lbs/day	29	lbs/day	N
trans-1,2-Dichloroethene	2.4E-05	5.8E-04	1.1E-04	2.1E-01	--		5.30	lbs/day	106	lbs/day	N
Trichloroethene	3.8E-02	9.0E-01	1.6E-01	**3.30E+02**	--		4.8	lbs/yr	95.6	lbs/yr	Y
Vinyl chloride	3.8E-04	9.2E-03	1.7E-03	**3.35E+00**	--		0.123	lbs/yr	2.46	lbs/yr	Y
Hydrogen chloride (HCl)	4.9E+00	**1.18E+02**	2.2E+01	4.3E+04	--		0.0591	lbs/day	1.18	lbs/day	Y
Hydrogen fluoride (HF)	1.2E-01	**2.94E+00**	5.4E-01	1.1E+03	--		0.092	lbs/day	1.84	lbs/day	Y

Notes

'-- = Exemption level not available because the pollutant is not classified as a criteria pollutant or TAP.

Cells formatted with bold values indicate exceedance of a Registration Exemption Threshold.

Cells formatted with highlighting indicate exceedance of an SQER.

(a) Emission unit NSR exemption levels for criteria pollutants are identified in WAC 173-400-110(5).

(b) Emission unit NSR exemption levels for TAPs are identified in WAC 173-400-110(5) as the *de minimis* values from WAC 173-460-150.

(c) Washington Small-Quantity Emission Rate as presented in WAC 173-460-150.

TABLE 5
AIR DISPERSION MODELING STACK PARAMETERS
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Parameter	Proposed RTO	
	Low VOC Loading	High VOC Loading
Release Height (meters)	6.10	6.10
Stack Diameter (meters)	0.305	0.305
Exit Temperature (Kelvin)	338.7	449.8
Exit Velocity (meters/second)	10.16	20.32

TABLE 6
AIR DISPERSION MODELING METEOROLOGICAL INPUTS
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Data Type	Source	Station	Latitude	Longitude
Hourly Surface Observation	National Oceanic and Atmospheric Administration - National Climatic Data Center	Pasco Tri-Cities Airport Station ID: 24163	46.265° N	119.11° W
Twice-Daily Upper Air Soundings	National Oceanic and Atmospheric Administration - National Climatic Data Center	Spokane Station ID: 4106	47.68° N	117.63° W

TABLE 7
AIR DISPERSION MODELING RESULTS
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Criteria Pollutant	National Standards		Washington State Standards	Maximum RTO-Only Ambient Impact Concentration (µg/m³)	Filename	Regional Background Concentrations (µg/m³)(a)	Maximum Ambient Impact Concentration Added to Background (If Available) (µg/m³)
	Primary	Secondary					
Total Suspended Particulates							
Annual average	--	--	60 µg/m³	0.025	PM_071014a	--	0.025
24-hour average	--	--	150 µg/m³	0.17	PM_071014a	111	111
Particulate Matter (PM_{10})							
Annual average	--	--	50 µg/m³	0.025	PM_071014a	--	0.025
24-hour average	150 µg/m³	150 µg/m³	150 µg/m³	0.17	PM_071014a	111	111
Particulate Matter ($PM_{2.5}$)							
Annual average	15 µg/m³	15 µg/m³	15 µg/m³	0.025	PM_071014a	6.5	6.5
24-hour average	35 µg/m³	35 µg/m³	--	0.16	PM25_071014a-e	19	19
Carbon Monoxide (CO)							
8-hour average	9 ppm (10,000 µg/m³)	--	9 ppm (10,000 µg/m³)	5	CO_071014a	846	851
1-hour average	35 ppm (40,000 µg/m³)	--	35 ppm (40,000 µg/m³)	12	CO_071014a	1,358	1,370
Nitrogen Oxides (NO_x)							
Annual average	0.053 ppm (100 µg/m³)	0.053 ppm (100 µg/m³)	0.05 ppm (94 µg/m³)	0.80	NO2_071014a	8.1	9
1-hour average	0.100 ppm (188 µg/m³)	--	--	21.2	NO2_071014b-f	43	64
Sulfur Dioxide (SO_2)							
Annual arithmetic mean	0.03 ppm (79 µg/m³)	--	0.02 ppm (52 µg/m³)	0.0019	SO2_071014a	1.3	1.3
24-hour average	0.14 ppm (366 µg/m³)	--	0.10 ppm (262 µg/m³)	0.013	SO2_071014a	3.9	3.9
3-hour average	--	0.50 ppm (1,309 µg/m³)	--	0.027	SO2_071014a	10	10
1-hour average	75 ppb (196 µg/m³)	--	0.40 ppm (1,047 µg/m³)	0.053	SO2_071014a	12	12

Toxic Air Pollutant	ASIL (µg/m³)	Averaging Period	Maximum Ambient Impact Concentration (µg/m³)	Filename
Hydrogen Chloride	9	24-hour average	90	HCl_071014a
Hydrogen Fluoride	14	24-hour average	2.2	See Table 8, calculated based on dispersion factor
Benzene	0.0345	Annual average	0.0064	See Table 8, calculated based on dispersion factor
1,2-Dichloroethane	0.0385	Annual average	0.016	See Table 8, calculated based on dispersion factor
Ethylbenzene	0.4	Annual average	0.16	See Table 8, calculated based on dispersion factor
Methylene Chloride	1	Annual average	0.24	See Table 8, calculated based on dispersion factor
Trichloroethene	0.5	Annual average	0.15	See Table 8, calculated based on dispersion factor
Vinyl chloride	0.0128	Annual average	0.0015	See Table 8, calculated based on dispersion factor

Notes:
µg/m³ = Micrograms per cubic meter.
ppm = Parts per million.
ppb = Parts per billion.
ASIL = Acceptable source impact level.
Shaded items indicate the modeled ambient impact exceeds the ASIL
(a) Regional background values were obtained from WSU's NW Airquest webpage based on state-wide grid modeling of all identified sources in the state (WSU website 2014).

