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National Environmental Technology Test Sites (NETTS)

Technology Demonstration Application Analysis Report

Titanium Dioxide Photocatalytic Oxidation Of Vapors Contaminated With Chlorinated Compounds

McClellan Air Force Base
California

URS Greiner - California
Sacramento, CA

DoD EPA DOE

SERDP

Strategic Environmental Research and Development Program

Improving Mission Readiness Through Environmental Research

September 1997

AQM01-03-0589

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ABBREVIATIONS

°F	Degrees Fahrenheit
µg/L	Micrograms per liter
%	percent
<	Less than
AB	Ambient blank
AFB	Air Force Base
ARAR	Applicable or Relevant and Appropriate Requirement
ARP	Advanced reduction/oxidation process
AS	Audit sample
AST	Above ground storage tank
ASTM	American Society of Testing and Materials
BACT	Best Available Control Technology
bgs	Below ground surface
cis-1,2-DCE	cis-1,2-dichloroethene
CARB	California Air Resources Board
CatOx	Catalytic oxidation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
Cl_2	Chlorine
CO	Carbon monoxide
CO_2	Carbon dioxide
CSE	Caustic scrubber effluent
CTCL	Carbon tetrachloride
CWA	Clean Water Act
1,2-DCA	1,2-dichloroethane
DNAPLs	Dense, non-aqueous phase liquids
DoD	Department of Defense
DRE	Destruction and removal efficiency
DTSC	Department of Toxic Substances Control
E18	EPA Method 18
ECS	Emission control system
EE/CA	Engineering evaluation/cost analysis
EMR	Environmental Restoration Division, Environmental Management Directorate
EPA	U.S. Environmental Protection Agency
FD	Field duplicate
FIFRA	Federal Insecticide, Fungicide, Rodenticide Act
GAC	Granulated activated carbon
GC	Gas chromatography
gpm	Gallons per minute
H_2O	Water
H_2O_2	Hydrogen peroxide
HCl	Hydrochloric acid
HVDPE	High vacuum dual phase extraction

IC	Investigation cluster
ID	Identification
IEA	Irreversible electron acceptors
IWL	Industrial waste line
IWTP	Industrial wastewater treatment plant
kWH	Kilowatt-hour
L/min	Liters per minute
lb/hr	Pound(s) per hours
LCSPH	Long chain, saturated petroleum hydrocarbons
mg/kg	Milligrams per kilogram
MS	Mass spectroscopy
NaOH	Sodium hydroxide
NCP	National Oil and Hazardous Substances Contingency Plan
NETTS	National Environmental Technology Test Sites
nm	Nanometers
NMOC	Non-methane organic compounds
NOx	Oxides of nitrogen
O_2	Oxygen
O_3	Ozone
OH	Hydroxyl radicals
OSHA	Occupational Safety and Health Act
OU	Operable unit
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethene
PCO	Photocatalytic oxidation
PCOE	Photocatalytic oxidation effluent
PCOI	Photocatalytic oxidation influent
POL	Petroleum, oils, and lubricants
ppbv	Parts per billion by volume
ppmv	Parts per million by volume
PRL	Potential release location
psi	Pounds per square inch
PZ	Piezometer
QA	Quality assurance
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RIs	Remedial investigations
RPD	Relative percent difference
RWQCB	Regional Water Quality Control Board
SA	Study area
SDWA	Safe Drinking Water Act
SERDP	Strategic Environmental Research and Development Program
SMAQMD	Sacramento Metropolitan Air Quality Management District
SVE	Soil vapor extraction
SVOCs	Semivolatile organic compounds
1,1,1-TCA	1,1,1-trichloroethane

TCE	Trichloroethene
TCLME	Chloroform
TICs	Tentatively identified compounds
TiO_2	Titanium dioxide
TNMHC	Total non-methane hydrocarbons
TO	Toxic organics
TPH	Total petroleum hydrocarbons
TPHG	Total petroleum hydrocarbons as gasoline
TSCA	Toxic Substances Control Act
TSOP	Technical standard operating procedures
TV	Method TO-14 verification sample
TVOC	Total volatile organic compounds
UST	Underground storage tank
UV	Ultraviolet
V	Volts
VOCs	Volatile organic contaminants
VPN	Vapor piezometer nest
VW	Vapor wells
WIP	Work Implementation Plan

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1.0 EXECUTIVE SUMMARY

1.1 Background

McClellan Air Force Base (AFB), located in Sacramento, California, was selected by the Strategic Environmental Research and Development Program (SERDP) program to demonstrate the feasibility of using a titanium dioxide (TiO_2)-based photocatalytic oxidation (PCO) system to destroy mixtures of chlorinated compounds in the vapor phase at McClellan AFB. The demonstration was attempted at Site Operable Unit (OU) C1 and then moved to Site Investigation Cluster (IC) 29 at the base.

1.2 Demonstration Description

The purpose of the demonstration was to assess the cost and performance of using a PCO system to destroy mixtures of chlorinated compounds found in contaminated vapors from environmental remediation. The demonstration was carried out at OU C1, however elevated concentrations of long chain saturated petroleum hydrocarbons (LCSPHs) in the vapor stream fouled the catalyst. The demonstration was moved to IC 29 to test the PCO system's ability to destroy a richer chlorinated off-gas containing trichloroethene (TCE), chloroform (TCLME), carbon tetrachloride (CTCL), and cis-1,2-dichloroethene (cis-1,2-DCE).

The only input to the PCO system is electric power. The basic system component is the photocatalytic cell which, depending on the concentration of the contaminants, the required throughput, and the amount of organic destruction desired, can be linked in a serial mode or parallel mode. The PCO system performance was augmented by the addition of ozone, a hydroxyl promoter. The test had two phases: optimization and operation. During the optimization phase, three separate parameters were varied:

Flow rate	Residence time is a function of flow rate. One blower was used for the low-flow condition; two blowers were used for the high-flow condition.
Ozone (O_3)	Serves as an electron acceptor and promotes the oxidation process. The tests were run with and without O_3 addition to test its effectiveness.
Lamp type	Different lamps emit different ultraviolet (UV) wavelengths. To determine the optimum UV wavelength for the system, two lamp types were used: one that emits light at 254 nanometers (nm) and a hybrid type that emits at both 185 and 254 nm.

The demonstration was also conducted to determine if the system performance would meet the Sacramento Metropolitan Air Quality Management District (SMAQMD) Best Available Control Technology (BACT) requirement of a 95 percent destruction and removal efficiency (DRE).

1.3 Results

The demonstration, first performed at OU C1 was terminated due to low DREs. Before the demonstration began, a soil vapor extraction (SVE) removal action was implemented in August 1995. By the end of October 1995, the removal action had caused order of magnitude reductions in the target chlorinated hydrocarbons. In addition to the lower chlorinated hydrocarbon concentrations, the

presence of several LCSPHs fouled of the PCO catalyst. Another factor contributing to the low DRE was UV lamp performance. The regenerative blowers used to obtain a slipstream from the SVE manifold piping increased the temperature of the influent stream above 120 degrees Fahrenheit (°F), 10°F above the optimum operating temperature, causing the power output of the lamps drop significantly. The demonstration at OU C1 was terminated due to low DREs which were in the range of 10 to 40 percent with a high degree of scatter in the data.

The optimization phase results from IC 29 showed optimum DREs were obtained at low flow with O_3 addition and using hybrid lamps. During the operation phase, the TiO_2-based PCO technology removed 98 percent of the TCE and 98 percent of the cis-1,2-DCE from the vapor stream derived from IC 29. However the technology did not meet the treatment objective for several other contaminants, i.e., DREs under 95 percent: 87 percent for tetrachloroethene (PCE), 58 percent for chloroform, 26 percent for carbon tetrachloride, 60 percent for 1,2-dichloroethane (1,2-DCA). DREs for total VOCs exceeded 90 percent, but did not meet the SMAQMD's BACT requirement of 95 percent.

1.4 Conclusions

Successful implementation of PCO technology relies upon a complete characterization of the contaminant vapor stream to be treated. Vapor samples taken from the inlet during start-up showed that these fuel hydrocarbons comprised more than half of the contaminants detected. The LCSPHs caused the catalyst to foul resulting in low DREs. Additionally the initial configuration at OU C1 produced process temperatures in excess of 120°F, depressing the power output of the lamps. Any configuration must take into account the optimum operating temperatures of the two types of lamps which are 110°F for the 254 nm lamps and 140°F for the hybrid lamps that emit at both 185 nm and 254 nm.

The technology demonstration at IC 29 showed that the PCO technology achieved DREs in excess of 90 percent for total VOCs present in off-gas. When optimized, the system accomplished a DRE of 92 percent for total VOCs and 98 percent DRE for TCE and cis-1,2-DCE. The technology emitted low concentrations (1.5 parts per million by volume [ppmv]) of oxides of nitrogen (NOx).

1.5 Recommendations

Off gas stream needs to be completely characterized to ensure compatibility between contaminants and catalyst. The technology should not be applied to sites contaminated with high concentrations of LCSPHs. The residence time of a system should be conservatively designed to ensure that the technology meets applicable DRE requirements. In the event of periodic system shutdowns, it is recommended that the system be allowed to continue to operate/maintain "steady state" by passing ambient air through it via a three way valve.

2.0 INTRODUCTION AND BACKGROUND

This report summarizes the findings of a demonstration of the PCO technology developed by Matrix Photocatalytic, London, Ontario, Canada.

2.1 SERDP National Environmental Technology Test Sites (NETTS)

The SERDP NETTS program sponsored the development of five national test locations which have established infrastructures and well-characterized contamination. SERDP selected a McClellan AFB proposal to demonstrate the application of TiO_2-based PCO treatment of off-gas contaminated with vapors from environmental restoration activities.

Congress established SERDP to improve cooperation between the U.S. Environmental Protection Agency (EPA) and the Department of Defense (DoD), and to use resources more effectively to develop technologies to clean up military sites. SERDP funded the NETTS to facilitate the demonstration, evaluation, and commercial promotion of cost-effective, innovative, environmental technologies. Within this program, each armed service has focused areas for research, development, and demonstration:

- Army: Energetics and heavy-metal contamination.
- Navy: Petroleum, oils, and lubricants (POL) contamination.
- Air Force: Solvents contamination.

The EPA also has focused on on-site bioremediation of organic contaminants.

The goal of SERDP's NETTS is to identify and establish federal test locations at federal sites where governmental and private organizations can be invited to rigorously test and evaluate new environmental control and remediation technologies. The test program at each location is designed to obtain realistic environmental and economic information that may be applied nationwide to support the adoption and use of the more successful technologies.

The five National Test Locations provide a consistent and uniform environment to compare and evaluate promising cleanup and monitoring technologies. Table 2-1 summarizes the program emphasis and pertinent characteristics of each National Test Location.

2.2 Technology Objectives

The objective of using a TiO_2-based PCO system is to destroy vapor phase mixtures of chlorinated hydrocarbons, mainly chlorinated solvents such at TCE, PCE, and 1,2-DCE. The objective of the demonstration at McClellan AFB was to demonstrate the feasibility of using a TiO_2 based PCO system to treat contaminant laden off gases from environmental restoration. As part of the demonstration, the PCO system performance was tested to see that it would meet the BACT requirement of a 95 percent DRE.

Table 2-1

MATRIX OF NATIONAL ENVIRONMENTAL TECHNOLOGY TEST SITE (NETTS) LOCATIONS AND ENVIRONMENTAL CONDITIONS

General Test Location Characteristics	LOCATION OF TEST SITES				
	Naval Construction Battalion Center Port Hueneme, CA	**Volunteer AAP Chattanooga, TN**	**McClellan AFB Sacramento, CA**	**Groundwater Remediation Field Laboratory Dover AFB Dover, DE**	**National Center for Integrated Bioremed. Research and Development Former Wurtsmith AFB Oscoda, MI**
Demonstration Emphasis	ex situ (some in situ) marine sediments	in situ and ex situ (TNT manufacture)	in situ and ex situ	in situ/ex situ controlled release cells	in situ bioremediation
Primary Contaminants of Interest	fuel hydrocarbons	explosives	solvents	solvent and fuel LNAPLs and DNAPLs	fuels, solvents, and organic mixtures
SITE CHARACTERISTICS					
Contaminants	**Contaminated Media**				
Fuels LNAPL Diesel, gasoline, waste oil	soil, sediment, and groundwater				soil, sediment, and groundwater
JP4			soil and groundwater		
Solvents VOC, SVOC				soil and groundwater	
DNAPLs (TCE, PCE)					
Explosives TNT, RDX[1], HMX[1]		soil and groundwater			
Soil Type(s)	alluvial unconsolidated clay silt, sand, and gravel	cherty, silty clay	alluvial, alternate layers un-consol. sand, silt, clay, gravel	homogeneous sandy soil	glacio-fluvial sands, sand and gravel
Depth to Groundwater (ft)	3-14	20-40	100	10-12	< 10-20
Low/High Monthly Average Temperature (annual avg) (°F)	55/70 (62)	41/79 (60)	45/75 (60)	25/67 (45)	14/58 (37)
Average Annual Precipitation (in) (wettest month)	11.6 (Jan)	51.9 (Mar)	17.2 (Jan)	40.4 (Aug)	29.8 (Jul)

[1] RDX and HMX contamination sites are available at two cooperating DoD facilities near VAAP.

LNAPL Light, non-aqueous phase liquids; DNAPLs Dense, non-aqueous phase liquids; ft Feet; in Inch(es); °F Degrees Fahrenheit; VOC Volatile organic compound; SVOC Semivolatile organic compound; TCE Trichloroethene; PCE Tetrachloroethene; RDX Cyclotrimethylene-trinitramine; HMX Cyclotetraethylene-tetranitramine

To evaluate and assess this technology's applicability to other contaminated sites, please refer to EPA's innovative technology evaluation report, "Matrix Photocatalytic, Inc., Photocatalytic Oxidation Technology," and Atomic Energy Canada Limited's research paper, "Destruction of Organic Contaminants in Industrial Wastewater using Oil Coalescence and Photochemical Oxidation (UV/Ozone) Technologies," presented at the Electric Power Research Institute's Conference in Norfolk, Virginia July 25 through 27, 1994.

2.3 Technology Overview

TiO_2-catalyst-based PCO technology can destroy chlorinated compounds present in both vapor and aqueous phases. The Matrix Photocatalytic TiO_2 Technology is an advanced redox, reduction/oxidation process (ARP) developed by Matrix Photocatalytic to remediate vapors contaminated with chlorinated compounds.

Vapors laden with chlorinated compounds are drawn through the PCO treatment system by regenerative blowers. The treatment system is a series of reactor cells, called wafers. Each wafer is comprised of six reactor cells. Each reactor cell comprises an outer stainless steel jacket which contains the process, an internal photocatalytic matrix wrapped around a quartz sleeve, and a lamp for illumination. For the demonstration, the wafers were mounted into a portable trailer. The lamp emits low intensity UV light and is mounted coaxially within the quartz sleeve. Around the lamp lies a multi-layered sleeve of special fiberglass mesh bonded with TiO_2 that forms the catalyst matrix and is mounted coaxially within the quartz sleeve. The TiO_2 catalyst is activated by the light to produce two effects:

- One, the momentary shifting of an electron into a much higher orbital shell where it can react with an electron acceptor (such as ozone) to create oxidizing hydroxyl (OH-) radicals.
- Second, the "hole" left open momentarily by the shifting of the electron to a higher orbital shell. This "hole" exhibits a reduction effect where it may participate in reactions to create oxidizing species or directly with contaminants.

These two effects break down and mineralize organic molecules. As contaminated air flows into the reactor, it passes through the catalyst matrix where the organic contaminants undergo both oxidization and reduction processes. The organic contaminants are attracted to the electron "hole" created by the elevation of the electron to a higher orbital shell. Electron acceptors aid the process by accepting the electrons, thus averting "electron-hole recombination" and increasing the opportunity for a reaction to occur. The principles of the technology are described in detail in Section 4.1.

The PCO system is modular in construction and will treat air streams of 1 to 1,000 cubic feet per minute (cfm). The system size is based on flow rate, contaminant level, and target reduction objectives. Systems are configured based on the number of wafers required to treat the contaminants. Wafers can be added or removed from systems, providing flexibility for changing treatment parameters (e.g., flow rate, contaminant concentration).

The benefits TiO_2 PCO systems offer over other technologies in the treatment of vapor contaminated with organic compounds include:

- Onsite treatment of organic pollutants.

- Ambient temperature process (no combustion source).
- Photocatalytic air treatment systems generate minimal amounts of NOx and therefore do not raise the concerns associated with obtaining permits for thermal (high temperature) treatment systems.
- Vapor phase systems are not adversely affected by humidity.

The TiO_2 PCO technology is an advanced oxidation process (ARP) which offers an effective method for mass production of hydroxyl radicals which are capable of destroying chlorinated compounds in the vapor phase. TiO_2 is the most common form of titanium and is used in a wide range of products and has not been shown to adversely effect humans or the environment.

2.4 Demonstration Scope

SERDP selected McClellan AFB to demonstrate the cost and performance of using a TiO_2-based PCO system to destroy mixtures of chlorinated compounds found in the vapor phase.

The PCO demonstration was divided into two phases: optimization and operation. During the optimization phase, selected parameters in the process were varied to determine optimum operating parameters. Three separate parameters were varied:

- Flow rate. The flow rate determines the residence time of the contaminants within the reactor. Two blowers were used in parallel configuration. One blower was used for the low-flow condition; two blowers were used for the high-flow condition.
- Ozone addition. O_3 serves as an electron acceptor, promoting the formation of hydroxyl radicals that promote the oxidation process. The tests were run with and without O_3 addition to test its effectiveness in increasing the DRE.
- UV wavelength. The lamp type is determined by the UV wavelength the lamp emits. Different lamp types emit different UV wavelengths. Two lamp types were used during the optimization phase: The first set of lamps emitted UV energy at a wavelength of 254 nm; the second set of hybrid lamps emitted UV energy at both 185 and 254 nm.

2.5 Document Organization

The document is organized to present the technical and cost information to allow other site operators to evaluate the feasibility of applying the technology to their sites. The document is divided into ten sections:

- Section 1 is an executive summary.
- Section 2 describes the SERDP NETTS program, the technology and its objectives.
- Section 3 is an in depth characterization of the site.
- Section 4 describes the technology demonstration.
- Section 5 summarizes the demonstration results at IC 29. The demonstration at OU C1 was terminated during the optimization phase.
- Section 6 discusses issues related to applicable federal, state, and local regulations.
- Section 7 details the cost of purchasing, operating, and maintaining the PCO system.
- Section 8 contains recommendations based on the experience gained at the site.
- Section 9 summarizes the conclusions.
- Section 10 lists references.