TABLE 8
AMBIENT IMPACTS CALCULATED WITH DISPERSION FACTORS
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

Dispersion Factors

24-hour average (a):	18.3	μg/m^3 per pound of TAP emitted in 1 hour
Annual average (b):	1.93	μg/m^3 per pound of TAP emitted in 1 hour

Toxic Air Pollutant	Previously Modeled Emission Rate (lbs/hr)	New Emission Rate (lbs/hr)	Averaging Period	Previously Modeled Maximum Ambient Impact Concentration (μg/m^3)	New Maximum Ambient Impact Concentration (μg/m^3)(c)	ASIL (μg/m^3)	Model File Name
Hydrogen Chloride (HCl)	4.92	–	24-hour average	90	–	9	HCl_071014a
Hydrogen Fluoride (HF)	–	0.12	24-hour average	–	2.2	14	–
Benzene	0.0017	0.0033	Annual average	0.0033	0.0064	0.0345	BE_071014a
1,2-Dichloroethane	0.0041	0.0083	Annual average	0.0079	0.016	0.0385	–
Ethylbenzene	0.041	0.083	Annual average	0.079	0.16	0.4	–
Methylene Chloride	0.061	0.12	Annual average	0.12	0.24	1	–
Trichloroethene	0.037	0.075	Annual average	0.071	0.15	0.5	–
Vinyl chloride	0.00038	0.00076	Annual average	0.00073	0.0015	0.0128	–

Notes:

(a) Dispersion factor for 24-hour averaging period calculated by dividing the previously modeled maximum impact concentration for HCl by the previously modeled HCl emission rate.

(b) Dispersion factor for annual averaging period calculated by dividing the previously modeled maximum impact concentration for benzene by the previously modeled benzene emission rate.

(c) New maximum impact concentration calculated by multiplying the new emission rate for that compound by the dispersion factor that corresponds to the averaging period applicable to that compound.

TABLE 9
PROPOSED PROJECT-SPECIFIC EMISSION LIMITS
PASCO SANITARY LANDFILL
PASCO, WASHINGTON

	Proposed Emission Limits				
Pollutant	lbs/hr	lbs/day	lbs/yr	tons/yr	Basis for Emission Limit
PM (Total)	0.29	6.8	2,500	1.25	Exemption levels in Table 110(5) of WAC 173-400
PM_{10}	0.17	4.1	1,500	0.75	Exemption levels in Table 110(5) of WAC 173-400
$PM_{2.5}$	0.11	2.7	1,000	0.50	Exemption levels in Table 110(5) of WAC 173-400
Nitrogen Oxides (NO_x)	0.46	11	4,000	2.0	Exemption levels in Table 110(5) of WAC 173-400
Carbon Monoxide (CO)	50	1210	10,000	5.0	tons/yr limits based on exemption levels in Table 110(5) of WAC 173-400
Volatile Organic Compounds (VOCs)	7	158	57,758	29	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Sulfur Dioxide (SO_2)	1.5	35	4,000	2.0	lbs/hr and lbs/day limits equal to SQER; lbs/yr and tons/yr limits based on exemption levels in Table 110(5) of WAC 173-400
1,1,1-Trichloroethane	5.5	131	47,815	24	Emission limits equal to SQER
1,1-Dichloroethane	0.014	0.33	120	0.06	Emission limits equal to SQER
1,1-Dichloroethene	1.1	26.3	9,600	4.8	Emission limits equal to SQER
1,2-Dichloroethane	0.0082	0.20	72	0.036	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
1,2-Dichloropropane	0.0022	0.053	19.2	0.0096	Emission limits equal to SQER
1,4-Dichlorobenzene	0.0020	0.048	17.4	0.0087	Emission limits equal to SQER
2-butanone (MEK)	27.4	657	239,805	120	Emission limits equal to SQER
4-Methyl-2-pentanone (MIBK)	16.4	394	143,810	71.9	Emission limits equal to SQER
Acetaldehyde	0.0081	0.195	71	0.036	Emission limits equal to SQER
Acrolein	0.00033	0.0079	2.9	0.00144	Emission limits equal to SQER
Benzene	0.0035	0.080	29	0.015	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Carbon disulfide	4.4	105	38,325	19.2	Emission limits equal to SQER
Chlorobenzene	5.5	131	47,815	23.9	Emission limits equal to SQER
Chloroform	0.000953	0.023	8.4	0.0042	Emission limits equal to SQER
Ethylbenzene	0.085	2.0	725	0.36	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Formaldehyde	0.0037	0.088	32	0.016	Emission limits equal to SQER
Hexane	3.8	92	33,580	16.8	Emission limits equal to SQER
Isopropylbenzene	2.2	53	19,199	9.6	Emission limits equal to SQER
m,p-Xylene	1.2	29	10,585	5.3	Emission limits equal to SQER
Methylene chloride	0.12	2.9	1,077	0.54	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Naphthalene	0.00064	0.015	5.6	0.00282	Emission limits equal to SQER
Nitrogen Dioxide (NO_2)	1.03	24.7	9,023	4.5	Emission limits equal to SQER
o-Xylene	1.2	29	10,585	5.3	Emission limits equal to SQER
Propylene	16.4	394	143,810	72	Emission limits equal to SQER
Tetrachloroethene	0.0037	0.089	32	0.0162	Emission limits equal to SQER
Toluene	27.4	657	239,805	120	Emission limits equal to SQER
Total Xylenes	1.2	29	10,585	5.3	Emission limits equal to SQER
trans-1,2-Dichloroethene	4.4	106	38,690	19.3	Emission limits equal to SQER
Trichloroethene	0.075	1.8	660	0.33	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Vinyl chloride	0.00076	0.018	6.7	0.0034	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2
Hydrogen chloride (HCl)	4.9	118	43,117	22	Emission limits equal to maximum calculated emission rate presented in Table 4
Hydrogen fluoride (HF)	0.25	5.9	2,148	1.1	Emission limits equal to maximum calculated emission rate presented in Table 4 multipied by a factor of 2

Notes:

PM = Particulate Matter

SQER = Small-Quantity Emission Rate as defined in WAC 173-460-020(7)

APPENDIX A

Regenerative Thermal Oxidizer Specifications

Gulf Coast Environmental
Systems

Gulf Coast Environmental Systems LLC
1689 Hawthorne Drive
Conroe, TX 77301
Phone: 832.476.9024
Fax: 855.301.9672

Date:	August 29, 2014
Proposal No:	800-12 Rev. 3a Technical
Proposal For:	**Anchor Qea, LLC** 101 N. Capital Way, Ste. 107 Olympia, WA 98501 U.S.A. Attn: Mr. Mike Riley Mr. Adam Morine of Environmental Partners, Inc.
Phone:	Mr. Riley: 360-528-2442; 360-870-4856 (cell) Mr. Morine: 425-395-0028; 425-677-5727 (cell)
Fax:	206-287-9131 (Seattle)
Email:	mriley@anchorqea.com adamm@epi-wa.com
Proposed Equipment:	2,000 SCFM 2-Canister Regenerative Thermal Oxidizer (RTO) with Condensate Treatment – For the Pasco Sanitary Landfill Site in Pasco, WA

Gulf Coast Environmental Systems (GCE) is comprised of executives, engineers, and service technicians worldwide with many years of experience to service the air pollution control and industrial oven market. Through our extensive knowledge of the various technologies and design of air processing equipment, we are able to offer full service oven and abatement solutions for your plant.

This proposal details the supply of one (1) 2,000 SCFM Regenerative Thermal Oxidizer (RTO) System designed to treat the Volatile Organic Compounds (VOCs) emissions from the Landfill Site. The unit shall process up to 1,000 SCFM (future volume; 600 SCFM current) of vent gas and up to 7 gallons/hour of condensate as described in this proposal and the RFI provided by Anchor Qea. The additional 1,000 SCFM of capacity is to allow operation of the equipment well below 25% of the Lower Flammability Limit (LFL) and provide flexibility in controlling the potential maximum heat release from processing up to 1,500 lbs per 24-hour day of VOCs.

With this technology and application, auxiliary fuel use for maintaining heat in the unit shall be minimal at a wide range of operating parameters.

It is understood, that average VOC loading shall be much lower than the designed maximum conditions. The proposed system shall provide seamless turndown capability to handle fluctuations in the heat release loading.

In consideration of the site producing vapor for many years and containing the stated concentrations of chlorinated hydrocarbons, GCE has quote the base equipment out of higher grade materials of construction at process contact points that may be exposed to highly corrosive by-products.

GCE prides itself on providing heavy-duty long-life, reliable, and efficient equipment. By having control of schedule and quality in our own manufacturing facility, GCE is considered one of the industry leaders in providing the best value equipment. This is validated with an industry-leading 2 year limited warranty in material and workmanship for all equipment manufactured by GCE. Expected life of the equipment with proper care and maintenance is 25 years or more (less corrosion).

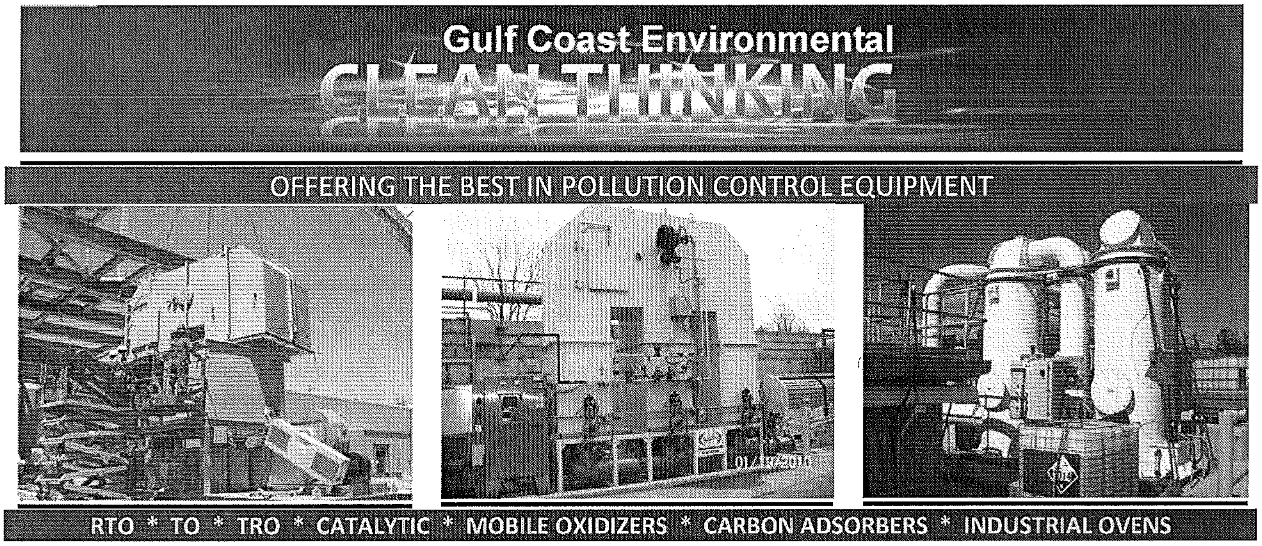
The product quoted conforms to GCE specification standards. Adaptation to customer specifications shall be evaluated if provided.