3.0 SITE DESCRIPTION

Site descriptions for OU C1 (Subsection 3.1) and IC 29 (Subsection 3.2) are provided below.

3.1 OU C1

OU C1 comprises approximately 23 acres in the southwest portion of McClellan AFB (Figure 3-1). Site features, history, contamination, and a description of the current removal action are described below.

3.1.1 Location and Setting

The land surface within OU C1 is relatively flat with approximately two-thirds of the surface area paved. OU C1 is currently the location of the McClellan AFB Industrial Waste Treatment Plant (IWTP), as well as a portion of Building 704, paved parking areas, an excess clean soil and building rubble storage area, and open, undeveloped land.

3.1.2 Geology

OU C1 geology is similar to other sections of McClellan AFB, that is, a fluvial-alluvial depositional environment. The soil beneath Site 22 appears to be more sandy than the soil underlying Site 42 and PRL 68, where silt appears to be the dominant soil type. First encountered groundwater is found between 100 and 110 feet bgs.

3.1.3 Hydrogeology

Not applicable.

3.1.4 Site History

OU C1 has been associated with waste management and disposal activities throughout most of McClellan AFB's history. Formerly, OU C1 was the site of waste oil and solvent storage and burn pits, a refuse incinerator, and building debris storage and burial areas. Open bulk storage and open burning of liquid and solid wastes took place at various times in this area from the mid 1940s to approximately 1970.

A total of three confirmed sites (Sites 22, 42, and 69) and two potential release locations (PRLs 41 and 68) are located in OU C1 (Figure 3-2). Based on past remedial investigations (RIs) conducted in this OU (Jacobs 1993), three of these five locations, Site 22, Site 42, and PRL 68, were deemed to be candidates for an SVE removal action. Site descriptions and RI results for these locations are summarized below.

Site 22. Site 22 was the location of a large, solid waste burn pit and later, a sheet-metal "teepee" refuse incinerator. Incinerator ash and residue were disposed in the original burn pit. Records also indicate that substantial quantities of TCE and other spent solvents also were burned at Site 22. The burial pit and incinerator were closed in 1968; since that time the area has been used to store excess soil and building rubble. The industrial wastewater line (IWL) also crosses a portion of Site 22.

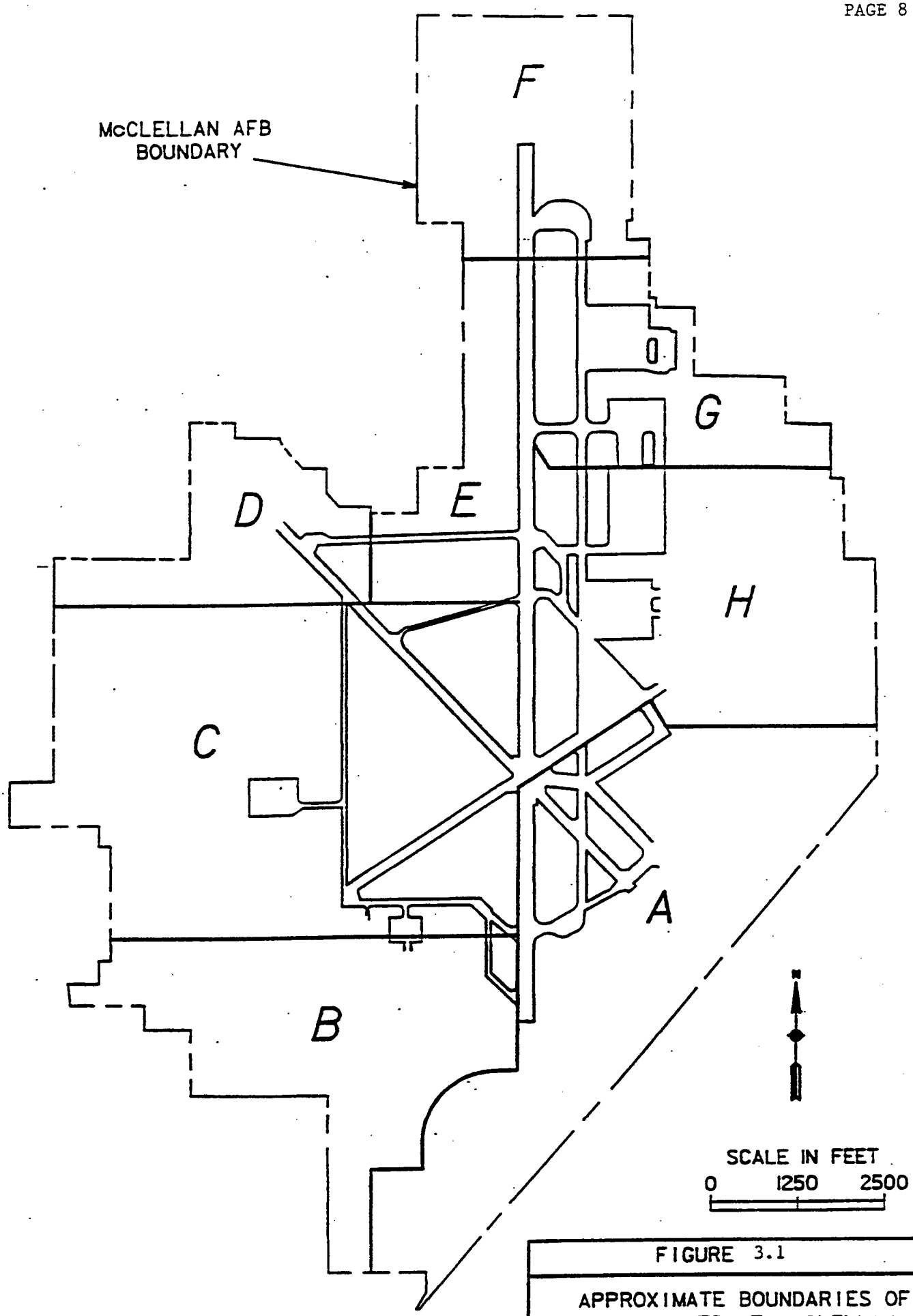


FIGURE 3.1

APPROXIMATE BOUNDARIES OF OPERABLE UNITS AT McCLELLAN AFB

URS Consultants, Inc.

M-AFB\REPORTS\FIGS

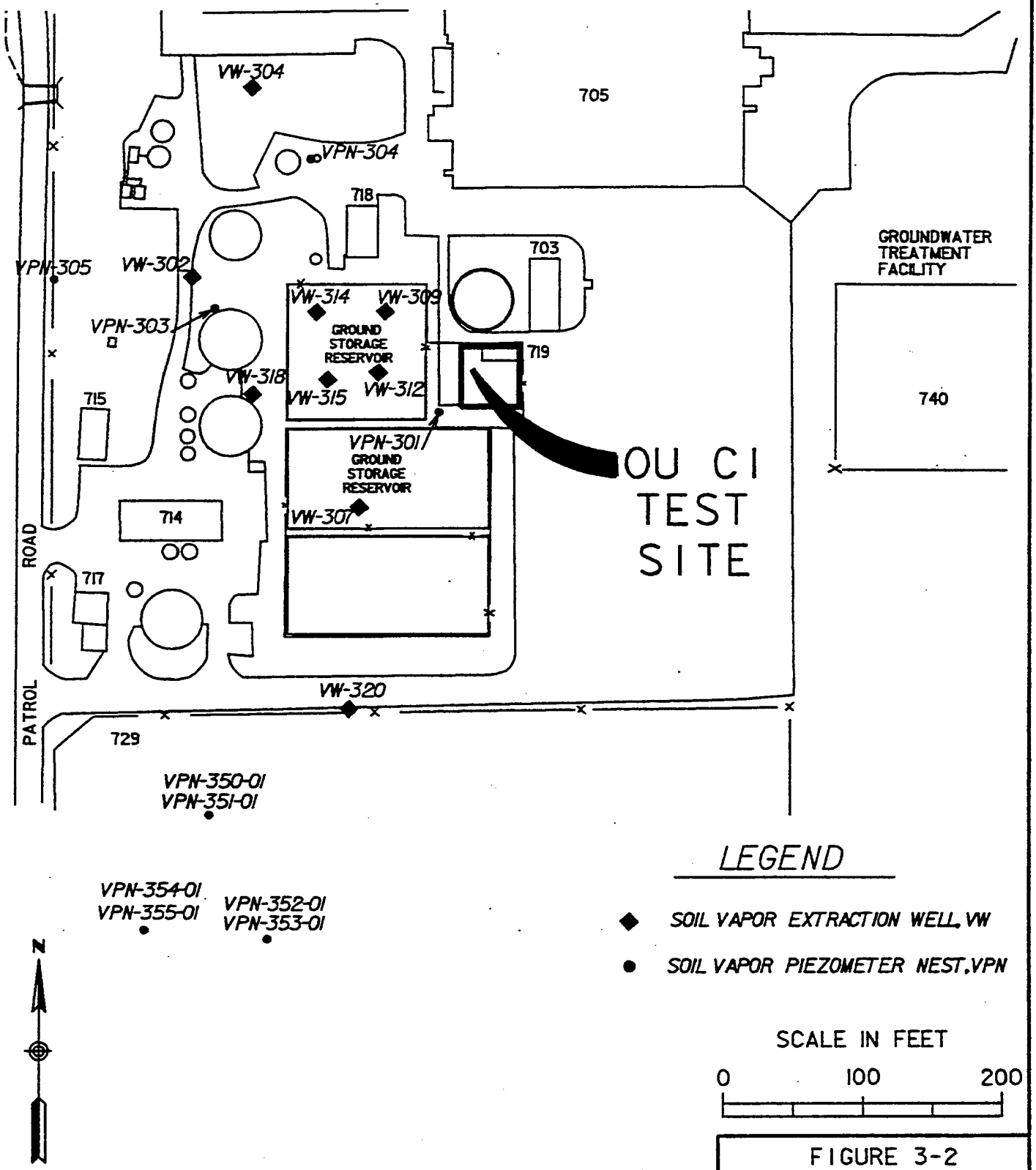


FIGURE 3-2

OU CI SITE MAP

URS Greiner

M-AFB\OUCI\TREAT\100%\COVERSHT

Site 42. The northern portion of Site 42 formerly contained pits which reportedly held waste solvents and "oil burning sludge." This area may also have been used as a burn pit/fire training area. The IWTP, including an aeration basin, was constructed over this entire area. The aeration basin was removed from service in 1987, but remains in-place. Site 42's southern portion was formerly the location of a pit used primarily to bury debris removed from the Site 22 burn pit. This pit also lies beneath a portion of the IWTP and the IWTP blending ponds.

PRL 68. This area is located immediately west of the northern portion of Site 42 and consists of four small areas, each corresponding to a former pit location. These four pits are thought to have been used for waste oil storage. This area was in use from the mid 1940s to 1953.

3.1.5 Site Investigation and Contamination Extent

Investigation of soil contamination at OU C1 dates from 1986 when the area was surveyed by McLaren Environmental Engineering. Additional investigations were conducted by McClellan AFB in 1988; CH2M HILL in 1991; and by Jacobs Engineering from 1991 to 1993. Later investigations focused on obtaining soil, soil gas and geologic information in and around each of the confirmed sites and potential release locations. Analysis of soil gas data indicates that Site 42 and PRL 68 have the most significant VOC contamination. Soil gas and historical soil data suggested that Site 22 be examined for evidence of a VOC spreading center.

Groundwater samples from monitoring wells located downgradient from Site 22, Site 42, and PRL 68 were contaminated with compounds also observed in soil gas samples analyzed from these sites. A-zone aquifer monitoring wells contained the highest levels of contaminants. One or more areas in OU C1 are suspected of contributing to the observed groundwater VOC contamination.

3.1.5.1 Site 42/PRL 68 (42/68)

The pits in the Site 42/PRL 68 area are considered to be potential source areas, along with the IWTP and the IWL. High TCE concentrations were reported in two borings located inside and along the western boundary of the aeration basin and within the outlines of the original disposal pits. TCE concentrations in soil gas averaged between 1,500 and 6,000 ppmv from approximately 27 to 90 feet below ground surface (bgs). These data indicate that a core zone of contamination is located in the general area of the aeration basin and old disposal pits. TCE concentrations in other borings within the 42/68 area were lower. Data from these borings indicate that the plume concentrations are decreasing rapidly to the northeast, east, and south.

TCE concentrations greater that 500 ppmv have been observed in two boreholes to the north of the 42/68 area at depths greater that 70 feet bgs. The same patterns were also observed in two boreholes to the south, where the highest concentrations of TCE are at lower depths.

Based on the pattern of contamination observed near the edges of the plume, it appears that there is a TCE plume extending from the core zone under the aeration basin in a north-south direction. The principal dispersion mechanism for contaminants found in the peripheral borings may be related to the movement of contaminated groundwater in the recent past or to vapor dispersion above the capillary fringe of the water table.

TCE concentrations in remaining borings help define the edge of the plume originating near the aeration basin. Low TCE concentrations were measured at all depths in borings located near the southeastern area.

Borings located near the eastern section of the oblong pit contained elevated levels of toluene and xylene indicating that fuel products could have been deposited in the oblong pit in the past.

Groundwater concentrations of TCE in excess of 10,000 to 20,000 micrograms per liter (μg/L) have been observed in at least one monitoring well approximately 350 feet south of the vadose zone contamination in the 42/68 area. The contamination in the 42/68 area may contribute, at least in part, to the observed high TCE concentrations in groundwater.

3.1.5.2 Site 22

An area of highly-contaminated soil near the western end of Site 22 exists, though it does not appear to be a significant core zone, nor does it appear to have spread far. Other data, indicating some widely dispersed TCE contamination at moderate concentrations, suggest that there might be two zones of contamination: an upper zone of elevated TCE, separated by tens of feet of low TCE concentrations from a lower zone of elevated TCE near the groundwater table. RI results lead to the conclusion that contamination found in the western portion of the site is localized (limited dispersion in both horizontal and vertical directions), and high in concentration. The area of the former teepee burner contained relatively low TCE concentrations (maximum of 18 to 100 ppmv) which indicate that there is no significant spreading center near this portion of Site 22.

3.1.6 Removal Action

An SVE removal action has been in progress at OU C1 since July 25, 1995. The OU C1 SVE/emission control system (ECS) consists of 8 vapor wells (VWs), several vapor piezometer nests (VPNs), a catalytic oxidizer (CatOx) unit, and a caustic scrubber. The system is designed to extract up to 1,000 standard cfm of soil gases from the VWs at vacuum levels up to 12 inches of mercury. The CatOx is designed to destroy a minimum of 95 percent of the VOCs extracted; the caustic scrubber is designed to remove greater than 99 percent of the hydrochloric acid and hydrofluoric acid generated by the destruction of halogenated VOCs. In addition to the compounds extracted and destroyed, the SVE system enhances air flow through the vadose zone, increasing the oxygen content, and therefore amplifying the natural, in situ biodegradation processes.

The primary contaminant measured in extracted soil vapor is TCE; at least 14 other halogenated, and 17 non-halogenated compounds have also been detected (Table 3-1).

Table 3-1

VOLATILE ORGANIC COMPOUNDS DETECTED AT OU C1
DURING REMOVAL ACTION SAMPLING

Halogenated	Non-Halogenated
Trichloroethene	Benzene
cis-1,2-Dichloroethene	Toluene
Tetrachloroethene	Ethylbenzene
1,1-Dichloroethene	Xylenes
1,2-Dichloroethene	1,2,4-Trimethylbenzene
1,1-Dichloroethane	1,3,5-Trimethylbenzene
1,1,1-Trichloroethane	2,2-Dimethylhexane (T)
Freon® 113	2-Methylpentane (T)
Methylene chloride	Methylcyclohexane (T)
Vinyl chloride	2-Methylbutane (T)
Chloromethane	4-Methylheptane (T)
Chloroform	Heptane (T)
1,2-Dichlorobenzene	Methylcyclopentane (T)
1,4-Dichlorobenzene	Hexane (T)
1,2,4-Trichlorobenzene	Cyclohexane (T)
	Octane (T)
	Nonane (T)

(T) Tentatively identified compound by Method TO-14

3.2 IC 29

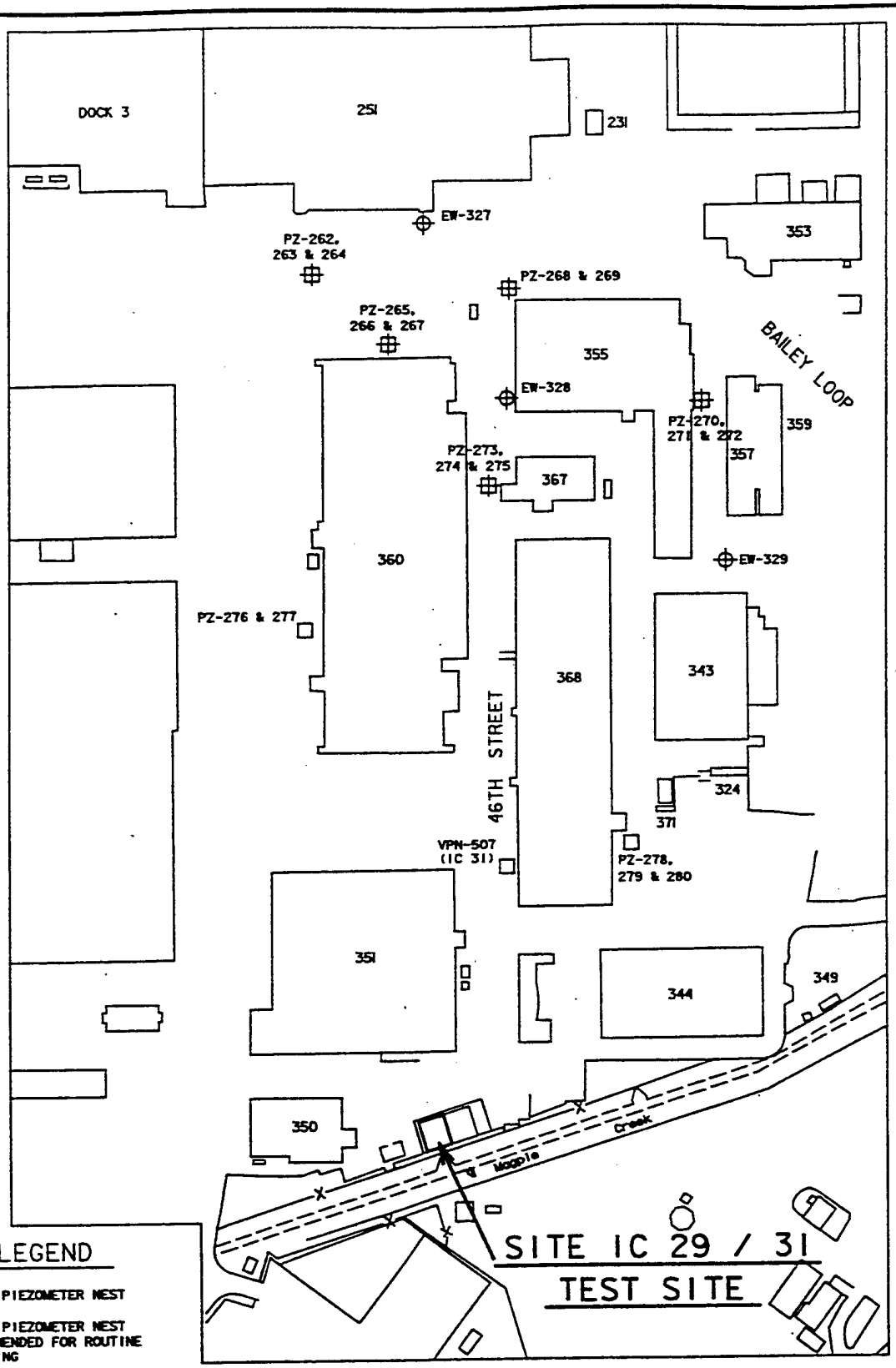
IC 29 covers approximately 9 acres in the north-central portion of operable unit (OU) A (Figure 3-2) and contains six sites: PRL L-2B, PRL S-1, PRL S-22, study area (SA) 67, SA 69, and SA 70 (Figure 3-3).