Please do not hesitate to contact us with any questions and we look forward to this opportunity to work with you.

Sincerely,

Chad Clark

Chad Clark
Gulf Coast Environmental Systems
cclark@gcesystems.com



Gulf Coast Environmental offers durable equipment for a wide range of applications.
Thank You for Considering Gulf Coast Environmental.

A Word about BACT (Best Available Control Technology) and NOx.

Gulf Coast Environmental Systems (GCE) provides low NO_x rated burners and controls for each application. NO_x emissions will vary based on the burner load required to maintain combustion temperature and the amount of heat release available from the process air. NO_x emissions from an idle unit or a unit in startup mode may vary from a unit processing plant air based on the makeup of the process stream and the compounds being abated. Please advise GCE if there are any specific NO_x limits that are necessary to achieve.

Uptime and Reliability.

Gulf Coast Environmental Systems units have been operating in some of the most challenging environments. The vast majority of units installed by GCE operate 24 hours a day, 7 days a week in production facilities across the world. Our systems consistently perform at greater than 99% uptime in rendering facilities, chemical mixing plants, petrochemical facilities and other harsh process environments. GCE stands by its equipment and backs it up with a strong guaranty and a knowledgeable service department that is available 24 hours a day.

TABLE OF CONTENTS

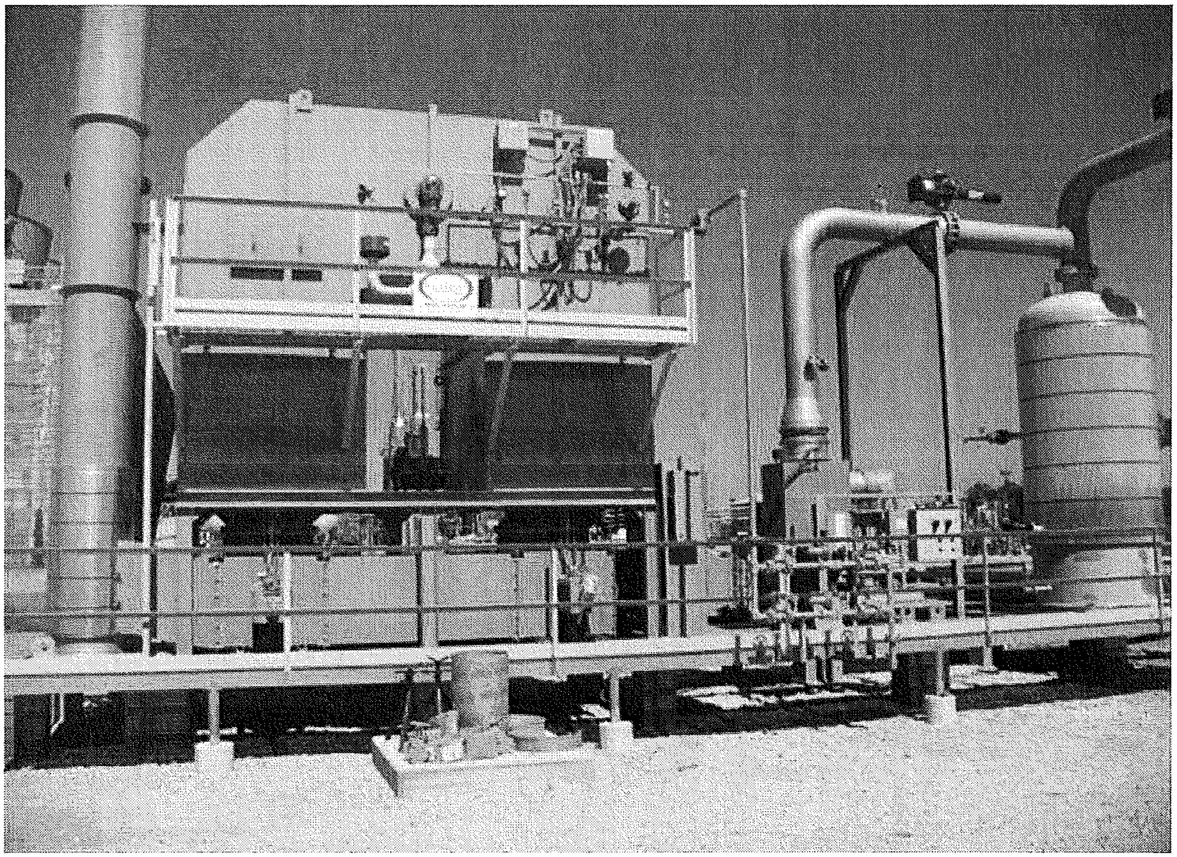
SECTION 2: EXECUTIVE SUMMARY

2.1 THEORY OF OPERATION

Regenerative Thermal Oxidizer (RTO)

The method of reduction of Volatile Organic Compounds in a Regenerative Thermal Oxidizer revolves around thermal oxidation. The chemical process of thermal oxidation is quite simple; the exhaust stream temperature is raised to a point that the chemical bonds that hold the volatile organic molecules together are broken. The VOCs in the process exhaust stream are converted to carbon dioxide, H_2O, and thermal energy by the high temperature of the combustion chamber.