3.2.1 Location and Setting

IC 29's surface features include buildings, asphalt parking lots, concrete roads, and open dirt areas. The site is relatively flat with an elevation of approximately 70 to 77 feet above mean sea level (Jacobs 1995). Magpie Creek is located south of IC 29. The contamination occurred as the result of historical chemical disposal procedures at McClellan AFB.

3.2.2 Geology

The IC 29 geology is primarily silt with interbeds of sand and sandy silt. One clay lens, approximately 1-foot thick, occurs at approximately 60 feet bgs. Sand beds vary in thickness from a few feet to approximately 45 feet. Typical of a fluvial depositional environment, the soil layers are relatively discontinuous (Jacobs 1995). Groundwater occurs at approximately 105 feet bgs and flows to the southwest.



LEGEND

- VAPOR PIEZOMETER NEST
- VAPOR PIEZOMETER NEST RECOMMENDED FOR ROUTINE SAMPLING
- VAPOR WELL
- VAPOR WELL RECOMMENDED FOR EXTRACTION

* LOCATIONS ARE APPROXIMATE

SCALE IN FEET

0 100 200

FIGURE 3-3

IC 29 / 31 SITE MAP

McCLELLAN AFB

SACRAMENTO, CA

URS Greiner

M-AFB\IC29\WELLFIG

3.2.3 Hydrogeology

Not applicable

3.2.4 Site History

PRL L-2B consists of a portion of the IWL, an underground piping system used to collect wastewater from various McClellan AFB processing and work areas for treatment at the IWTP in OU C1.

PRL S-1 is the former location of a plating shop at Building 343 and is currently used as office space for the 2951 Squadron Combat Support Logistics. Building 343 housed a plating shop, a sandblasting shop, a battery shop, a buffing shop, a lacquer shop, and a chemical degreasing operation from 1944 to 1959. Trenches were located beneath the plating line tanks to collect and transport spilled and discharged wastes. The wastes were neutralized and pretreated in tanks before being discharged into the trenches. The trenches carried wastes from Building 343 into either of two IWL lines.

PRL S-22 consists of Building 355, which has housed several types of operations since its construction in the late 1930s including battery and hydraulic pump and motor repair. Two solvent spray booths with IWL drains were located in the building: one in the south wind in which batteries were repaired, and one located in the hydraulic shop. A bulk solvent aboveground storage tank (AST) was located adjacent to the south wall of Building 355. In 1981, ongoing operations included a degreaser and a paint spray booth. The degreaser was locate din the general area of the hydraulic shop. In 1983, the hydraulic and pneumatic shops were converted to office space. The concrete floors were washed and all of the ceiling tiles were replaced because hydraulic fluid had splashed on them. Three underground storage tanks (USTs) located adjacent to Building 355 stored fuel for the boiler at Building 367. The tanks were cleaned out in 1988 and currently contain diesel fuel.

SA 67 consists of Building 360, the former location of an aircraft washrack and the current location of aircraft maintenance. The building is divided into eight bays. The area adjacent to the building is used as a parking lot. To the west of Building 360 is the former location of a washrack used to clean and remove paint from aircraft. The washrack was situated on concrete/asphalt that was badly cracked. It is unknown if the washrack drained into the storm drain system or the IWL system. Adjacent to the west side of the building is a 400-gallon hydraulic fluid AST which rests on asphalt, and a 1,000-gallon steel bowser tank used to store spent oil and hydraulic fluid. It is in an asphalt berm where oily residue was observed during a site visit. A sump is located west of the building; another sump is located in the floor of Building 360. A hazardous waste storage area is located at the southeast corner of Building 360.

SA 69 consists of Building 367, the location of the Base steam generation facility, an abandoned-in-place concrete UST northwest of Building 367 used to store JP-5 fuel, chemical mixing tanks outside the building, a sump in the northwest portion of the building used to store oil and water run-off from the boilers (no longer used), and an IWL sump located on the south side of Building 367.

SA 70 is the location of a former physical testing laboratory and a parachute shop at Building 368. In the physical testing laboratory, tests were performed on hazardous materials, aircraft parts, fuels, industrial waste, soils, and water that are collected throughout McClellan AFB. Parachute operations mainly involve parachute and parachute parts maintenance. A hydraulic unit located on the west side of Building 368 supplies hydraulic fluid to a hydraulic press in Building 368. Historically,

approximately 150 different hazardous materials have been used in the laboratory and parachute maintenance operations. Disposal methods for these materials have consisted of discarding into the IWL and transportation and disposal off-site of bulk material.

3.2.5 Contaminant Extent

Contaminant sources identified in IC 29 include:

- The IWL sections on the east side of Building 360 where halogenated VOCs were present in shallow and downhole soil gas samples.
- PRL S-22. The diesel UST is a source of petroleum hydrocarbons and semivolatile organic compound (SVOC) contamination; the solvent AST is a source of halogenated VOC contamination in soil gas.
- Former SA 67 washrack. Soil gas, soil, and groundwater are contaminated with polychlorinated biphenyls (PCBs), diesel, and aromatic and halogenated VOCs.
- Former SA 69 UST. The former UST was likely the source of diesel found in one grab water sample at 3.5 feet bgs. TCE, PCE. and total volatile hydrocarbons were reported in shallow soil gas around the perimeter of Building 67.

A groundwater plume exists beneath IC 29 with TCE being the most widespread contaminant. IC 29 appears to be a partial contributor to the plume since TCE concentrations in groundwater increase downgradient of IC 29. The sources of groundwater contamination, however, have not been completely identified.

Table 3-2

VOLATILE ORGANIC COMPOUNDS DETECTED AT IC 29 DURING REMOVAL ACTION SAMPLING

Halogenated	Non-Halogenated
Trichloroethene	Benzene
cis-1,2-Dichloroethene	Toluene
Tetrachloroethene	Ethylbenzene
1,1-Dichloroethene	Xylenes
cis-1,2-Dichloroethene	Non-Methane Hydrocarbons
1,1,1-Trichloroethane	
Dichloromethane	
Freon® 113	
Chlorobenzene	
Chloroform	
Vinyl chloride	
Dichloromethane	
Carbon Tetrachloride	
Methylene Chloride	

4.0 DEMONSTRATION DESCRIPTION

4.1 Technology Principles

Photocatalytic ARPs use UV light in the presence of oxidants (O_3 and hydrogen peroxide [H_2O_2]) or semiconductors to produce OH^-. The Matrix TiO_2 Photocatalytic Technology utilizes a semiconductor (TiO_2) in the presence of UV light and O_3 to generate reduction/oxidation species to destroy organic contaminants.

Semiconductors are solids that have electrical conductivities between those of conductors and those of insulators. Semiconductors are characterized by two separate energy bands: a low-energy valence band and a high-energy conduction band. Each band consists of a spectrum of energy levels in which electrons can reside. The separation between energy levels is small, essentially forming a continuous spectrum. The energy separation between the valence and conduction band is called the "band gap" and consists of energy levels in which electrons cannot reside.

Photons can be used to excite an electron from the valence band into the conduction band. When an electron in the valence band absorbs a photon, the absorption of the photon increases the energy of the electron and enables the electron to move into one of the unoccupied energy levels of the conduction band. However, because the energy levels of the valence band are lower than those of the conduction band, electrons in the conduction ban will eventually move back into the valence band leaving the conduction band empty. As this occurs, energy corresponding to the difference in energy between the bands is released as photons or heat. Because photons can be used to excite a semiconductor's electrons and enable easy conduction, semiconductors are said to exhibit photoconductivity.

Semiconductors that have been studied for commercial photocatalytic processes include TiO_2, strontium titanium trioxide, and zinc oxide. Because of TiO_2's high level of photoconductivity, ready availability, low toxicity, and low cost, TiO_2 is generally preferred for use in commercial AOP applications. TiO_2 has three crystalline forms: rutile, anatase, and brookite. Studies indicate that the anatase form provides the highest OH^- formation rates (Tanaka et al. 1993).

TiO_2 exhibits photoconductivity when illuminated by photons having an energy level that exceeds the TiO_2 band gap energy level of 3.2 electron volts. For TiO_2, the photon energy required to overcome the band gap energy and excite an electron from the valence to the conduction band can be provided by UV radiation having a wavelength between 185 and 385 nm. When an electron in the valence band is excited into the conduction band, a vacancy or hole is left in the valence band. These holes have the effect of a positive charge. The result is that the electron is in an unstable, excited state, and the electron-hole pairs within a semiconductor tend to reverse to a stage where the electron-hole pair no longer exists; however, the band gap inhibits this reversal long enough to allow excited electrons and holes near the surface of the semiconductor to participate in reactions at the semiconductor surface.

Because of the relatively low cost and hazards associated with UV-A lamps with a predominant wavelength of 350 nm, they are frequently used in TiO_2 photocatalytic oxidation applications. Matthews and McEvoy (1992) indicate that photocatalytic reactors that use UV lamps with a predominant wavelength of 254 nm (UV-C) are more effective in promoting organic compound destruction than reactors that use UV-A lamps with a predominant wavelength of 350 nm. One

possible reason for the improved performance of the 254-nm light is that 254-nm light is strongly absorbed by TiO_2; therefore, the penetration distance of photons is relatively short, allowing electron-hole pairs to form closer to the TiO_2 surface where contaminant destruction occurs. Many organic molecules are excited by 254-nm light and may be solely excited by 254-nm light. Hybrid low pressure mercury lamps that emit both 185 and 254 nm wavelength light were used during the optimization phase of the demonstration.

A simplified TiO_2 photocatalytic process flow diagram is presented in Figure 4-1. This mechanism is still being researched, and published research indicates that the primary photocatalytic mechanism is believed to proceed as follows (Al-Ekabi and others 1993):

$$TiO_2 + hv => e^-_{CB} + h^+_{VB} \qquad (1\text{-}1)$$

where

hv	=	light energy (photon)
e^-_{CB}	=	electron in the conduction band
h^+_{VB}	=	hole in the valence band

At the TiO_2 surface, the holes react with hydroxide ions (OH^-) to form •OH as follows:

$$h^+_{VB} + H_2O => \bullet OH + H^+ \qquad (1\text{-}2)$$

$$h^+_{VB} + OH^- => \bullet OH \qquad (1\text{-}3)$$

where

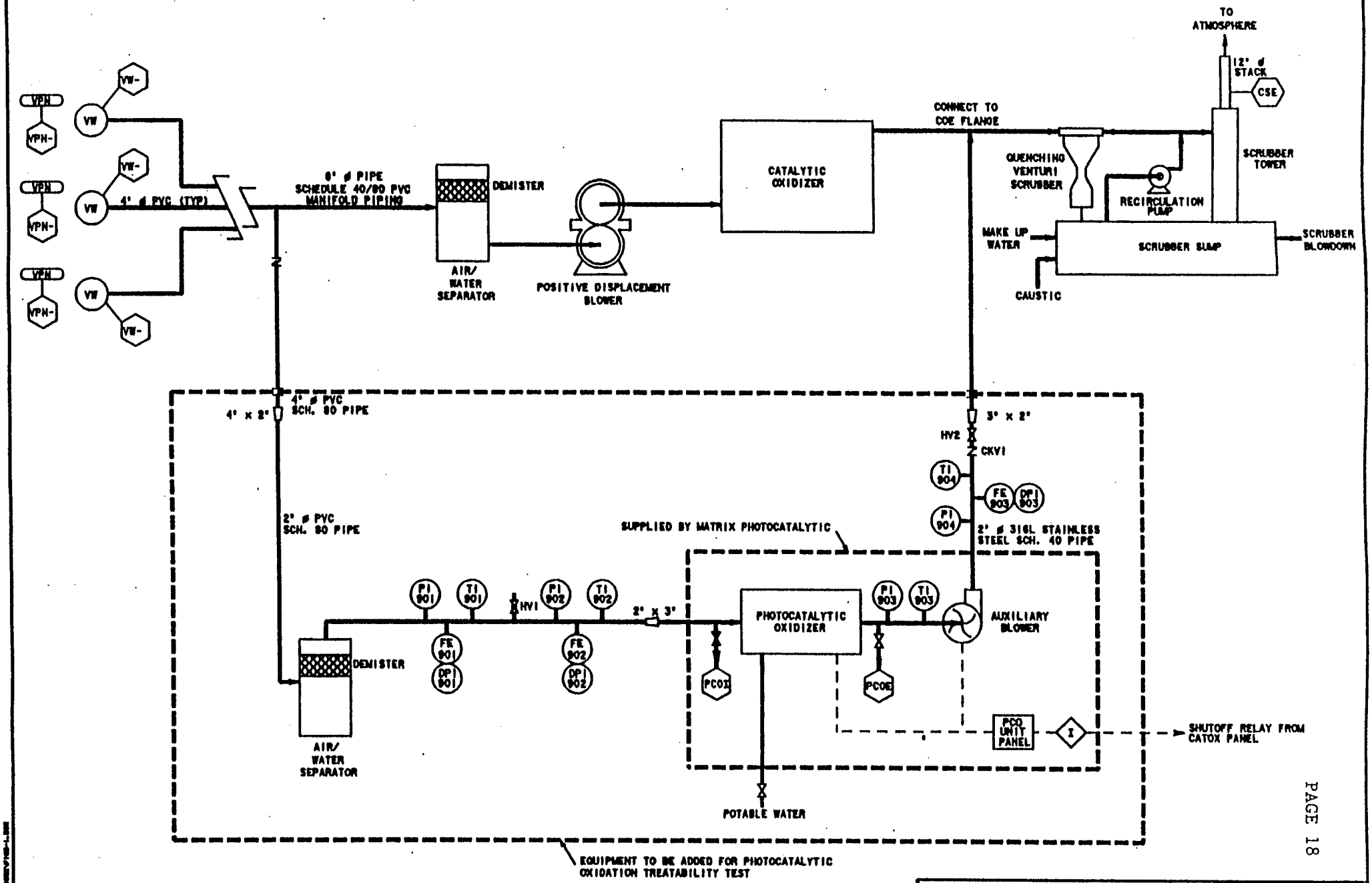
H^+	=	proton

An additional reaction may occur when the electron in the conduction band reacts with oxygen (O_2) to form superoxide ions ($\bullet O_2^-$) as follows:

$$e^-_{CB} + O_2 => \bullet O_2^- \qquad (1\text{-}4)$$

These $\bullet O_2^-$ can then react with H_2O to provide additional •OH, OH^-, and O_2 as follows:

$$2\bullet O_2^- + 2\,H_2O => 2\bullet OH + 2\,OH^- + O_2 \qquad (1\text{-}5)$$



URS Consultants

FIGURE 4-1
PIPING AND INSTRUMENTATION DIAGRAM
PHOTOCATALYTIC OXIDATION TREATABILITY TEST

The OH^- then can react with the hole in the valence band in accordance with Equation 1-3 to form additional •OH. One practical problem of semiconductor photoconductivity is the electron-hole reversal process. The overall result of this reversal is the generation of photons or heat instead of •OH. This process significantly decreases the photocatalytic activity of a semiconductor (Al-Ekabi et al. 1993). One possible method of increasing the photocatalytic activity of a semiconductor is to add irreversible electron acceptors (IEA) such as O_3 to the vapor to be treated. Once IEAs accept an electron in the conduction band or react with $\bullet O_2^-$, the IEAs dissociate and provide additional routes for •OH generation. H_2O_2 is an IEA and can illustrate the role IEAs may play in AOPs. When the IEA O_3 accepts an electron in the conduction band, it dissociates in accordance with the following reaction:

$$2O_3 + 2e^-_{CB} => O_2 + 2\bullet O_2^- \qquad (1\text{-}6)$$

O_3 not only inhibits the electron hole reversal process and prolongs the lifetime of the photo-generated hole, it also generates additional OH.

Organic compounds can be destroyed by a variety of reactions with •OH. These reactions include addition, hydrogen abstraction, electron transfer, and radical-radical combination.

The photocatalytic oxidation of gaseous alkanes, alkenes and alcohols, over illuminated TiO_2 has been well documented in the literature. The reactions under these conditions proceed, if not controlled, all the way to CO_2 and H_2O. The oxidation of these organic compounds proceed via the following scheme:

$$\text{Alkanes} \xrightarrow[TiO_2]{hv} \text{Alcohols} \xrightarrow[TiO_2]{hv} \text{Alkenes} \xrightarrow[TiO_2]{hv} \text{Aldehydes and/or Ketones} \xrightarrow[TiO_2]{hv} CO_2 \text{ and } H_2O$$

The adsorbed photoactivated atomic oxygen oxidizes the alkanes into the corresponding alcohol. The photooxidation of alcohols could take two pathways: (a) dehydration into the corresponding alkenes or (b) direct oxidation to aldehydes or ketones. The first step in the photooxidation of a tertiary alcohol should always be its dehydration into an alkene which is then oxidized into aldehydes and ketones. Primary alcohols, on the other hand, oxidize directly to aldehydes. Secondary alcohols could dehydrate into alkenes or oxidize directly into ketones.