The process of regenerative thermal oxidation operates around two energy recovery canisters in use on the system, which are the housings for the ceramic heat recovery media. The ceramic heat recovery media acts as a heat exchanger for the system. The two canisters operate under a "swing bed" absorption principle: which is the principle of transfer through two beds by the use of flow reversal. In the use of this principle with ceramic stoneware, the process is called regeneration.



As the dirty exhaust stream travels through the first bed of ceramic media, the exhaust stream adsorbs the heat energy stored in the ceramic media mass, which pre-heats the exhaust stream. The exhaust stream then enters the burner reactor chamber, where heat energy is added from the burner to reach the system operating temperature. After the temperature has been elevated and retained, the clean exhaust stream then passes through the second energy recovery canister. As the exhaust stream passes through the canister, the cold ceramic media mass absorbs the heat energy of the exhaust stream, and stores the heat energy for the reverse flow of the system. Once the heat energy of the first canister has been depleted through the absorption of the incoming air stream, the flow through the system is rotated, so the incoming dirty air stream is then directed through the previous absorption canister, with the clean waste gas now going through the previous canister. In a unit with three canisters, the same principle applies, but there are now three different cycles available. The canister not part of a cycle is used for purging the RTO. This allows for a greater achievable destruction efficiency of the VOCs.

By using the reversal of exhaust flow through the ceramic beds, a minimal amount of heat energy needs to be added to the incoming exhaust stream to maintain the systems minimum operating temperature. The sizing of the ceramic media beds is such that a maximum of 95% heat recovery efficiency is possible through the regenerating, reversal flow process.

2.2 PROPOSAL OVERVIEW

The proposal details the supply of one (1) 2,000 SCFM Two-Canister RTO. The entire system shall be capable of processing up to 1,000 SCFM of process vapor, 7 gallons/hour of condensate, and 1,000 SCFM of dilution air. The dilution air source shall be fresh ambient air and be provided by others through the fresh air fan supplied by GCE. The following is a summary of the scope of supply for our offering:

- One (1) Two-Canister RTO with 98% or less than 20 ppm_v Destruction Removal Efficiency (DRE) of the VOCs (to H_2O & CO_2)
- One (1) System Dilution Air Fan and Motor
- Two (2) Heat Exchanger Canisters designed for 92% heat recovery with structured and saddle ceramic heat recovery media – carbon steel with internal zinc coating
- One (1) Combustion Chamber section – carbon steel with internal zinc coating
- One (1) Natural Gas Fired Burner for the RTO combustion chamber
- One (1) Combustion Air Fan and Motor with Air Filter
- One (1) Fuel Train designed per NFPA regulations
- Two (2) Flow Directional Poppet Valves – Alloy C276
- One (1) Inlet Duct Manifold – 316 SS
- One (1) Outlet Duct Manifold – Alloy C276
- One (1) Process Isolation Damper / Fresh Air Damper Assembly
- One (1) Cold-Side Bypass System – 316 SS
- One (1) Exhaust Stack – 20' discharge height above grade – Alloy C276
- One (1) Control Panel – Outdoor Rated: Mounted at the RTO Unit
- One (1) Aqueous Injection System for condensate (pump by others)
- One (1) Compressed Air Reservoir Tank
- One (1) Lot Factory Mounting, Pre-Piping, and Pre-Wiring to the greatest extent possible for shipping
- One (1) Lot Installation, Installation Supervision, & Commissioning Services
- Approximate Equipment Footprint: 20'L x 6'W
- Approximate Equipment Dry Weight: 20,000 lbs

SECTION 3: DESIGN CONSIDERATIONS

3.1 Process Data – Supplied by Customer

APPLICATION STREAM:	SVE Off-Gas and Condensate
PROCESS VAPOR STREAM VOLUME:	Up to 1,000 SCFM @ up to 225°F
CONDENSATE VOLUME:	Up to 7 gallons per hour or up to 0.117 gallons per minute maximum
MAXIMUM DILUTION VOLUME:	Up to 1,000 SCFM @ 70°F
MAXIMUM VOC LOADING & TYPE:	1,200,000 btu/hr release value or 20,000 btu/min