If sufficient •OH is not generated to completely oxidize contaminants to carbon dioxide (CO_2) and water (H_2O), stable intermediates may be formed. The types of intermediates formed depend on the initial levels and types of contaminants. Studies of TiO_2 photocatalytic technologies have analyzed potential stable intermediates resulting from treatment of chlorinated organics.

Some compounds commonly present in the vapor stream may react with the reactive species formed by the Matrix treatment system, thereby exerting an additional demand for reactive species on the system. These compounds are called scavengers and can potentially impact system performance. A scavenger is defined as any compound in the vapor stream other than the target contaminants that consumes reactive species such as •OH

4.2 Treatment System Installation and Operation

4.2.1 Well Installation, Drilling, and Sampling

Not applicable

4.2.2 Monitoring System

The monitoring system for the PCO system consisted of pitot tubes to calculate flow and bi-metal thermometers for temperature readings upstream of the PCO inlet and downstream of the PCO outlet. Sampling occurred at the inlet and exhaust of the PCO unit. Additionally, sampling for chlorine and phosgene was conducted at the caustic scrubber exhaust to monitor the stack emission for protection of workers and the general public.

4.2.3 Instrumentation and Control

The PCO unit instrumentation and control consisted of:

- Averaging pitot tubes to calculate flow rate.
- Bi-metal thermometers for temperature readings at the PCO inlet and outlet.
- Start-up and shutdown switches to control the regenerative blowers.
- Individual circuit breakers to control the bank of UV lamps.
- Interconnection with the air stripper supplying the vapor stream to shut the system down in the event of an air stripper shutdown.
- Interconnection with the caustic scrubber that was treating the exhaust from the PCO to shut down the system in the event of a caustic scrubber shutdown.

The 440 volt power was supplied to a transformer which stepped the voltage down to 220 volts. This was controlled by an on/off switch. The 220 volt power was then wired to a power panel within the PCO trailer.

4.3 The Two Phases of the Technology Demonstration

Two phases of the treatability study were conducted: the optimization phase and the operation phase. The purpose of sampling and analysis during the optimization phase was to determine the optimal operating parameters to meet at least 95 percent DRE with minimal generation of byproducts

The demonstration was originally scheduled to be performed at OU C1, however before the demonstration began, an SVE removal action was implemented in August 1995. By the end of October 1995, the removal action had resulted in an order of magnitude reduction in the target chlorinated hydrocarbons. In addition, several LCSPHs were present in the vapor stream that caused fouling of the catalyst. The demonstration was terminated during the optimization phase due to low DREs which were in the range of 10 to 40 percent with a high degree of scatter in the data.

The demonstration was then moved to IC 29 where the optimization required approximately 2 weeks. The operation phase also lasted approximately 2 weeks during which samples were collected and analyzed to monitor the DRE and emissions to verify system performance.

4.4 Sampling Strategy and Quality Assurance/Quality Control (QA/QC) Results

This section presents the rationale and procedures for sampling activities proposed during the PCO treatability test at McClellan AFB.

4.4.1 Pre-Demonstration Sampling

No pre-demonstration sampling was required as part of the demonstration. Sampling results from the air stripper were provided by Mr. Jeff Lawrence of Radian International, the operator of the air stripper at IC 29.

4.4.2 Technology Operation

The system optimization at OU C1 was carried out in accordance with the matrix presented on Table 1 of Appendix A. The demonstration was carried out in accordance with the Final Titanium Dioxide Photocatalytic Oxidation Treatability Test Work Implementation Plan (WIP), October 1995. The demonstration at OU C1 was terminated during the optimization phase due to low DREs, as mentioned above. The vendor had the catalyst examined by a scanning electron microscope and determined that the catalyst had been fouled by LCSPHs present in the contaminant stream that were not identified during the demonstration's design phase. URSG worked with EMR to locate a site with a higher percentage of chlorinated compounds, which also did not have high petroleum contaminant concentrations. EMR identified IC 29 where an air stripper was stripping chlorinated compounds extracted from groundwater wells into a vapor stream.

The WIP was not formally reissued, rather it was adapted to the conditions present at IC 29. Specifically, since the vapor was dilute (20 parts per million by volume [ppmv]), no dilutions were performed, and a path length of two reactors was employed. During the time between the optimization at OU C1 and the mobilization at IC 29, the hybrid lamps became available and were integrated into the matrix. These changes reduced the total number of optimization runs from 24 conditions to 8 conditions.

The PCO system was optimized using the dilute off-gas stream from the air stripper at IC 29 according to the sampling matrix presented in Table 5-2, using the analytical methods presented in Tables 4-1 and 4-2. The air stripper was stripping contaminants from groundwater wells EW321, EW323, EW324, and MW224. The influent and effluent concentrations were analyzed by Method 8021. This optimization testing yielded the highest DREs with a combination of a low flow, O_3 addition, and hybrid low-pressure mercury lamps emitting frequencies of 185 and 254 nm. This condition was selected for demonstration.

During the operation phase, once system parameters had been optimized, samples were collected for the analyses listed in Table 4-3. Samples were collected more frequently at the beginning of the

operation phase to monitor system performance and decreased to once per week to minimize analytical costs. Six samples for each parameter were expected to be sufficient to determine relative stability of the system, average DRE, and influent concentration-dependent emissions.

4.4.3 Post-Demonstration Sampling

Not applicable

4.4.4 Shutdown Monitoring

Not applicable

4.4.5 Quality Assurance Sampling

Sampling occurred at three locations during the optimization and operation phases: 1) the influent (photocatalytic oxidizer influent [PCOI]), 2) the effluent (photocatalytic oxidizer effluent [PCOE]), and 3) the caustic scrubber effluent (CSE) (Figure 4-1). The CSE was only sampled for compounds with no demonstrated IC 29 scrubber removal efficiency which had a potential to be present (i.e., chlorine [Cl_2], phosgene). The purpose of the CSE sampling was to ensure that if these constituents were being produced during the process, they would be neutralized by the scrubber to protect workers and the general public from exposure. The majority of samples were collected from the PCOI and PCOE. During the optimization phase, samples were collected for all of the analyses presented in Table 4-1 for every set of system parameters. Three sets of varying system parameters were tested. The frequency and total number of field and QC samples are presented in Table 4-2.

Gas samples collected for analysis by an on-site gas chromatograph (GC) were collected in Tedlar® bags following the technical standard operating procedure (TSOP) PCO-002 and California Air Resources Board (CARB) Method 422.1, "Standard Operating Procedures for the Sampling of Volatile Organic Compounds in Emissions from Stationary Sources into Tedlar® Bags." Cleaned, leak-free, evacuated Tedlar® bags were used to collect gas samples from the PCOI and PCOE locations. These samples were taken to an on-site laboratory and analyzed by GC using modified EPA Method 8021 and EPA Method 18 (E18).

Carbon monoxide (CO) was tested for at the PCOE in Tedlar® bags according to American Society of Testing and Materials (ASTM) Method D3416. The Tedlar® bag samples were shipped to an off-site laboratory for GC analysis.

Vapor samples were screened for phosgene, hydrochloric acid (HCl), and Cl_2 using Draeger® tubes. All Draeger® tube samples were collected in triplicate. Clean Tedlar® bags were used to collect samples from the PCOE. The sample was then drawn from the Tedlar® bag through the Draeger® tube sample orifice according to procedures outlined in the Draeger® manual.

Table 4-1

SUMMARY OF SAMPLE LOCATIONS AND ANALYSES DURING THE PCO TREATABILITY STUDY OPTIMIZATION PHASE

Sampling Location	PCO System Treatability Study Monitoring Analyses			
	Vapor			
	Flow, Temperature, Pressure, Humidity	Halogenated and Aromatic VOCs and NMOCs (8021 and TO14)	Phosgene (Draeger® Colorimetric Tube)	Carbon Monoxide (ASTM D3416)
PCOI	X	X		
PCOE	X	X[1]	X	X
CSE			X[2]	

PCO	Photocatalytic oxidation	VOCs	Volatile organic compounds
NMOCs	Non-methane organic compounds	PCOI	PCO influent
PCOE	PCO effluent	CSE	Caustic scrubber effluent
ASTM	American Society of Testing and Materials		

(1) The 8021 method included the reporting of unknown analytes and estimation of concentration so that the presence or absence and relative concentration of intermediates (although not identified) can be determined.

(2) This sample was only collected at this location if phosgene had been detected at the PCOE under these same operating parameters.

Table 4-2

PCO SYSTEM SAMPLING - OPTIMIZATION PHASE

Parameter	Method	Sample Location	Samples (Primary + Field QC Type)		
			Each Test Condition[3]	Location Total	Analysis Total
Flow, Temperature, Pressure, Humidity	–	PCOI	1	8	16
		PCOE	1	8	
Halogenated and Aromatic VOCs and NMOCs	8021 and E18 modified (On-site GC)	PCOI	1	8	16
		PCOE	1	8	
Phosgene	Draeger® Tube[1]	PCOE	1	8	12
		CSE[2]	1	4	
Carbon Monoxide	ASTM D3416	PCOE	1	8	8
				GRAND TOTAL	52[4]

(1) All samples were collected and analyzed in triplicate.
(2) These samples were only collected at this location if phosgene has been detected at the PCOE under these same operating parameters.
(3) Estimate of 8 test conditions using TO14 analysis.
(4) QC samples are not included in the total analyses. The QC samples analyzed at the optimization phase included those described in Subsection 4.6 at the required frequencies.

PCO	Photocatalytic oxidation	VOCs	Volatile organic compounds
NMOCs	Non-methane organic compounds	PCOI	PCO influent
PCOE	PCO effluent	CSE	Caustic scrubber effluent
ASTM	American Society of Testing and Materials	GC	Gas chromatography
QC	Quality control		

Table 4-3
SUMMARY OF SAMPLE LOCATIONS AND ANALYSES DURING THE PCO TREATABILITY STUDY OPERATION PHASE
PCO System Treatability Study Monitoring Analyses

Vapor Monitoring Parameters	Sampling Location		
	PCOI	PCOE	CSE
Flow, temperature, pressure, humidity	X	X	
Halogenated and aromatic VOCs and NMOCs (8021 and E18 mod.)	X	X	X
VOCs (Method TO-14 plus TICs and TPH)	X[1]	X[1]	X[2]
Carbon monoxide (ASTM D3416)		X	
Hydrochloric acid (Draeger® Tube)		X	
Chlorine (Draeger® Tube)		X	X[2]
Nitrogen oxides (CARB 100)		X	

[1] Method TO-14 analyses included total petroleum hydrocarbons (TPH), and tentatively identified compounds (TICs).

[2] Samples were collected at this location if phosgene or other toxic VOCs (analyzed by Method TO-14) or chlorine (analyzed by Draeger® tubes) were detected at the PCOE previously under these same operating parameters.

PCOI	Photocatalytic oxidation influent	PCOE	Photocatalytic oxidation effluent
CSE	Caustic scrubber effluent	VOCs	Volatile organic compounds
NMOCs	Non-methane organic compounds	TICs	Tentatively identified compounds
TPH	Total petroleum hydrocarbons	CARB	California Air Resources Board
ASTM	American Society of Testing and Materials		

Canister Samples

Vapor samples collected for analysis by EPA Method TO-14 were collected in canisters following EPA guidance (EPA 1984). Canister samples are collected to verify the on-site GC analytical results, calculate analyte-specific DREs, and provide definitive emission data during the operation phase.

Continuous Monitoring

Gas samples were collected from the PCOE and drawn through a continuous analyzer for determination of NOx by CARB Method 100. Three readings were taken and reported.

4.4.6 Flow Rate Determination

Vapor flow rates were measured using an averaging pitot tube. Gas density is necessary to calculate volumetric flow rates from differential pressures measured by pitot tubes. Since moisture content can affect density, it was monitored with a hand-held humidity meter (Omega Model No. RH-20). Gas density is also affected by gas temperature and pressure, which was monitored with dial gauges installed at the PCO unit inlet and outlet.

4.4.7 Sample Containers, Holding Times, and Preservation

The sample containers, preservation requirements, and analytical holding times for the vapor samples collected during the treatability study are specified in Table 4-4.

4.5 Sample Designation

The sample numbering scheme was developed to easily identify the location of each sample and calculate DRE and emissions during the optimization and operation phases. Samples were identified according to the sample identification scheme specified in Table 4-5.

Samples collected on the same day and at the same location (i.e., influent or effluent) for different analyses were given the same identification number. Influent and effluent samples collected on the same day with the same set of conditions both contained the same xx (see Table 4-5) part of the sample number for ease in determining which influent and effluent samples are related. Note that only one set of samples for the various parameters were collected on any given day in accordance with the WIP.

4.6 Field Quality Control

The field QC samples included VOC verification samples, field duplicates, trip blanks, and field blanks. A description of the purpose and frequency of collection of each of these follows.

- VOC Verification Samples. VOC verification samples were collected to verify the identity and concentration of the contaminants identified in the on-site laboratory sample results. During the optimization phase, approximately 10 percent of the vapor samples sent to the on-site laboratory for VOC analysis were also collected in SUMMA® canisters and analyzed using Method TO-14 at an off-site laboratory.

  VOC samples collected during the operation phase were analyzed by both the on-site laboratory for rapid assessment of the PCO process and the off-site laboratory using Method TO-14 for verification of on-site laboratory sample results and identification of any intermediate products or byproducts (i.e., phosgene). The canister samples collected during operation were considered primary samples and were collected at both the PCOI and the PCOE, providing 100 percent verification.

Table 4-4

SAMPLE CONTAINER AND HOLDING TIME REQUIREMENTS FOR VAPOR SAMPLES FROM THE PCO TREATABILITY STUDY

Parameter	Analytical Method	Sample Container	Holding Time	Preservation
Halogenated and Aromatic VOCs and NMOCs (On-site GC)	Method 8021 and E18 modified	Tedlar® bag	24 hours	None
VOCs (Off-site lab)	Method TO-14	SUMMA® Canister	14 days	None
Hydrochloric Acid	Draeger® tube	Tedlar® bag	As collected	None
Chlorine	Draeger® tube	Tedlar® bag	As collected	None
Phosgene	Draeger® tube	Tedlar® bag	As collected	None
Carbon Monoxide	ASTM D3416	Tedlar® bag	72 hours[1]	None
Nitrogen Oxides	CARB 100	Continuous Monitor	As collected	None

[1] No holding time is documented in the method; this holding time is typical for samples collected in Tedlar® bags.

VOCs Volatile organic compounds
NMOCs Non-methane organic compounds
ASTM American Society of Testing and Materials
GC Gas chromatography
CARB California Air Resources Board

Table 4-5

SAMPLE IDENTIFICATION SCHEME

Phase	Sample Location	Sample Identification Number[1]
Optimization	Process Influent	OPTA - xx
Optimization	Process Effluent	OPTE - xx
Operation	Process Influent	A - xx
Operation	Process Effluent	E - xx
Operation	Caustic Scrubber Effluent	SE - xx
Both Phases	Field Duplicates	QD - xx
Both Phases	Field Blanks	QB - xx
Operation	Trip Blanks	QT - xx
Both Phases	Audit Samples	QS - xx

(1) xx indicates consecutive numbers from the start of each phase of the treatability study.

Field Duplicates. Field duplicate results are used to assess overall precision, which includes variability of both the sample collection process and laboratory analysis. For this project, field duplicates were collected at a minimum frequency of one per ten samples. Draeger® tube samples were collected and analyzed in triplicate for every sample location.

Trip Blanks. Trip blank results are used to identify VOC contamination from sample media or transport and storage procedures. Trip blanks are subject to the same handling protocols as environmental samples. Trip blanks accompanied one of the shipments of VOC gas samples analyzed by the off-site laboratory using Method TO-14 at a frequency of approximately 10 percent. Trip blanks did not accompany samples hand-delivered to the on-site laboratory.

Field Blanks. Field blanks are used to determine whether contaminants detected in samples are actually present in the sample, or are a result of external contamination of the sample media during the sampling process. Field blanks were collected for VOCs and HCl to assess the on-site ambient concentrations. The field blanks were collected in a manner similar to field sample collection and at a minimum frequency of 10 percent.

5.0 TECHNOLOGY PERFORMANCE EVALUATION

This section summarizes the results of the system optimization of the TiO_2 based PCO system at OU C1, and the subsequent system optimization and demonstration at IC 29. The complete details of the system optimization at OU C1 are presented in Appendix A.

5.1 Optimization at OU C1

The demonstration was originally scheduled for OU C1 based on the design maximum influent concentrations provided to the vendor and presented in Table 5-1. As previously mentioned, an SVE removal action changed the character of the contamination present at the site (see Table 5-1).

Table 5-1
PROCESS STREAM CHARACTERIZATION AT OU C1

Compound	Design Maximum Influent Concentration (ppmv)	Actual Influent Concentration (Oct. 25, 1997) (ppmv)
Vinyl Chloride	11	2.1
1,1-Dichloroethene	6	<1
Methylene Chloride	61	17.5
1,1-Dichloroethane	4	<1
cis-1,2-Dichloroethene	260	19.9
Chloroform	5	<1
1,1,1-Trichloroethane	8	3.9
Benzene	20	3.2
1,2-Dichloroethane	120	8.8
Trichloroethene	3,000	176
Toluene	38	10.3
Ethylbenzene	11	1.8
m,p-Xylene	37	2.8
o-Xylene	13	2.6
Styrene	19	<1
1,3,5-Trimethylbenzene	5	1.9
1,2,4-Trimethylbenzene	19	5.6
1,4-Dichlorobenzene	1	<1
1,2-Dichlorobenzene	5	<1
n-Octane	50	17.1
Acetone	140	<1
Cyclohexane	100	<1
Tetrachloroethene	100	<1
Total Freons®	<5	<1
TNMHC	6,000	3,500-4,400

ppmv Parts per million by volume TNMHC Total non-methane hydrocarbons

5.1.1 Performance Data/System Optimization

The parameters tested during optimization at OU C1 included flow rate, O_3 addition, dilution of the contaminant stream, and varying path length in accordance with the sampling matrix presented in the Treatability Test Parameters Matrix Results (Table 1, Appendix A). Flow rates were varied by use of two regenerative blowers in a parallel configuration. One blower was used for the minimum flow (11 to 13 cfm) and two blowers were used to achieve the maximum flow (46 to 49 cfm). The path length was varied by varying the number of reactor path lengths that the vapors passed through. The shorter path length passed the vapor through 2 reactors, and the longer path length passed it through 6 reactors (each reactor cell is approximately 6 feet in length). The O_3 addition was varied between no ozone and 1.13 cfm at a concentration of 30,000 parts per billion by volume (ppbv) of ozone. The vapor concentrations were varied by using no dilution air, 50 percent dilution air, and 90 percent dilution air.

5.1.2 Remediation Efficiency

The results of the optimization at OU C1 showed very low DREs ranging from -30 percent (the minus denoting generation of the constituent) to 26.5 percent for 1,2-DCE, from -25.9 to 28.6 percent for TCE, and from -23 to 41 percent for NMOCs. The DREs for each test condition are presented in Table 1, Appendix A. On the basis of these results, the demonstration was terminated.

5.1.3 Process Flow Efficiency

Technical problems were encountered during the optimization of the PCO unit at OU C1. The lessons learned during the optimization included:

1) The power output of the UV lamps dropped significantly above 120°F. To solve this problem, the regenerative blowers were placed downstream of the PCO unit so that the vapor were drawn through the unit and did not heat the UV lamps.

2) The catalyst was fouled by the introduction of LCSPHs. To solve this problem the vendor replaced the old catalyst with new catalyst and requested a new site to conduct the demonstration.

Vendor supplied material indicates that the PCO unit has a low destruction efficiency when treating acetonitrile, acrylonitrile, bromodichloromethane, carbon tetrachloride, 1,1-DCA, dibromochloromethanecetornitrile, 1,2-dibromo-3-chloropropane, 1,2-dichloroethane, dichloropropane, hydrazines, MeCl, 1,1,1-TCA, 1,1,2-Trichloroethane. A vendor supplied list of contaminants and their relative destruction performance is presented in Appendix B.

EMR identified IC 29 where an air stripper was being operated to strip chlorinated compounds from groundwater into a vapor stream. EMR personnel approved the proposed redeployment of the PCO unit to IC 29.

5.2 Performance Data/System Optimization at IC 29

The system was optimized on a slipstream drawn from the air stripper at the groundwater treatment plant at IC 29. The parameters tested during optimization included flow rate, O_3 addition, and UV wavelength, values for which are summarized in Table 5-2. The tests were conducted as follows:

- Test 1 used the maximum flow rate, without O_3 addition and normal lamps
- Test 2 used the maximum flow rate, with O_3 addition and normal lamps
- Test 3 used the minimum flow rate, with O3 addition and normal lamps
- Test 4 used the minimum flow rate, without O_3 addition and normal lamps
- Tests 5-8 replicated the flow rates and O_3 additions in Tests 1 through 4 using the hybrid lamps
- Tests 9 replicated the conditions of Test 7. The vendor then modified the ozone generator to savage oxygen (O_2) from atmospheric air to create ozone, and varied the concentrations of O_3 from 10 liters/minute (l/min) for Test 10, to 5 (l/min) for Test 11, and 20 (l/min) for test 12.

Table 5-2
Major Variables Associated with Optimization Phase

Test	Flow Rate	Ozone Addition		UV Wavelength		Destruction and Removal Efficiency (DRE)	
	(scfm)	None	10 L/min	254 nm	185 & 254 nm	Total VOC %	TCE %
1	49	X		X		83.2	90.2
2	50		X	X		92.1	97.9
3	48		X	X		93.9	99.8
4	49	X		X		93.2	99.9
5	45	X			X	92.7	99.4
6	45		X		X	95.0	99.8
7	47		X		X	95.1	99.9
8	47	X			X	94.9	99.9
9	49		X		X	93.0	99.7
10	49		10 L/min atm. air		X	95.5	99.7
11	47		5 L/min atm. air		X	95.6	99.7
12	47		20 L/min atm. air		X	96.1	99.8

nm Nanometers
VOC Volatile organic compounds
% Percent
atm. air Atmospheric air
L/min Liters per minute
TCE Trichloroethene
UV Ultraviolet

- Groundwater Collection and Control
- Air Pollution/Gas Collection and Control
- Solids Collection and Control
- Solids Collection and Containment
- Liquids/Sediments/Sludges Collection and Containment
- Drums/Tanks/Structures/Misc. Demolition and Removal
- Scheduled Equipment Maintenance

7.2.1 Mobilization and Preparatory Work

All PCO cost information was provided by the vendor (Doug Garside, pers. comm.) and reviewed by URSG for reasonableness. The cost information is presented in Appendix J. The mobilization and preparatory costs are the same for the 100 and 500 ppmv streams. The 2,000 ppmv system is slightly larger in size and thus requires more extensive mobilization efforts and preparation.

The cost analysis will assume that the site is located at McClellan AFB. The vendor would charter a semi-tractor trailer to transport the units at an approximate cost of $2,500. The three units are similar enough in size that all three may be characterized by the same cartage fee. A fork lift would be required to unload the equipment from the tractor trailer at a approximate cost of $180 per day rental for 1 day.

Vendor personnel would be mobilized to the site via commercial air travel at a approximate cost of $600 per person for a total cost of $1,200.

Assembly and shakedown of the 100 and 500 ppmv equipment would take vendor personnel 4, 8-hour days at a cost of $45 per hour for a total cost of $1,500.

Assembly and shakedown of the 2,000 ppmv equipment would take vendor personnel 6, 8-hour days at a cost of $45 per hour for a total cost of $2,200.

The estimated total mobilization and preparatory work required for the 100 and 500 ppmv systems would be $5,400 and $6,120 for the 2,000 ppmv system.

7.2.1 Monitoring, Sampling, Testing, And Analysis: Pre-Demonstration and Post-Demonstration

Not applicable

7.2.2 Site Work

The equipment requires installation of 220-240 volt, single-phase, 60 Hertz electrical service, if it is not already present at the site. The 100 and 500 ppmv systems would require a 150 amp service and the 2,000 ppmv system would require a 200 amp service. The equipment has existing panel boxes and requires electrical lines to be run from the electrical supply. The estimated cost of providing 500 feet of adequate electrical line for the 100 and 500 ppmv systems is $5,000, with an additional electrical hook-up/start-up fee of $4,000. The estimated cost of providing 500-feet of adequate electrical line for the 2,000 ppmv system is $6,000, with an additional electrical hook-up/start-up fee of $4,000.

7.2.3 Surface Water Collection and Control

Not applicable

7.2.4 Groundwater Collection and Control

Not applicable

7.2.5 Air Pollution /Gas Collection and Control

Operating and Consumable Costs

The primary input to the Matrix system is electricity. The photon source (UV lamps) and irreversible electron acceptor source (ozone generator) both require electrical input. The cost analysis assumes an electrical cost of $0.09 per kWH. Due to the modular nature of the equipment, modules may be turned off as VOC concentrations decay reducing electrical consumption. The electrical savings is incremental with the use of the wafer modules.

The Matrix PCO technology is transportable via a tractor-trailer rig. Assembly and disassembly took approximately 1 day each for two people. The Matrix equipment was capable of utilizing existing site facilities. The demonstration equipment required an area of approximately 200 square feet (ft^2)(10 x 20 feet). A 240V/60 Hertz/single phase/100 amp service is required for the equipment.

The 100 ppmv system contains 324, 65-watt UV lamps, drawing 24.3 kW, at a cost of $2.19 per hour at full capacity. The yearly cost of electricity for the system, with 95 percent operational time, would be $16,000.

The 500 ppmv system contains 396, 65-watt UV lamps, drawing 29.7 kW, at a cost of $2.67 per hour at full capacity. The yearly cost of electricity for the system, with 95 percent operational time, would be, $18,000.

The 2,000 ppmv system contains 540, 65-watt UV lamps, drawing 40.5 kW, at a cost of $3.64 per hour at maximum capacity. The yearly cost of electricity, with 95 percent operational time, for the system would be $22,300.

Destruction of chlorinated compounds in the system produces chloro-acidic effluent. Gaseous acidic emissions are effectively controlled by passing the vapor through a packed tower sodium hydroxide (NaOH) scrubber. The scrubber design is sensitive to flow throughput; variance in acidic concentration is compensated for by adjustment of caustic input. The scrubber would be fitted with a pumping and spray system, demister, recycle tank, pH monitor/controller, electronic valve, and actuator in a closed, skid-mounted system. The scrubber would be electrically interlocked to the PCO. The cost of the scrubber unit would be $9,900 for all three scenarios. Installation of the caustic scrubber, by the manufacturer, is estimated to require a maximum of 5 days at a labor rate of $750 per day for a total of $3,750.

Caustic consumption will decline as off-gas concentrations decay. The consumption of caustic is estimated to be at a maximum of 0.5 gallons per day of 50 percent weight/weight (w/w) NaOH to

remove 99.9 percent of the acidic effluent from the 2,000 ppmv VOC stream. The anticipated cost of 50 percent w/w NaOH is $10 per gallon. The annual cost of caustic per year for the 100 ppmv system would be $700, for the 500 ppmv would be $1,000, and for the 2,000 ppmv would be $1,500.

Operating cost for the systems includes day-to-day operation with scheduled sampling and monitoring. The labor required to replace components is not included in this figure. The operational labor for the equipment is estimated to be: $40,000 for the 100 ppmv system, $45,000 for the 500 ppmv system, and $55,000 for the 2,000 ppmv system.

Equipment Cost

The vendor supplied the following equipment costs:

- The 100 ppmv system would have a capital cost of $112,500.
- The 500 ppmv system would have a capital cost of $137,500.
- The 2,000 ppmv system would have a capital cost of $187,500.

Scheduled Maintenance Cost

The UV lamps are rated by the manufacturer to maintain 85 percent UV output for 10,000 hours. Replacement may be dictated by a gradual decline in performance. The vendor will supply replacement lamps at a cost of $50 per lamp. Labor to change out UV lamps is estimated to be less than 1 day for all 3 scenarios and may be performed by vendor staff or system operator. The portion of the original units required for operation after 10,000 hours of use would be 96 lamps for the 100 ppmv system, 120 lamps for the 500 ppmv system, and 192 lamps for the 2,000 ppmv system at costs of $4,800, $6,000, and $9,600 respectively. The replacement cost is incurred in the second year of operation; therefore, to report an annual rate, the costs have been divided by 2.

For these stream and phase characteristics, the TiO_2 catalyst mesh requires change out once every 3 years at a cost of $75 per cell. Labor to change out the catalyst would be 1 day for the 100 and 500 ppmv systems and 2 days for the 2,000 ppmv system and may be performed by vendor staff or system operator. The amount of catalyst requiring change out has been corresponded to the UV lamps being replaced, i.e., 1 catalyst section per lamp. The cost of replacement catalyst would be $7,200 for the 100 ppmv system, $9,000 for the 500 ppmv system, and $14,400 for the 2,000 ppmv system. The replacement cost is incurred in the third year of operation; therefore, to report an annual rate, the costs have been divided by 3.

7.2.6 Solids Collection and Containment

Not applicable

7.2.7 Liquids/Sediments/Sludges Collection and Containment

Not applicable

7.2.8 Drums/Tanks/Structures/Miscellaneous Demolition and Removal

Not applicable

7.2.9 Biological Treatment

Not applicable

7.2.10 Chemical Treatment

Not applicable

7.2.11 Physical Treatment

Not applicable

7.2.12 Thermal Treatment

Not applicable

7.2.13 Stabilization/Fixation/Encapsulation

Not applicable

7.2.14 Decontamination and Decommissioning

Not applicable

7.2.15 Disposal (Commercial)

Not applicable

7.2.16 Site Restoration

Not applicable

7.2.17 Demobilization

Demobilization of the of the 100 and 500 ppmv systems would require 2, 8-hour days by 2 personnel at a cost of $45 per hour, total cost of $1,500; forklift rental of $180 per day for 1 day to load equipment; and return transportation of equipment to Matrix in London, Ontario, Canada, via tractor trailer, at a cost of $2,500. The total demobilization costs would be $4,200.

Demobilization of the 2,000 ppmv system would require 3, 8-hour days by 2 personnel at a cost of $45 per hour, total cost of $2,200; forklift rental of $180 per day for 1 day to load equipment; and return transportation of equipment to Matrix in London, Ontario, Canada, via tractor trailer, at a cost of $2,500. The total demobilization costs would be $4,900.

7.3 RESULTS OF COST ANALYSIS

Table 7-1
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm) Catalytic Oxidation (CatOx)/PASS Unit

Capital Cost		Annual Operating Cost	
Catox Unit (Installed)	$107,000	Operating Labor	$100,000
Scrubber (installed)	$86,500	Catalyst Replenishment	$6,500
		Caustic	$2,500
		Natural Gas	$12,000
		Electricity	$3,500
		NOx Credits	$4,000
Total	**$193,500**	**Total**	**$128,500**

Table 7-2
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm) 100 Parts per Million by Volume (ppmv) Volatile Organic Compound (VOC) Matrix unit

Capital Cost		Annual Operating Cost	
PCO Unit (Installed)	$112,500	Operating Labor	$40,000
Caustic Scrubber (installed)	$13,600	Electricity	$16,000
		Caustic	$700
		UV lamp replacement[1]	$2,400
		Catalyst replacement[2]	$2,400
Total	**$126,100**	**Total**	**$61,500**

1 UV lamp replacement prorated, lamps require replacement after 10,000 hours of use
2 Catalyst replacement prorated , catalyst requires replacement after 25,000 hours of use

Table 7-3
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm)
500 Parts per Million by Volume (ppmv)
Volatile Organic Compound (VOC) Matrix unit

Capital Cost		Annual Operating Cost	
PCO Unit (Installed)	$137,500	Operating Labor	$45,000
Caustic Scrubber (installed)	$13,600	Electricity	$18,000
		Caustic	$1,000
		UV lamp replacement[1]	$3,000
		Catalyst replacement[2]	$3,000
Total	**$151,100**	**Total**	**$70,000**

1 UV lamp replacement prorated, lamps require replacement after 10,000 hours of use
2 Catalyst replacement prorated , catalyst requires replacement after 25,000 hours of use

Table 7-4
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm)
2,000 Parts per Million by Volume (ppmv)
Volatile Organic Compound (VOC) Matrix unit

Capital Cost		Annual Operating Cost	
PCO Unit (Installed)	$187,500	Operating Labor	$55,000
Caustic Scrubber (installed)	$13,600	Electricity	$22,300
		Caustic	$1,500
		UV lamp replacement[1]	$4,800
		Catalyst replacement[2]	$4,800
Total	**$201,100**	**Total**	**$88,400**

1 UV lamp replacement prorated, lamps require replacement after 10,000 hours of use
2 Catalyst replacement prorated , catalyst requires replacement after 25,000 hours of use

Table 7-5
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm)
100 Parts per Million by Volume (ppmv)
Volatile Organic Compound (VOC) GAC Unit

Capital Cost		Annual Operating Cost	
GAC Unit (Installed)	$14,700	Operating Labor	$40,000
		Electricity	$2,100
		GAC replacement	$105,300
Total	**$14,700**	**Total**	**$147,400**

Table 7-6
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm)
500 Parts per Million by Volume (ppmv)
Volatile Organic Compound (VOC) GAC Unit

Capital Cost		Annual Operating Cost	
GAC Unit (Installed)	$50,000	Operating Labor	$45,000
		Electricity	$2,100
		GAC replacement	$198,200
Total	**$50,000**	**Total**	**$245,300**

Table 7-7
Approximate Costs for the 250 Standard Cubic Feet per Minute (scfm)
2,000 Parts per Million by Volume (ppmv)
Volatile Organic Compound (VOC) GAC Unit

Capital Cost		Annual Operating Cost	
GAC Unit (Installed)	$110,000	Operating Labor	$55,000
	$	Electricity	$2,100
		GAC replacement	$495,400
Total	**$110,000**	**Total**	**$552,500**

Sensitivity Analysis

A number of factors affect the estimated cost of treating gaseous phase VOCs with the PCO TiO_2 technology. The cost analysis is based on the following:

- Off-gas composition. The chemical make up of the contaminants, to a large extent, governs the rate of destruction. Unsaturated and halogenated contaminants have shown to be more effectively remediated by the technology than saturated organics. Vendor modules are added in series to increase retention time for resistive compounds.
- Saturated aliphatics in the off-gas. Elevated concentrations of saturated aliphatics are not effectively remediated by this technology. Intermediates of the saturated aliphatics have been shown to adhere to and build up on the catalyst surface. The deposition of hydrocarbons inhibits photon penetration to the catalyst, effectively blinding it.
- Off-gas flow rate. The equipment is flow-rate sensitive; increasing flow requires more equipment. Modules are added in parallel to scale up flow rate throughputs.
- Humidity. Although the technology performs adequately on arid streams (less than 20% relative humidity), elevated water vapor in the air stream has been shown to enhance destruction.

8.0 RECOMMENDATIONS

As previously noted, during the demonstration, IC 29 was undergoing construction. The testing of the new equipment resulted in frequent shutdowns of the PCO early in the demonstration period. Testing for phosgene after these shutdowns yielded detections as high as 10 ppm, although the manufacturer of the Drager® tubes has indicated that the results may not be reliable under the conditions that they were used. As the demonstration continued the phosgene detections decreased to a level of non-detect over a 72-hour period. Although there is some concern as to the accuracy of these detections, due to potential interference of the colorimetric tubes with other constituents in the waste stream, to reduce the potential for phosgene formation the following recommendations are made:

1) Implementing an automatic purge with ambient air in the event of an unscheduled shutdown. The automatic purge could be accomplished with a three-way valve that would supply the PCO system with ambient air upon in the event of an unscheduled shutdown. By allowing the system to operate on ambient air, the system would obtain necessary cooling, from the vapor flow, allowing it to remain in "steady state" (i.e. constant temperature).

2) Operating the PCO unit in conjunction with caustic scrubber to neutralize any acid gases that result from the treatment of contaminated vapors within the PCO unit. The design of the scrubber will vary with site and waste stream.

Additional lessons learned include:

3) Because of potential fouling of the TiO_2 catalyst, the PCO technology should not be applied to sites where the contamination is principally due to LCSPHs. Anyone contemplating the use of the PCO at such a site should work closely with the technology vendor to minimize the risk of catalyst fouling.

4) The 254 nm lamps should not be used in applications where the process temperatures will exceed 120°F. The hybrid lamps, those that emit UV light at both 185 and 254 nm, used at IC 29 attain optimum performance at 140°F.

5) The residence time of the system should be conservatively designed. The demonstration utilized two path lengths, which did not consistently meet the DRE requirements. The system is capable of using two, four, or six pathlengths.

9.0 CONCLUSIONS

TiO_2-based PCO technology is an effective technology for destroying chlorinated compounds present in off-gas from SVE and HVDPE technology. During optimization the PCO system exceeded a DRE of 95 percent for total VOCs and 99 percent for TCE, during the demonstration run the system exceeded a DRE of 90 percent for total VOCs and 95 percent for TCE and 1,2-DCE. The technology emits low levels (1.5 ppmv) of NOx and is cost competitive with both CatOx and GAC for treatment of off-gases laden with chlorinated compounds when employed in conjunction with a caustic scrubber for the control of acid gases. However the SMAQMD 95 percent DRE for total VOCs was only met during the optimization phase and dropped to 92 percent during the demonstration.