Max. Process Composition Includes Condensate	Vol %	SCFM or LB/HR
Nitrogen	66.85	683
Oxygen	17.84	182
Water	14.42	147
Non-Corrosive VOCs Acetone, 2-Butanone, Ethanol, Ethylbenzene, Methyl Isobutyl Ketone, Toluene, Xylene, 1,2,4-Trimethylbenzene, 1-3,5-Trimethylbenzene, Methyl Ethyl Ketone, 2-Hexanone, 4-Methyl-2-Pentanone, Benzene, Isopropylbenzene, m,p-Xylene, Naphthalene, n-Butylbenzene, n-Propylbenzene, o-Xylene, p-Isopropyltoluene	0.88	85.5 lbs/hr
Corrosive Chlorinated VOCs Methylene Chloride, 1,1,1-Trichloroethane, 1-1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1-4-Dichlorobenzene, Chlorobenzene, Chloroethane, Chloroform, cis-1,2-Dichloroethene, Tetrachloroethene, trans-1,2-Dichloroethene, Trichloroethene, Vinyl Chloride	0.01	2.4 lbs/hr
**Corrosive CFC VOCs* Trichlorofluoromethane (CFC-11), Dichlorodifluoromethane (CFC-12)	Neg.	0.15 lbs/hr

The process stream composition is limited to the constituents in the above table. The VOCs are assumed to not include any additional halogenated, corrosive, or silicate forming compounds.***

*A higher combustion temperature is required for good conversion of CFCs. Therefore, a CFC destruction efficiency of 98% is not guaranteed under this equipment offering. In addition, the formation of HF from the CFCs results in the attack of silica (insulation, ceramic media). Due to the potential for very low concentrations, this may not be a concern, but with the unknown presence over time of the entering CFCs, expedited degradation of the silica components of the proposed system could occur.

The assumed HCl formation is 200 ppm$_v$ (worst case).

- PROCESS STREAM PRESSURE: 25”-100” w.c. (at iso. damper) [Will stabilize to system pressure drop]
- VOLUMETRIC TURNDOWN RATIO: ~4:1
- SITE LOCATION ELEVATION: <400’ above sea level (ASL)
- RTO EXPECTED OPERATING TEMP: 1,600°F or 871°C
- RTO POTENTIAL MAXIMUM TEMP: 1,800°F or 980°C
- MEDIA HEAT EXCHANGER EFFICIENCY: 92%
- DESTRUCTION REMOVAL EFFICIENCY: 98% or less than 20 ppm$_v$ (not including CFCs)
- OXIDIZER LOCATION/CLASSIFICATION: Outdoors / Controls Outdoors Standard Classification (General Purpose)
- NATURAL GAS REQUIREMENT (Start-up): 750 SCFH @ 10 psig LHV = ~1,000 btu/cu. ft.
- NATURAL GAS USAGE (Operation): <75 SCFH @ 10 psig At full volume and VOC release
- ELECTRICAL SUPPLY VOLTAGE: 480V / 60Hz / 3 Phase
- COMPRESSED AIR USAGE: 5 CFM peak – 2 CFM average
  Instrument Air Requirements: 80 psig @ -40°F dewpoint (clean)

SECTION 4: EQUIPMENT SPECIFICATIONS

This proposal is based on preliminary engineering intended to achieve the performance goals. GCE reserves the right to alter component selections during engineering.

4.1 System Dilution Fan

The system dilution fan is sized and supplied for pushing fresh ambient air through the Oxidizer System. The fan allows for a *neutral (0)* pressure of 0" w.c. at the inlet during normal operation. The fan shall be placed on the customer supplied pad.

The dilution fan is complete with an expected 5 horsepower energy efficient motor. The fan housing is fabricated of continuously welded heavy gauge carbon steel. The fan shall be supplied with heavy-duty roller bearings with grease fittings, OSHA approved belt / bearing and shaft guards, shaft seals, and an access door for fan maintenance, where applicable.

Volume control of the dilution air shall be controlled by the temperature inside the RTO combustion chamber. The fresh air damper (section 4.8) shall modulate to control the volume.

Fan Manufacturer	**New York Blower or equal**
Expected Motor Size	**5 HP**
Motor Type	**TEFC Premium Efficiency – Inverter Duty**
Fan Materials of Construction	**Carbon Steel Housing** **Base & Pedestal shall be Carbon Steel**
Differential Safety Pressure Switch	**Dwyer 1950 Series or equal**
Some Additional Fan Options Included	**Access Door and Drain** **Punched Inlet & Outlet Flanges**

4.2 Energy Recovery Canisters

The purpose of the energy recovery canisters in the RTO system are to house the heat recovery media used during the regeneration cycles of the system. The canisters are insulated with ceramic fiber block materials to insure the outer skin temperature is below 70°F (21°C) above ambient based upon an outdoor installation with a 5 mph (8 km/hr) wind and no sun or external heat load.

Each of the canisters shall be sized to handle the maximum anticipated airflow of the process and designed based upon the required thermal efficiency, pressure drop, and physical size requirements. The support structure for the ceramic media shall be made from alloy C276 in order to insure structural stability during high temperature operation and maintain corrosion resistance.

Total Capacity each Canister	**2,000 SCFM**
Maximum Inlet Temperature	**225°F**
Number Of Energy Recovery Canisters	**2**
Approx. Internal Canister Size	**2' x 3'**
Canister Shell Material	**Carbon Steel with Internal Zinc Coating**
Insulation Material	**Ceramic Fiber Modules**
Media Support	**Alloy C276 Material**

4.3 Ceramic Heat Exchange Media

The heat exchange media shall consist of a chemically resistant structured and saddle ceramic media. The quantity of media and bed configuration shall be as such to reach 92% thermal recovery efficiency at the maximum design flow conditions.