Cost and Performance

The Matrix Photocatalytic TiO_2 technology is not intended for long chain saturated petroleum hydrocarbon streams such as encountered at OU C1. However, at IC 29, the PCO unit removed in excess of 95 percent of the TCE and 1,2-DCE and 90 percent of the total VOCs from the gaseous stream. This performance, however, did not meet the SMAQMD BACT requirements for total VOCs of 95 percent.

Implementation of Matrix PCO technology should consider:

- The primary factors affecting gaseous stream remediation using Matrix PCO equipment are flow rate, contaminant type, process temperature, and contaminant concentration.

- The modular nature of the PCO equipment allows remediation over a broad range of flow rates, contaminant type, and contaminant concentration situations.

- The PCO technology efficiency may be compromised by significant concentrations of long-chain, saturated, aliphatic compounds in the air stream.

- The UV lamps have temperature limitations; above optimum temperatures the power output of the lamps is limited. The 254 nm lamps optimum operating temperature is 110°F and should not be operated in a process stream exceeding 120°F. The hybrid lamps capable of emitting UV light at both 185 and 254 nm have an optimum operating temperature of 140°F and should not be operated in a process stream exceeding 150°F.

- The PCO technology does not produce hazardous wastes, however it should be noted that contaminated vapor streams often contain entrained moisture. This entrained moisture is collected in a knock-out pot placed upstream of the PCO unit. The collected fluid may need to be managed as a hazardous waste

This technology decreases in cost-effectiveness as: the volume of the vapor flow increases beyond 2,000 scfm, the concentration of contaminant increases (on contaminant-specific basis TCE beyond 5,000 ppmv), and as the background or non-target organic concentration increases (Garside, pers. comm.)

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APPENDIX A

OU C1 INTERIM PERFORMANCE REPORT

URS
A PROFESSIONAL SERVICES C

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December 21, 1995

Mr. Robert Shirley
SM-ALC/EMR
5050 Dudley Blvd., Suite 3
McClellan AFB, CA 95652-1389

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Subject: **Contract No. 68-W9-0054 / WA No. 54-40-9341**
McClellan Air Force Base Soil Vapor Extraction Work Assignment
Letter Report on Performance of PCO Technology Demonstration and Recommendations for Future Demonstrations

Dear Bob:

This letter report is to notify you of the results of the Photocatalytic Oxidation (PCO) Technology Demonstration at Site OU C1. The purpose of the letter report is to inform you of the performance of the PCO unit and make recommendations for future demonstrations to be considered by EMR's Technology Team.

PCO Technical Demonstration History

The PCO unit engineering parameter optimization began on October 23, 1995 and continued for a two-day period through October 24. The initial results indicated that the system was achieving low destruction and removal efficiencies (DREs).

In response to the low DREs the URS team investigated the potential reasons for the poor performance in conjunction with Matrix, the supplier of the PCO unit. The results of the investigation showed that the ultraviolet (UV) lamps used in the PCO unit were unable to maintain their power output at influent temperatures of 150 degrees F. In addition, the high temperatures may have interfered with the performance of the catalyst. To rectify the poor performance Matrix proposed the following actions:

1) Cool the influent to ambient levels by placing a water-cooled heat exchanger on the exhaust side of the process blowers

2) Replace the titanium dioxide catalyst to eliminate the possibility of reduced performance due to impairment of the catalyst from the high inlet temperatures encountered.

On November 13, 1995 Matrix returned with the heat exchanger and new catalyst. On November 14, the new equipment was plumbed into the system and was determined to leak. To eliminate the need for heat exchanger, Matrix requested permission to place the blowers on the downstream side of the PCO to eliminate the gas stream heating problem. Due to the potential for blower degradation due to acid formation in the PCO exhaust, a protective cage was manufactured and installed.

The PCO unit engineering parameter optimization was restarted on November 20, 1995 and continued for a two-week period through November 30, 1995. The optimization phase was used to select engineering parameters to optimize the DRE. During the optimization phase, URS varied the throughput, ozone addition, percent dilution, and path length. The throughput was varied between approximately 10 and 50 cubic feet

per minute (cfm). The ozone addition was varied between zero and 1.13 standard cubic feet (scf) at a concentration of 30,000 parts per billion volume (ppbv). The percent dilution runs included zero, fifty, and ninety percent dilution. The path length was varied between 2 and 6 cells (each cell is approximately 6 feet in length).

Samples were collected at the PCO unit influent and effluent ports. The samples were analyzed by Methods E18 and 8021 by an on-site laboratory. The results were reviewed for quality assurance/quality control then entered into a database for DRE calculation. The DREs were used to compare the effectiveness of each unique combination of engineering parameters identified above. The runs producing the highest DREs were re-run to obtain confirmatory results.

PCO Performance Results

Based on the review of the DREs (see Table 1) calculated from the optimization, URS and Matrix concluded that the PCO unit was not meeting the desired level of destruction for trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), or non-methane organic compounds (NMOCs). Our review of the optimization data indicates that potential problems with the power output of the lamps and masking of the catalyst may be occurring. Specifically:

- Phosgene, a product of incomplete combustion appears to increase in concentration as the path length is increased (see Table 2). This result is counter to the expected result.

- The DRE mean values, when compared by dilution (see Table 3), have standard deviations that are typically greater than or equal to the mean values, indicating a high degree of scatter in the data. There is no clear relation between dilution and DREs.

- Ozone, an electron acceptor, was added to increase the performance of the PCO unit. It appears that the ozone addition (see Table 4) is most effective at maximum residence time.

- Residence time is a combination of path length and flow rate; maximum path lengths with minimum flow rates yield the maximum residence time. Table 5 and the accompanying Figure 1 show a wide scatter in the DRE data and a poorly defined trend indicating decreasing DREs with increasing residence time. This result is counter to the expected result.

To investigate the cause of the poor performance, URS analyzed samples of the slip stream from OU C1 using Method TO-14 and Matrix had the catalyst analyzed by X-ray photoelectron spectroscopy (XPS), Laser Raman Spectroscopy (LRS), and scanning electron microscopy (SEM).

The results from the TO-14 analysis (see Attachment 1) indicated that long-chain single bond aliphatic compound with between 6 and 10 carbon molecules was present in the slip stream and could potentially be responsible for fouling the catalyst. The results from the analysis of the titanium dioxide catalyst (see Attachment 2) showed:

1) The titanium dioxide is in the active anatase form as desired.
2) The coating particle size is in the 10 to 15 nanometer (nm) range.
3) The coating does not uniformly cover the fiberglass fibers, which is not desired.
4) High carbon levels on the catalyst surface are fouling the catalyst.

Matrix has concluded that the high concentrations of long chain, single-bond aliphatic compounds with between 6 and 10 carbon atoms contained in the slip stream of OU C1 have likely rendered the catalyst ineffective. Matrix requested that the technical demonstration team consider allowing Matrix to demonstrate their technology at an alternative site that contains a higher level of halogenated volatile organic compounds (VOCs) and a smaller amount of NMOCs, particularly those long chain, single-bond aliphatics.

Proposed Future Demonstration

Based on the results from OU C1 it appears that sites containing high concentrations of NMOCs are probably not suitable for a demonstration of the PCO technology. URS and Matrix personnel have jointly reviewed the data from IC 31 contained in the Final Characterization Summary/Field Sampling Plan Investigation Cluster 31, March 1995. Based on this review Matrix has indicated that the mix of contaminants found at IC 31 would be an appropriate site for the demonstration of the PCO technology.

Attached for your consideration (see Attachment 3) is a restructured budget to accommodate a demonstration of the PCO technology at IC 31. URS proposes to pay Matrix for the two mobilizations performed at OU C1, and if permission is received, for a third mobilization at IC 31; costs for all three mobilizations will stay **within the original budget of $119,000**. The proposed budget will cover Matrix's costs and reserves $10,544 as a performance incentive. Matrix will begin to be eligible for the performance incentive if the PCO unit meets a minimum DRE of 75% under operational conditions. Matrix will receive full payment of the incentive if the average DRE of the PCO unit meets or exceeds 95%. If the PCO technology does not achieve a DRE of 95% the payment will be reduced linearly in proportion to the DRE (i.e., if the average operational DRE is 85%, Matrix will be eligible for 50% of the performance incentive, or $5,277). Please note that this subcontract restructuring has been finalized with Matrix and now is subject to EMR approval.

URS appreciates the opportunity to work with EMR staff in demonstrating this innovative technology. URS hopes that the technology team will consider Matrix's request for a demonstration at IC 31. Should you have any questions regarding the PCO technology demonstration, please contact me or Marcus Taylor at (916) 929-2346.

Sincerely,

URS CONSULTANTS, INC.

Sarabjit Singh

Sarabjit Singh, P.E.
Site Manager

SS/mt

cc:

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K. Wong			Project & Chron Files
B. Hoda			
J. Vincent			
A. Elgal			

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T 1

TREATABILITY TEST PARAMETERS MATRIX RESULTS

Test No.	Flow Rate	Path Length	Ozone (cfm)	Dilution Air (%)	Flow Rate INF	Influent (ppmv)			Flow Rate EFF	Effluent (ppmv)			DRE (%)		
						1,2-DCE	TCE	NMOC		1,2-DCE	TCE	NMOC	1,2-DCE	TCE	NMOC
1	Max[a]	2	0	90	46	3.2	56	440	43	2.1	49	280	39.8	18.5	41
2	Min	6	0	0	12	12	340	2300	14	12	320	120	0	-12.1	94 *
3	Max	2	1.13	90	46	3.7	69	670	42	2.7	54	450	33.4	28.6	39
4	Max	2	0	50	45	8	250	2400	41	12	210	2400	-23.6	23.9	9
5	Max	6	0	90	12	3.9	97	900	13	3.7	110	720	0	-25.9	11
6	Max	6	0	50	13	12	340	2900	13	12	240	2700	-2.3	27.8	5
7	Min[b]	2	0	90	38	4.2	94	950	36	4	85	1100	11.5	16	-8
8	Min	2	0	50	38	14	210	3800	33	14	210	3380	13.0	13.0	18
9	Min	6	0	90	11	5.6	110	1500	15	7.9	120	1400	-85.7 *	-43.6 *	-23
10	Min	6	0	50	11	9.4	270	2900	14	9.6	240	2500	-30.1	-13.3	-10
11	Max	2	1.13	50	49	9.6	210	2600	45	8.5	210	2300	19	8.5	19
12	Max	6	1.13	90	12	8.2	120	1700	16	7.1	160	1100	-14.4	-76.2	14
13	Max	6	1.13	50	13	12	240	3300	14	11	210	2200	1.6	6.1	28
14	Min	2	1.13	90	36	5.1	84	1200	34	4.1	71	870	22.9	19	30
15	Min	2	1.13	50	38	11	150	3500	35	14	200	2900	-18.1	-23.7	23
16	Min	6	1.13	90	12	6.6	120	2200	14	6.1	100	1100	-9.3	1.5	41
17	Min	6	1.13	50	12	8.2	120	1700	14	7.1	160	1100	-14.4	-76.2 *	1.4
18	Max	2	No	0	48	16	340	3500	43	14	340	3400	21.3	10.1	13
19	Max	6	0	0	12	14	240	3500	14	10	230	2900	19.9	-7.5	7
20	Min	2	0	0	36	16	340	3900	31	15	310	4000	20.6	22.8	13
21	Max	2	1.13	0	47	14	330	4300	43	13	290	3900	15.1	19.7	17
22	Max	6	1.13	0	11	13	270	4000	13	12	190	2600	-16.0	11.5	18
23	Min	2	1.13	0	36	14	320	4200	34	11	300	3900	27.4	13.4	14
24	Min	6	1.13	0	12	13	310	4400	17	12	270	2800	26.5	19.4	13
25	Min	6	1.13	90	11	4.3	79	1200	14	2.7	59	610	16.5	0.7	32

Notes:
(a) Maximum flow capability of the path length configuration but not likely to exceed 75 cfm.
(b) Minimum flow capability of the path length configuration but not likely less than 25 cfm.
* Considered to be an outlier.

1,2-DCE 1,2-dichloroethene
EFF effluent
NMOC non-methane organic carbon
cfm cubic feet per minute
INF influent
TCE trichloroethene
ppmv parts per million volume
DRE destruction and removal efficiency

Table 2

TREATABILITY TEST PARAMETERS MATRIX RESULTS FOR PHOSGENE

Test No.	Flow Rate (Cubic Feet Per Minute [cfm])	Path Length	Ozone (cfm)	Dilution Air (%)	Phosgene (ppmv)
1	Max[a]	2	0	90	ND
2	Min	6	0	0	15
3	Max	2	1.13	90	7.5
4	Max	2	0	50	ND
5	Max	6	0	90	ND
6	Max	6	0	50	ND
7	Min[b]	2	0	90	ND
8	Min	2	0	50	ND
9	Min	6	0	90	ND
10	Min	6	0	50	ND
11	Max	2	1.13	50	ND
12	Max	6	1.13	90	10
13	Max	6	1.13	50	7.5
14	Min	2	1.13	90	ND
15	Min	2	1.13	50	ND
16	Min	6	1.13	90	7.5
17	Min	6	1.13	50	7.5
18	Max	2	No	0	ND
19	Max	6	0	0	ND
20	Min	2	0	0	ND
21	Max	2	1.13	0	ND
22	Max	6	1.13	0	ND
23	Min	2	1.13	0	ND
24	Min	6	1.13	0	10-15
25	Min	6	1.13	90	10

Notes:
(a) Maximum flow capability of the path length configuration but not likely to exceed 50 cfm.
(b) Minimum flow capability of the path length configuration but not likely less than 10 cfm.

ppmv parts per million volume
ND not detected

Table 3

CHANGES IN DESTRUCTION AND REMOVAL EFFICIENCY (DRE) BY DILUTION

Dilution	0%			50%			90%		
Constituent	DCE	TCE	NMOC	DCE	TCE	NMOC	DCE	TCE	NMOC
DREs	0	-12.1	94 *	-23.6	23.9	9	39.8	18.5	41
	21.3	10.1	13	-2.3	27.8	5	33.4	28.6	39
	19.9	-7.5	7	13.0	13.0	18	0	-25.9	11
	20.6	22.8	13	-30.1	-13.3	-10	11.5	16	-8
	15.1	19.7	17	19	8.5	19	-85.7 *	-43.6 *	-23
	-16.0	11.5	18	1.6	6.1	28	-14.4	-76.2 *	14
	27.4	13.4	14	-18.1	-23.7	23	22.9	19.0	30
	26.5	19.4	13	-14.4	-76.2 *	14	-9.3	1.5	41
							16.5	0.7	32
Mean	14.4	9.7	13.6	-6.9	6.0	13.3	12.6	8.3	18.8
Standard Deviation	15.0	12.8	3.6	17.6	18.7	11.9	19.5	18.1	21.9

* Considered to be an outlier.

DCE 1,2-Dichloroethene
TCE Trichloroethene
NMOC Non-methane organic compounds

Table 4

CHANGES IN DESTRUCTION AND REMOVAL EFFICIENCY (DRE) WITH OZONE ADDITION

DRE			
Runs	DCE	TCE	NMOC
3 vs 1	-	+	-
11 vs 4	+	-	+
12 vs 5	-	-	+
13 vs 6	+	-	+
14 vs 7	+	+	+
15 vs 8	-	-	+
16 vs 9	+	+	+
17 vs 10	+	-	-
21 vs 18	-	+	+
22 vs 19	-	+	+
23 vs 20	+	-	+
24 vs 6	+	-	+
25 vs 9	+	+	+

DCE 1,2-Dichloroethene
TCE Trichloroethene
NMOC Non-methane organic compounds

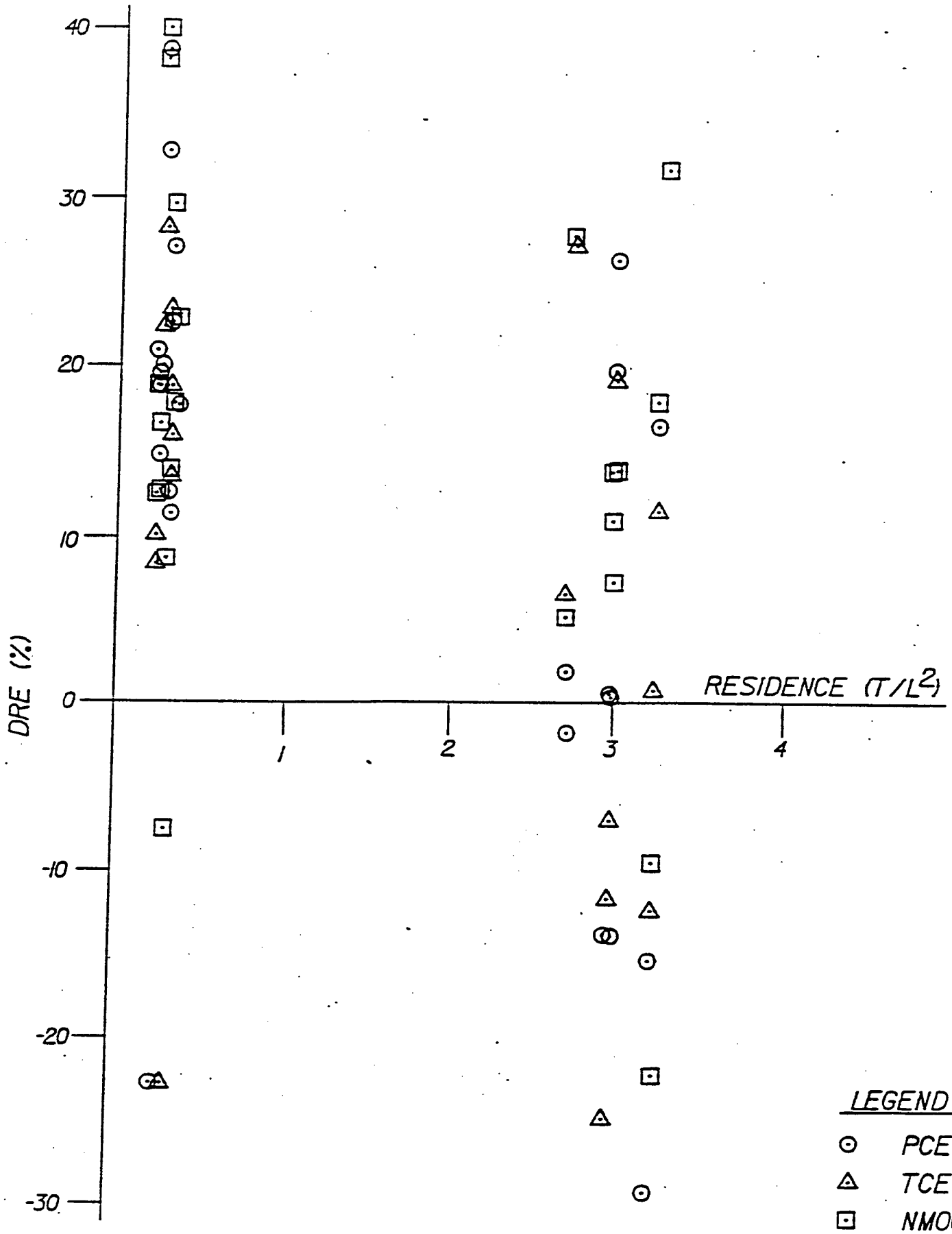
Table 5

DREs WITH RESIDENCE TIME

Run	Path Length	Influent Flowrate (scfm)	Velocity L^2/T	Residence T/L^2	DREs		
					DCE ○	TCE △	NMOC □
1	2	46	3.83	0.26	39.8	18.5	41
2	6	12	0.33	3.00	0	-12.1	94 *
3	2	46	3.83	0.26	33.4	28.6	39
4	2	45	3.75	0.27	-23.6	23.9	9
5	6	12	0.33	3.00	0	-25.9	11
6	6	13	0.36	2.77	-2.3	27.8	5
7	2	38	3.17	0.32	11.5	16.0	-8
8	2	38	3.17	0.32	13.0	13.0	18
9	6	11	0.31	3.27	-85.7 *	-43.6 *	-23
10	6	11	0.31	3.27	-30.1	-13.3	-10
11	2	49	4.08	0.24	19	8.5	19
12	6	12	0.33	3.03	-14.4	-76.2 *	14
13	6	13	0.36	2.77	1.6	6.1	28
14	2	36	3.00	0.33	22.9	19.0	30
15	2	38	3.17	0.32	18.1	-23.7	23
16	6	12	0.33	3.00	-9.3	1.5	41
17	6	12	0.33	3.00	-14.4	-76.2 *	14
18	2	48	4.00	0.25	21.3	10.1	13
19	6	12	0.33	3.00	19.9	-7.5	7
20	2	36	3.00	0.33	20.6	22.8	13
21	2	47	3.92	0.26	15.1	19.7	17
22	6	11	0.31	3.27	-16.0	11.5	18
23	2	36	3.00	0.33	27.4	13.4	14
24	6	12	0.33	3.00	26.5	19.4	13
25	6	11	0.31	3.27	16.5	0.7	32

Note: Assume 1 path = 6 feet
T = time in minutes
L = length in feet
* Considered to be an outlier.

DCE 1,2-Dichloroethene
TCE Trichloroethene
NMOC Non-methane organic compounds



URS Consultants, Inc.

FIGURE 1

DRE vs RESIDENC

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APPENDIX B

VENDOR CONTAMINANT TREATABILITY LIST

Figure 4: Treatability List

The TiO_2 photocatalytic systems are capable of, although not limited to, removing and destroying the following organic compounds in water and air:

Easily Decomposed Compounds

Acenaphthene
Acenaphtylene
Acetaldehyde
Acetic Acid
Acetone
Acrolein (Propenal)
Acrylic Acid
Alachlor
Alcohols
Aldicarb
Aldrin
Ammonia
Aniline
Anthracene
Benzene
Benzoic Acid
Benzyl butyl phthalate
Bis (2-ethylhexyl) ether
Bis (2-ethylhexyl) phthalate
Butyl Acrylate
Butyric Acid
Carbon Monoxide
Chlorinated Phenols
Chloroaniline
Chlorobenzene
Chloroform
Chloromethan
2-Chloronaphthalene
Chlorotoluene
Cresols
Cyanide
Cyclohenanone
1,1-DCE
1,2-DCE
1,1-Dichloroethene
1,2-Dichlorothene
2,4-Dichlorophenol
Dichlorobenzene
Dichlorobenzidine
Dichloropropene
Dieldrin
Dimethyl Nitrosamine
Dinitrophenol
Dimethyl Nitrosamine
Dinitrophenol
Dioxan
EDTA
Endrin
Ethylbenzene
Fluoranthene
Fluorene
Formaldehyde
Formic Acid
Hexachlorobenzene
Hydrazines
Hydrogen Sulphide
Isobutyric Acid
Isophorone
Isopropanol
Methylene chloride
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)
Methylmercaptan
Methyl t-butylether
MTBE
Napthalene
Nitrobenzene
Nitroglycerine
Nitrophenol
Nitrosamine
Nitrosodimethylamine
PCBs
Pentachlorophenol
Pesticide & Herbicide
Phenanthrene
Phenol
Simple Olefins
Simple Paraffins
Tetrachloroethene (PCE)
Tetrachloroethylene
Tetrahydrofuran
Toluene
Trichlorobenzene
Trichlorothene (TCE)
Trichlorothylene
2,4,6-Trichlorphenol
Triethylamine
Vinyl Chloride
Xylenes

Low Destruction Efficiency Compounds

Acetonitrile
Acrylonitrile
Bromodichloromethane
Carbon tetrachloride
Chloroethane
1,1-DCA
Dibromo-chloromethanecetonitrile
1,2-Dibromo-3-chloropropane
1,2-Dichloroethane
Dichloropropane
Hydrazines
MeCl
1,1,1-TCA
1,1,2-Trichloroethan

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

ANON ENON ACON ECON

AR CATEGORY ___ ___ . ___ ___

Originals Maintained at McClellan AFB EM

APPENDIX C

RESULTS OF OPTIMIZATION PHASE AT IC 29

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/14/97
Test Start Time: 10:00
Sample Date: 1/14/97

Test #: 1
Path #: 2
Dilution: 0%
Ozone: N
Ambient Temp: 40 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1.5	(in. Hg.)
Temperature	68	(deg F)
dP	1.750	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-01	
Sample Time	10:53	
Pressure	-6.9	(in. Hg)
Temperature	86	(deg F)
dP	1.8	(in. W.C.)
Flow Rate	62	(scfm)
Relative Humidity	54	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	61	

INFLUENT (PCOI)
Sample #: OPTA-01
Sample Time: 10:43 Vacuum: N/A (in. Hg) Temperature: N/A (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	49	0	61	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.27	0.000201	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.057	0.000037	0.038	0.000031	17.95%
cis-1,2-dichloroethene	DCE12C	97	0.36	0.000269	0.016	0.000015	94.53%
Chloroform	TCLME	119.4	0.6	0.000551	0.39	0.000441	20.00%
Carbon Tetrachloride	CTCL	153.84	0.78	0.000923	0.72	0.001049	-13.61%
1,2-Dichloroethane	DCA12	98.96	0.042	0.000032	0.028	0.000026	17.95%
Benzene	BZ	78	0.49	0.000294	0.25	0.000185	37.21%
Trichloroethene	TCE	131.4	20	0.020217	1.6	0.001991	90.15%
Tetrachloroethene	PCE	165.85	0.018	0.000023	0.028	0.000044	-91.45%
Total Target List VOCs			22.62	0.022547	3.07	0.003780	83.23%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:11	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	230		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	270		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	440		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	700		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	320		=	
Trichloroethene	TCE	79-01-6	200	16000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont)

Client:	URS Greiner, Inc.	URS Sample #:	A01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:11	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:41	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	3.4	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	3.4	ND		U	
Chloromethane	CLME	74-87-3	6.7	ND		U	
Vinyl chloride	VC	75-01-4	3.4	ND		U	
Bromomethane	BRME	74-83-9	3.4	ND		U	
Chloroethane	CLEA	75-00-3	6.7	ND		U	
Trichlorofluoromethane	FC11	75-69-4	3.4	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	3.4	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	3.4	ND		U	
Acetone	ACE	67-64-1	17	20		=	
Dichloromethane	MTLNCL	75-09-2	3.4	30		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	3.4	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	3.4	9.2		=	
Vinyl acetate	VA	108-05-4	17	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	3.4	4.3		=	
2-Butanone	MEK	78-93-3	17	ND		U	
Chloroform	TCLME	67-66-3	3.4	180		=	
1,1,1-Trichloroethane	TCA111	71-55-6	3.4	ND		U	
Carbon tetrachloride	CTCL	56-23-5	3.4	730	E	E	
1,2-Dichloroethane	DCA12	107-06-2	3.4	3.9		=	
Benzene	BZ	71-43-2	3.4	6.2		=	
Trichloroethene	TCE	79-01-6	3.4	270		=	
1,2-Dichloropropane	DCPA12	78-87-5	3.4	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	3.4	ND		U	
Toluene	BZME	108-88-3	3.4	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	3.4	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	17	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	3.4	ND		U	
Tetrachloroethene	PCE	127-18-4	3.4	ND		U	
1,2-Dibromoethane	EDB	106-93-4	3.4	ND		U	
Chlorobenzene	CLBZ	108-90-7	3.4	ND		U	
Ethylbenzene	EBZ	100-41-4	3.4	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	3.4	ND		U	
o-Xylene	XYLO	95-47-6	3.4	ND		U	
Styrene	STY	100-42-5	3.4	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	3.4	ND		U	
Benzyl chloride	BZLCL	100-44-7	17	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	3.4	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	3.4	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:41	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
1,3-Dichlorobenzene	DCBZ13	541-73-1	3.4	ND		U
1,4-Dichlorobenzene	DCBZ14	106-46-7	3.4	ND		U
1,2-Dichlorobenzene	DCBZ12	95-50-1	3.4	ND		U
1,2,4-Trichlorobenzene	TCB124	120-82-1	34	ND		U
Hexachlorobutadiene	HCBU	87-68-3	6.7	ND		U

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:41	Sample Vol. (ML):	
Dilution Factor:	10	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	20	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	20	ND		U	
Chloromethane	CLME	74-87-3	40	ND		U	
Vinyl chloride	VC	75-01-4	20	ND		U	
Bromomethane	BRME	74-83-9	20	ND		U	
Chloroethane	CLEA	75-00-3	40	ND		U	
Trichlorofluoromethane	FC11	75-69-4	20	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	20	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	20	ND		U	
Acetone	ACE	67-64-1	100	ND		U	
Dichloromethane	MTLNCL	75-09-2	20	30		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	20	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	20	ND		U	
Vinyl acetate	VA	108-05-4	100	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	20	ND		U	
2-Butanone	MEK	78-93-3	100	ND		U	
Chloroform	TCLME	67-66-3	20	170		=	
1,1,1-Trichloroethane	TCA111	71-55-6	20	ND		U	
Carbon tetrachloride	CTCL	56-23-5	20	810		=	
1,2-Dichloroethane	DCA12	107-06-2	20	ND		U	
Benzene	BZ	71-43-2	20	ND		U	
Trichloroethene	TCE	79-01-6	20	260		=	
1,2-Dichloropropane	DCPA12	78-87-5	20	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	20	ND		U	
Toluene	BZME	108-88-3	20	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	20	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	100	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	20	ND		U	
Tetrachloroethene	PCE	127-18-4	20	ND		U	
1,2-Dibromoethane	EDB	106-93-4	20	ND		U	
Chlorobenzene	CLBZ	108-90-7	20	ND		U	
Ethylbenzene	EBZ	100-41-4	20	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	20	ND		U	
o-Xylene	XYLO	95-47-6	20	ND		U	
Styrene	STY	100-42-5	20	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	20	ND		U	
Benzyl chloride	BZLCL	100-44-7	100	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	20	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	20	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	20	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:41	Sample Vol. (ML):	
Dilution Factor:	10	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR e
1,4-Dichlorobenzene	DCBZ14	106-46-7	20	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	20	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	200	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	40	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/14/97
Test Start Time: 13:00
Sample Date: 1/14/97

Test #: 2
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 53 (deg F)

Note: Spreadsheet calc'ing using in H2O - need conversion!

AIR STRIPPER FLOW DATA		
Pressure	-1.7	(in. Hg.)
Temperature	64	(deg F)
dP	1.750	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-02	
Sample Time	13:48	
Pressure	-6.9	(in. Hg)
Temperature	91	(deg F)
dP	1.8	(in. W.C.)
Flow Rate	62	(scfm)
Relative Humidity	UNK	(%)
Estimated Moisture (%)	0	
Est. Dry Gas Rate (dscfm)	62	

INFLUENT (PCOI)
Sample #: OPTA-02
Sample Time: 13:36 Vacuum: N/A (in. Hg) Temperature: N/A (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	0	50	0	62	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.29	0.000218	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.021	0.000017	NC
cis-1,2-dichloroethene	DCE12C	97	0.37	0.000279	0	0.000000	NC
Chloroform	TCLME	119.4	1.1	0.001020	0.09	0.000104	89.84%
Carbon Tetrachloride	CTCL	153.84	1.1	0.001314	0.79	0.001172	10.80%
1,2-Dichloroethane	DCA12	98.96	0.082	0.000063	0.018	0.000017	72.73%
Benzene	BZ	78	0.51	0.000309	0	0.000000	NC
Trichloroethene	TCE	131.4	18	0.018362	0.3	0.000380	97.93%
Tetrachloroethene	PCE	165.85	0.087	0.000112	0.0083	0.000013	88.15%
Total Target List VOCs			21.54	0.021677	1.23	0.001703	92.14%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:08	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U
Chloromethane	CLME	74-87-3	400	ND		U
Vinyl chloride	VC	75-01-4	200	ND		U
Bromomethane	BRME	74-83-9	200	ND		U
Chloroethane	CLEA	75-00-3	400	ND		U
Trichlorofluoromethane	FC11	75-69-4	200	ND		U
1,1-Dichloroethene	DCE11	75-35-4	200	240		=
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U
Acetone	ACE	67-64-1	1000	ND		U
Dichloromethane	MTLNCL	75-09-2	200	ND		U
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U
Vinyl acetate	VA	108-05-4	1000	ND		U
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	300		=
2-Butanone	MEK	78-93-3	1000	ND		U
Chloroform	TCLME	67-66-3	200	460		=
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U
Carbon tetrachloride	CTCL	56-23-5	200	820		=
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U
Benzene	BZ	71-43-2	200	270		=
Trichloroethene	TCE	79-01-6	200	18000		=
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U
Toluene	BZME	108-88-3	200	ND		U
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U
Tetrachloroethene	PCE	127-18-4	200	ND		U
1,2-Dibromoethane	EDB	106-93-4	200	ND		U
Chlorobenzene	CLBZ	108-90-7	200	ND		U
Ethylbenzene	EBZ	100-41-4	200	ND		U
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U
o-Xylene	XYLO	95-47-6	200	ND		U
Styrene	STY	100-42-5	200	ND		U
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U
Benzyl chloride	BZLCL	100-44-7	1000	ND		U
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U

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Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:08	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	46	50
Toluene-d8	BZMED8	2037-26-5	48	50
Bromofluorobenzene	BR4FBZ	460-00-4	40	50

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Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:46	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
Dichlorodifluoromethane	FC12	75-71-8	3.4	ND		U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	3.4	ND		U
Chloromethane	CLME	74-87-3	6.7	ND		U
Vinyl chloride	VC	75-01-4	3.4	ND		U
Bromomethane	BRME	74-83-9	3.4	ND		U
Chloroethane	CLEA	75-00-3	6.7	ND		U
Trichlorofluoromethane	FC11	75-69-4	3.4	ND		U
1,1-Dichloroethene	DCE11	75-35-4	3.4	ND		U
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	3.4	ND		U
Acetone	ACE	67-64-1	17	18		=
Dichloromethane	MTLNCL	75-09-2	3.4	29		=
trans-1,2-Dichloroethene	DCE12T	156-60-5	3.4	ND		U
1,1-Dichloroethane	DCA11	75-34-3	3.4	9.7		=
Vinyl acetate	VA	108-05-4	17	ND		U
cis-1,2-Dichloroethene	DCE12C	156-59-2	3.4	ND		U
2-Butanone	MEK	78-93-3	17	ND		U
Chloroform	TCLME	67-66-3	3.4	210		=
1,1,1-Trichloroethane	TCA111	71-55-6	3.4	ND		U
Carbon tetrachloride	CTCL	56-23-5	3.4	770	E	E
1,2-Dichloroethane	DCA12	107-06-2	3.4	4.5		=
Benzene	BZ	71-43-2	3.4	ND		U
Trichloroethene	TCE	79-01-6	3.4	200		=
1,2-Dichloropropane	DCPA12	78-87-5	3.4	ND		U
trans-1,3-Dichloropropene	DCP13T	10061-02-6	3.4	ND		U
Toluene	BZME	108-88-3	3.4	ND		U
cis-1,3-Dichloropropene	DCP13C	10061-01-5	3.4	ND		U
4-Methyl-2-pentanone	MIBK	108-10-1	17	ND		U
1,1,2-Trichloroethane	TCA112	79-00-5	3.4	ND		U
Tetrachloroethene	PCE	127-18-4	3.4	ND		U
1,2-Dibromoethane	EDB	106-93-4	3.4	ND		U
Chlorobenzene	CLBZ	108-90-7	3.4	ND		U
Ethylbenzene	EBZ	100-41-4	3.4	ND		U
m- & p-Xylene(s)	XYLMP	1330-20-7	3.4	ND		U
o-Xylene	XYLO	95-47-6	3.4	ND		U
Styrene	STY	100-42-5	3.4	ND		U
1,1,2,2-Tetrachloroethane	PCA	79-34-5	3.4	ND		U
Benzyl chloride	BZLCL	100-44-7	17	ND		U
1,3,5-Trimethylbenzene	TMB135	108-67-8	3.4	ND		U
1,2,4-Trimethylbenzene	TMB124	95-63-6	3.4	ND		U

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:46	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,3-Dichlorobenzene	DCBZ13	541-73-1	3.4	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	3.4	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	3.4	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	34	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	6.7	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	48	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