Type	**Structured and Saddle Media**
Efficiency of Media	**92%**
Approx. Bed Depth per Canister	**5.0'**
Approx. Media Volume	**each canister 30 ft^3** **total 60 ft^3**

4.4 Combustion Chamber

The combustion chamber serves two purposes within the system. Purpose #1 is to input the required heat energy to bring the pre-heated air exiting the energy recovery bed up to the required operating temperature with the burner firing into the chamber. Purpose #2 is to retain the process stream at the operating temperature for the required elevated temperature in order to achieve the desired destruction efficiency – this is typically called the residence time.

Design Operating Temperature Expected Operating Potential Maximum	 **1,600°F or 871°C** **1,800°F or 980°C**
Minimum Destruction Removal Efficiency	**98% or less than 20 ppm$_v$ Excluding CFCs**
Shell Material	**Carbon Steel with Internal Zinc Coating**
Insulation Material	**Ceramic Fiber Modules**
Temperature Elements	**Duplex Type "K" Thermocouples**
Access Door(s)	**Internally Insulated Davit-Assisted**

4.5 Burner & Combustion Air

The purpose of the burner on the RTO is to input the heat energy required to raise the heat exchange media outlet temperature to the required combustion chamber operating temperature.

One combustion blower shall be used on the application for the combustion chamber burner. The combustion air blower shall feed the required air volume to the burner and shall be provided with an inlet filter and a damper to control volume.

Burner Manufacturer	**Eclipse or equal**
Number Of Burners	**1**
Approx. Rated Capacity of each burner	**0.75 mm Btu/hr**
Combustion Air Blower	**New York Blower or equal**
Number of Combustion Air Blowers	**1**
Approx. Combustion Air Volume of Each Blower	**160 SCFM**

4.6 Fuel Train

The fuel train consists of a main gas line that safely delivers natural gas to the combustion chamber burner. One main line shall be used to feed the burner.

The fuel train shall be designed as per NFPA standards.

Manual Shut-off Cocks	**Apollo or equal**
Y-Strainer	**Mueller or equal**
Pressure Regulator	**Sensus or equal**
Low and High Gas Pressure Switches	**Karl Dungs or equal**
Fuel Gas Shut-off Valves with limit switches	**Siemens or equal**
Pressure Gauges	**Mil Jocco or equal**

4.7 Valve System

The purpose of the flow control valves is to direct the process stream movement into and out of the energy recovery canisters for the process of regeneration.

The dampers shall be designed to handle maximum designed exhaust temperatures experienced during high temperature operation. The seal on the system shall be primary metal to metal seat with a secondary tadpole gasket for minimal leakage across the valves.

The inlet and outlet manifolds shall be a flanged connection.

Damper Type	**Poppet**
Damper Number	**Two (2)**
Damper Material of Construction	
Approx. Size	**12" diameter**
Housing	**Alloy C276**
Blade	**Alloy C276**
Shaft	**Alloy C276**
Actuator Type	**Pneumatic**
Actuator Manufacturer	**SMC or equal**
Directional Valve Manufacturer	**SMC or equal**
Inlet and Outlet Manifolds	
Approx. Size	**7" x 20"**
Material	**Inlet: 316 SS; Outlet: Alloy C276**

4.8 Process Isolation Damper / Fresh Air Damper

The purpose of the process isolation damper is to isolate the RTO system from the process stream. It shall be on / off actuation.

The fresh air damper shall allow ambient air to purge the oxidizer system during a system start-up and allow fresh air introduction during vapor processing. The fresh air damper shall modulate based on the fresh air demand and be located on the discharge of the dilution air fan.

Damper Type	**Butterfly**
Damper Process Material of Construction	**Isolation: 316 Stainless Steel** **Fresh Air: Carbon Steel**
Actuator Type	**Pneumatic**
Actuator Manufacturer	**Max-Air or equal**
Directional Valve Manufacturer	**Max-Air or equal**
Positioner Manufacturer	**Max-Air or equal**

4.9 Cold-Side Bypass

Due to the potentially high hydrocarbon loading, a "cold-side" bypass system shall be included with the RTO to control the VOC oxidation temperature. A cold-side bypass damper shall be provided for automatic temperature control. The bypass damper shall modulate to divert the required portion of the incoming process gas around the heat exchange media to control the excess energy released by the VOC oxidation. The bypass shall allow the system to operate during periods of high VOC loading without high temperature shut-downs.

The bypass shall consist of a duct, modulating damper, and pneumatic actuator with positioner for control. The damper shall modulate via a PID controller to allow only the required amount of air to bypass the exchanger as required to control the pre-heat temperature.

As the temperature in the combustion chamber rises due to an increase in the VOC load, the damper shall open proportionally to bypass the pre-heat side of the heat exchange media by sending the process directly to the combustion chamber.

Damper Type	**Butterfly**
Damper Material of Construction Material	**316 Stainless Steel**
Actuator Type	**Pneumatic**
Actuator Manufacturer	**Max-Air or equal**
Modulating Positioner Manufacturer	**Max-Air or equal**

4.10 Exhaust Stack

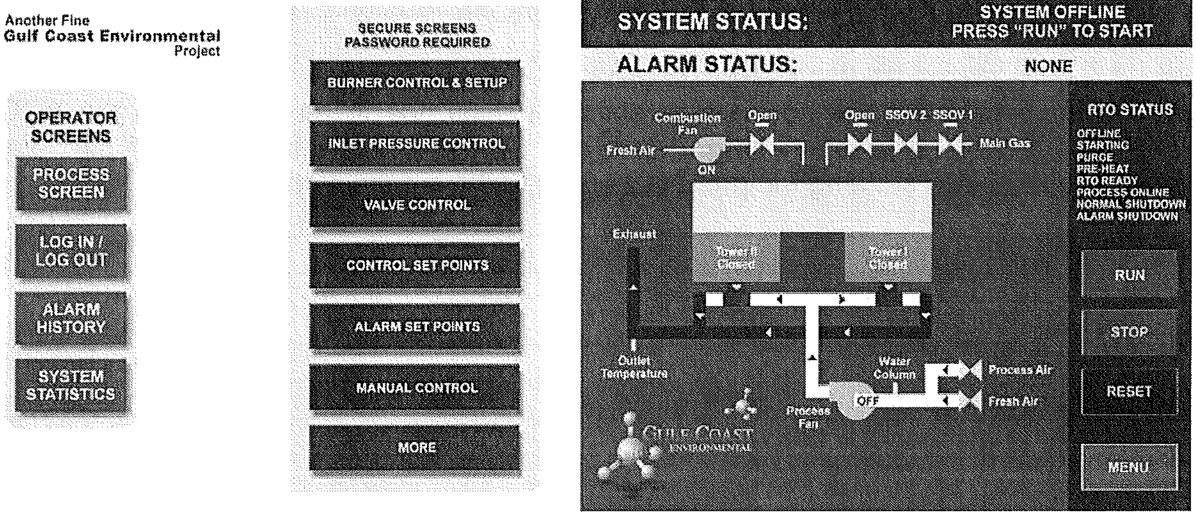
An exhaust stack shall be provided with the equipment to direct the clean air volume to atmosphere. The stack shall be shipped loose from the equipment and will require mounting and support at the installation site. The stack is currently designed and quoted to discharge at a height of 20' above grade and be constructed out of alloy C276. Two (2) 3" diameter test ports shall also be provided.

An exhaust stack ladder and platform has NOT been included.

4.11 System Controls / Safety Equipment

GCE designs, assembles, and manufactures a fully automatic control system for the abatement system. The control system shall consist of a GCE designed "SCS" (Safety Control System). The SCS system is manufactured and custom tailored per the National Electric Code and UL508A standards.

The SCS shall be a fully automated push button operation for the sequence of operation. The single button start/stop design has been utilized for ease of use and to eliminate the possibility of costly operator error. The SCS has been designed to provide a self-checking safety control and monitoring system that is user-friendly during all periods of system operation.



SYSTEM STATUS: SYSTEM OFFLINE PRESS "RUN" TO START

ALARM STATUS: NONE

DIAGRAM IS A SAMPLE ONLY: ACTUAL MAY VARY.

The system shall incorporate displays and graphics for operational status and fault / troubleshooting messages. The fault indicator shall display messages defining the reason for any system or control shutdown. The messages minimize any time needed to correct operation of a faulty condition; minimizing time spent troubleshooting faults and maximizing the process run time.

Control Panel Type	**NEMA 4X (Stainless Steel) – Outdoor Rated With A/C**
Operator Interface	**AUD EZTouch**
Control Panel Standard	**UL508a**
Programmable Logic Controller	**Allen Bradley MicroLogix or equal**
Burner Management System	**Eclipse or equal**
Flame Safety Type	**Flame Rod**
Voltage Main	**480 VAC / 3 phase / 60 Hz**
Control	**120 VAC / 1 phase / 60 Hz (via trans. by GCE)**

4.12 Aqueous Injection System

An aqueous injection system shall be supplied with the system to provide the condensate for treatment. The condensation injection piping shall be made from stainless steel and include a solenoid valve for each heat recovery canister that shall alternate with each process inlet recovery canister.

The condensate pump provided by others shall have the ability to briefly (less than 10 seconds under normal operation) recirculate the water through the use of bypass solenoid valve provided by GCE with the aqueous injection system.

SECTION 5: DOCUMENTATION, SERVICES, & EXCLUSIONS

5.1 Surface Painting & Preparation

All carbon steel, which is not galvanized or aluminized, shall be treated and painted in GCE's standard color. Stainless steel, plastic, and other finishes shall not be painted.

5.2 Factory Acceptance Testing

GCE Systems shall assemble the system in the factory to the greatest extent reasonable. A full quality assurance testing of the control panel shall be performed before shipment of the equipment. Safeties, controls, and components shall be verified through operation as functionally correct and calibrated. The customer is always welcome and recommended to visit during the shop testing of the control panel.

5.3 Standards & Codes

Equipment manufactured by GCE Systems complies with the U.S. applicable sections of the Occupational Safety and Health Act (OSHA), National Fire Protection Association (NFPA), National Electric Code (NEC) and National Electric Manufacturers Association (NEMA).

5.4 Operations & Maintenance Manuals

GCE Systems shall supply a complete **electronic** copy of the operations and maintenance manual for the equipment. The manual shall be supplied during the startup of the equipment. The manual shall have all of the necessary documentation for the operation and maintenance of the equipment. Written instructions, general arrangement drawings, equipment drawings, process flow diagrams, electrical schematics, and the components original OEM information shall be provided.

5.5 Installation, Start-Up, & Training Services

GCE Systems shall supply a factory trained field service crew for the installation, startup, and confirmation of proper equipment operation and for validation of the warranty. Training will commence immediately after the final checkout of the equipment. The allotted period for the crew is expected to be a continuous 10 business days.

Gulf Coast Environmental
Systems

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APPENDIX B

Electronic Data Files
(on DVD)

Available
upon
request