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Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	15:22	Sample Vol. (ML):	
Dilution Factor:	10	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	U R
Dichlorodifluoromethane	FC12	75-71-8	20	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	20	ND		U	
Chloromethane	CLME	74-87-3	40	ND		U	
Vinyl chloride	VC	75-01-4	20	ND		U	
Bromomethane	BRME	74-83-9	20	ND		U	
Chloroethane	CLEA	75-00-3	40	ND		U	
Trichlorofluoromethane	FC11	75-69-4	20	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	20	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	20	ND		U	
Acetone	ACE	67-64-1	100	ND		U	
Dichloromethane	MTLNCL	75-09-2	20	31		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	20	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	20	ND		U	
Vinyl acetate	VA	108-05-4	100	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	20	ND		U	
2-Butanone	MEK	78-93-3	100	ND		U	
Chloroform	TCLME	67-66-3	20	210		=	
1,1,1-Trichloroethane	TCA111	71-55-6	20	ND		U	
Carbon tetrachloride	CTCL	56-23-5	20	900		=	
1,2-Dichloroethane	DCA12	107-06-2	20	ND		U	
Benzene	BZ	71-43-2	20	ND		U	
Trichloroethene	TCE	79-01-6	20	180		=	
1,2-Dichloropropane	DCPA12	78-87-5	20	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	20	ND		U	
Toluene	BZME	108-88-3	20	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	20	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	100	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	20	ND		U	
Tetrachloroethene	PCE	127-18-4	20	ND		U	
1,2-Dibromoethane	EDB	106-93-4	20	ND		U	
Chlorobenzene	CLBZ	108-90-7	20	ND		U	
Ethylbenzene	EBZ	100-41-4	20	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	20	ND		U	
o-Xylene	XYLO	95-47-6	20	ND		U	
Styrene	STY	100-42-5	20	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	20	ND		U	
Benzyl chloride	BZLCL	100-44-7	100	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	20	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	20	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	20	ND		U	

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Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	18:12	Sample Vol. (ML):	
Dilution Factor:	51	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	100	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	100	ND		U	
Chloromethane	CLME	74-87-3	200	ND		U	
Vinyl chloride	VC	75-01-4	100	ND		U	
Bromomethane	BRME	74-83-9	100	ND		U	
Chloroethane	CLEA	75-00-3	200	ND		U	
Trichlorofluoromethane	FC11	75-69-4	100	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	100	250		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	100	ND		U	
Acetone	ACE	67-64-1	510	ND		U	
Dichloromethane	MTLNCL	75-09-2	100	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	100	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	100	ND		U	
Vinyl acetate	VA	108-05-4	510	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	100	310		=	
2-Butanone	MEK	78-93-3	510	ND		U	
Chloroform	TCLME	67-66-3	100	470		=	
1,1,1-Trichloroethane	TCA111	71-55-6	100	ND		U	
Carbon tetrachloride	CTCL	56-23-5	100	900		=	
1,2-Dichloroethane	DCA12	107-06-2	100	ND		U	
Benzene	BZ	71-43-2	100	310		=	
Trichloroethene	TCE	79-01-6	100	18000		=	
1,2-Dichloropropane	DCPA12	78-87-5	100	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	100	ND		U	
Toluene	BZME	108-88-3	100	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	100	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	510	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	100	ND		U	
Tetrachloroethene	PCE	127-18-4	100	ND		U	
1,2-Dibromoethane	EDB	106-93-4	100	ND		U	
Chlorobenzene	CLBZ	108-90-7	100	ND		U	
Ethylbenzene	EBZ	100-41-4	100	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	100	ND		U	
o-Xylene	XYLO	95-47-6	100	ND		U	
Styrene	STY	100-42-5	100	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	100	ND		U	
Benzyl chloride	BZLCL	100-44-7	510	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	100	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	100	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	100	ND		U	

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Volatile Organics by GCMS - EPA TO14 (cont)

Client:	URS Greiner, Inc.	URS Sample #:	A03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	18:12	Sample Vol. (ML):	
Dilution Factor:	51	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
1,4-Dichlorobenzene	DCBZ14	106-46-7	100	ND		U
1,2-Dichlorobenzene	DCBZ12	95-50-1	100	ND		U
1,2,4-Trichlorobenzene	TCB124	120-82-1	1000	ND		U
Hexachlorobutadiene	HCBU	87-68-3	200	ND		U

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

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Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	18:40	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	4.2	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	4.2	ND		U	
Chloromethane	CLME	74-87-3	8.4	ND		U	
Vinyl chloride	VC	75-01-4	4.2	ND		U	
Bromomethane	BRME	74-83-9	4.2	ND		U	
Chloroethane	CLEA	75-00-3	8.4	ND		U	
Trichlorofluoromethane	FC11	75-69-4	4.2	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	4.2	4.3		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	4.2	ND		U	
Acetone	ACE	67-64-1	21	ND		U	
Dichloromethane	MTLNCL	75-09-2	4.2	39		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	4.2	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	4.2	19		=	
Vinyl acetate	VA	108-05-4	21	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	4.2	8.1		=	
2-Butanone	MEK	78-93-3	21	ND		U	
Chloroform	TCLME	67-66-3	4.2	440		=	
1,1,1-Trichloroethane	TCA111	71-55-6	4.2	ND		U	
Carbon tetrachloride	CTCL	56-23-5	4.2	940	E	E	
1,2-Dichloroethane	DCA12	107-06-2	4.2	8.7		=	
Benzene	BZ	71-43-2	4.2	5.8		=	
Trichloroethene	TCE	79-01-6	4.2	370		=	
1,2-Dichloropropane	DCPA12	78-87-5	4.2	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	4.2	ND		U	
Toluene	BZME	108-88-3	4.2	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	4.2	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	21	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	4.2	ND		U	
Tetrachloroethene	PCE	127-18-4	4.2	ND		U	
1,2-Dibromoethane	EDB	106-93-4	4.2	ND		U	
Chlorobenzene	CLBZ	108-90-7	4.2	ND		U	
Ethylbenzene	EBZ	100-41-4	4.2	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	4.2	ND		U	
o-Xylene	XYLO	95-47-6	4.2	ND		U	
Styrene	STY	100-42-5	4.2	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	4.2	ND		U	
Benzyl chloride	BZLCL	100-44-7	21	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	4.2	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	4.2	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	18:40	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
1,3-Dichlorobenzene	DCBZ13	541-73-1	4.2	ND		U
1,4-Dichlorobenzene	DCBZ14	106-46-7	4.2	ND		U
1,2-Dichlorobenzene	DCBZ12	95-50-1	4.2	ND		U
1,2,4-Trichlorobenzene	TCB124	120-82-1	42	ND		U
Hexachlorobutadiene	HCBU	87-68-3	8.4	ND		U

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

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Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	14:56	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	21	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	21	ND		U	
Chloromethane	CLME	74-87-3	42	ND		U	
Vinyl chloride	VC	75-01-4	21	ND		U	
Bromomethane	BRME	74-83-9	21	ND		U	
Chloroethane	CLEA	75-00-3	42	ND		U	
Trichlorofluoromethane	FC11	75-69-4	21	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	21	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	21	ND		U	
Acetone	ACE	67-64-1	110	ND		U	
Dichloromethane	MTLNCL	75-09-2	21	35		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	21	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	21	ND		U	
Vinyl acetate	VA	108-05-4	110	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	21	ND		U	
2-Butanone	MEK	78-93-3	110	ND		U	
Chloroform	TCLME	67-66-3	21	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	21	ND		U	
Carbon tetrachloride	CTCL	56-23-5	21	910		=	
1,2-Dichloroethane	DCA12	107-06-2	21	ND		U	
Benzene	BZ	71-43-2	21	ND		U	
Trichloroethene	TCE	79-01-6	21	320		=	
1,2-Dichloropropane	DCPA12	78-87-5	21	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	21	ND		U	
Toluene	BZME	108-88-3	21	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	21	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	110	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	21	ND		U	
Tetrachloroethene	PCE	127-18-4	21	ND		U	
1,2-Dibromoethane	EDB	106-93-4	21	ND		U	
Chlorobenzene	CLBZ	108-90-7	21	ND		U	
Ethylbenzene	EBZ	100-41-4	21	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	21	ND		U	
o-Xylene	XYLO	95-47-6	21	ND		U	
Styrene	STY	100-42-5	21	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	21	ND		U	
Benzyl chloride	BZLCL	100-44-7	110	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	21	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	21	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	21	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	14:56	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	R Re
1,4-Dichlorobenzene	DCBZ14	106-46-7	21	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	21	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	210	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	42	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	47	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	19:08	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	4.2	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	4.2	ND		U	
Chloromethane	CLME	74-87-3	8.4	ND		U	
Vinyl chloride	VC	75-01-4	4.2	4.2		=	
Bromomethane	BRME	74-83-9	4.2	ND		U	
Chloroethane	CLEA	75-00-3	8.4	ND		U	
Trichlorofluoromethane	FC11	75-69-4	4.2	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	4.2	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	4.2	ND		U	
Acetone	ACE	67-64-1	21	ND		U	
Dichloromethane	MTLNCL	75-09-2	4.2	37		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	4.2	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	4.2	18		=	
Vinyl acetate	VA	108-05-4	21	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	4.2	6.7		=	
2-Butanone	MEK	78-93-3	21	ND		U	
Chloroform	TCLME	67-66-3	4.2	420		=	
1,1,1-Trichloroethane	TCA111	71-55-6	4.2	ND		U	
Carbon tetrachloride	CTCL	56-23-5	4.2	910	E	E	
1,2-Dichloroethane	DCA12	107-06-2	4.2	8.8		=	
Benzene	BZ	71-43-2	4.2	5.4		=	
Trichloroethene	TCE	79-01-6	4.2	330		=	
1,2-Dichloropropane	DCPA12	78-87-5	4.2	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	4.2	ND		U	
Toluene	BZME	108-88-3	4.2	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	4.2	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	21	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	4.2	ND		U	
Tetrachloroethene	PCE	127-18-4	4.2	ND		U	
1,2-Dibromoethane	EDB	106-93-4	4.2	ND		U	
Chlorobenzene	CLBZ	108-90-7	4.2	ND		U	
Ethylbenzene	EBZ	100-41-4	4.2	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	4.2	ND		U	
o-Xylene	XYLO	95-47-6	4.2	ND		U	
Styrene	STY	100-42-5	4.2	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	4.2	ND		U	
Benzyl chloride	BZLCL	100-44-7	21	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	4.2	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	4.2	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	19:08	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
1,3-Dichlorobenzene	DCBZ13	541-73-1	4.2	ND		U
1,4-Dichlorobenzene	DCBZ14	106-46-7	4.2	ND		U
1,2-Dichlorobenzene	DCBZ12	95-50-1	4.2	ND		U
1,2,4-Trichlorobenzene	TCB124	120-82-1	42	ND		U
Hexachlorobutadiene	HCBU	87-68-3	8.4	ND		U

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

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Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	15:49	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	21	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	21	ND		U	
Chloromethane	CLME	74-87-3	42	ND		U	
Vinyl chloride	VC	75-01-4	21	ND		U	
Bromomethane	BRME	74-83-9	21	ND		U	
Chloroethane	CLEA	75-00-3	42	ND		U	
Trichlorofluoromethane	FC11	75-69-4	21	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	21	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	21	ND		U	
Acetone	ACE	67-64-1	110	ND		U	
Dichloromethane	MTLNCL	75-09-2	21	33		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	21	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	21	ND		U	
Vinyl acetate	VA	108-05-4	110	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	21	ND		U	
2-Butanone	MEK	78-93-3	110	ND		U	
Chloroform	TCLME	67-66-3	21	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	21	ND		U	
Carbon tetrachloride	CTCL	56-23-5	21	900		=	
1,2-Dichloroethane	DCA12	107-06-2	21	ND		U	
Benzene	BZ	71-43-2	21	ND		U	
Trichloroethene	TCE	79-01-6	21	280		=	
1,2-Dichloropropane	DCPA12	78-87-5	21	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	21	ND		U	
Toluene	BZME	108-88-3	21	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	21	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	110	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	21	ND		U	
Tetrachloroethene	PCE	127-18-4	21	ND		U	
1,2-Dibromoethane	EDB	106-93-4	21	ND		U	
Chlorobenzene	CLBZ	108-90-7	21	ND		U	
Ethylbenzene	EBZ	100-41-4	21	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	21	ND		U	
o-Xylene	XYLO	95-47-6	21	ND		U	
Styrene	STY	100-42-5	21	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	21	ND		U	
Benzyl chloride	BZLCL	100-44-7	110	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	21	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	21	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	21	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	15:49	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	Re
1,4-Dichlorobenzene	DCBZ14	106-46-7	21	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	21	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	210	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	42	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/15/97
Test Start Time: 09:00
Sample Date: 1/15/97

Test #: 4
Path #: 2
Dilution: 0%
Ozone: N
Ambient Temp: 43 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1	(in. Hg.)
Temperature	49	(deg F)
dP	0.950	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-04	
Sample Time	09:37	
Pressure	-3.6	(in. Hg)
Temperature	84	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	54	(scfm)
Relative Humidity		(%)
Estimated Moisture (%)	0	
Est. Dry Gas Rate (dscfm)	54	

INFLUENT (PCOI)
Sample #: OPTA-04
Sample Time: 09:32 Vacuum: -1 (in. Hg) Temperature: 49 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	80	49	0	54	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.28	0.000207	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.054	0.000035	0.043	0.000031	12.34%
cis-1,2-dichloroethene	DCE12C	97	0.45	0.000333	0	0.000000	NC
Chloroform	TCLME	119.4	0.95	0.000866	0.25	0.000251	71.03%
Carbon Tetrachloride	CTCL	153.84	1.4	0.001644	1	0.001292	21.37%
1,2-Dichloroethane	DCA12	98.96	0.063	0.000048	0.031	0.000026	45.83%
Benzene	BZ	78	0.8	0.000476	0.065	0.000043	91.06%
Trichloroethene	TCE	131.4	21	0.021057	0.018	0.000020	99.91%
Tetrachloroethene	PCE	165.85	0	0.000000	0.0049	0.000007	NC
Total Target List VOCs			25.00	0.024665	1.41	0.001669	93.23%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	12:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	R Re
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	240		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	250		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	810		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	240		=	
Trichloroethene	TCE	79-01-6	200	16000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	12:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	47	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	12:43	Sample Vol. (ML):	
Dilution Factor:	3.4	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ
Dichlorodifluoromethane	FC12	75-71-8	6.7	ND		U
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	6.7	ND		U
Chloromethane	CLME	74-87-3	13	ND		U
Vinyl chloride	VC	75-01-4	6.7	ND		U
Bromomethane	BRME	74-83-9	6.7	ND		U
Chloroethane	CLEA	75-00-3	13	ND		U
Trichlorofluoromethane	FC11	75-69-4	6.7	ND		U
1,1-Dichloroethene	DCE11	75-35-4	6.7	ND		U
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	6.7	ND		U
Acetone	ACE	67-64-1	34	ND		U
Dichloromethane	MTLNCL	75-09-2	6.7	29		=
trans-1,2-Dichloroethene	DCE12T	156-60-5	6.7	ND		U
1,1-Dichloroethane	DCA11	75-34-3	6.7	13		=
Vinyl acetate	VA	108-05-4	34	ND		U
cis-1,2-Dichloroethene	DCE12C	156-59-2	6.7	ND		U
2-Butanone	MEK	78-93-3	34	ND		U
Chloroform	TCLME	67-66-3	6.7	270		=
1,1,1-Trichloroethane	TCA111	71-55-6	6.7	ND		U
Carbon tetrachloride	CTCL	56-23-5	6.7	880		=
1,2-Dichloroethane	DCA12	107-06-2	6.7	6.8		=
Benzene	BZ	71-43-2	6.7	ND		U
Trichloroethene	TCE	79-01-6	6.7	330		=
1,2-Dichloropropane	DCPA12	78-87-5	6.7	ND		U
trans-1,3-Dichloropropene	DCP13T	10061-02-6	6.7	ND		U
Toluene	BZME	108-88-3	6.7	ND		U
cis-1,3-Dichloropropene	DCP13C	10061-01-5	6.7	ND		U
4-Methyl-2-pentanone	MIBK	108-10-1	34	ND		U
1,1,2-Trichloroethane	TCA112	79-00-5	6.7	ND		U
Tetrachloroethene	PCE	127-18-4	6.7	ND		U
1,2-Dibromoethane	EDB	106-93-4	6.7	ND		U
Chlorobenzene	CLBZ	108-90-7	6.7	ND		U
Ethylbenzene	EBZ	100-41-4	6.7	ND		U
m- & p-Xylene(s)	XYLMP	1330-20-7	6.7	ND		U
o-Xylene	XYLO	95-47-6	6.7	ND		U
Styrene	STY	100-42-5	6.7	ND		U
1,1,2,2-Tetrachloroethane	PCA	79-34-5	6.7	ND		U
Benzyl chloride	BZLCL	100-44-7	34	ND		U
1,3,5-Trimethylbenzene	TMB135	108-67-8	6.7	ND		U
1,2,4-Trimethylbenzene	TMB124	95-63-6	6.7	ND		U
1,3-Dichlorobenzene	DCBZ13	541-73-1	6.7	ND		U

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	12:43	Sample Vol. (ML):	
Dilution Factor:	3.4	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	6.7	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	6.7	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	67	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	13	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	52	50
Toluene-d8	BZMED8	2037-26-5	53	50
Bromofluorobenzene	BR4FBZ	460-00-4	49	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/15/97
Test Start Time: 12:30
Sample Date: 1/15/97

Test #: 5
Path #: 2
Dilution: 0%
Ozone: N
Ambient Temp: 45 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1.8	(in. Hg.)
Temperature	54	(deg F)
dP	-1.800	(in. W.C.)
Flow Rate	45	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-05	
Sample Time	13:26	
Pressure	-6	(in. Hg)
Temperature	90	(deg F)
dP	-1.1	(in. W.C.)
Flow Rate	46	(scfm)
Relative Humidity	17	(%)
Estimated Moisture (%)	1	
Est. Dry Gas Rate (dscfm)	46	

INFLUENT (PCOI)
Sample #: OPTA-05
Sample Time: 13:18 Vacuum: -1.8 (in. Hg) Temperature: 54 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	45	0	46	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.24	0.000164	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.063	0.000038	0.043	0.000026	31.29%
cis-1,2-dichloroethene	DCE12C	97	0.39	0.000267	0	0.000000	NC
Chloroform	TCLME	119.4	0.93	0.000784	0.3	0.000255	67.53%
Carbon Tetrachloride	CTCL	153.84	1.2	0.001303	0.93	0.001017	21.98%
1,2-Dichloroethane	DCA12	98.96	0.064	0.000045	0.029	0.000020	54.38%
Benzene	BZ	78	0.67	0.000369	0.13	0.000072	80.47%
Trichloroethene	TCE	131.4	19	0.017626	0.12	0.000112	99.36%
Tetrachloroethene	PCE	165.85	0.076	0.000089	0.012	0.000014	84.11%
Total Target List VOCs			22.63	0.020685	1.56	0.001516	92.67%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0004-SA
Time Analyzed:	13:09	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	280		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	270		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	390		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	900		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	270		=	
Trichloroethene	TCE	79-01-6	200	17000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0004-SA
Time Analyzed:	13:09	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0005-SA
Time Analyzed:	13:35	Sample Vol. (ML):	
Dilution Factor:	4.2	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	8.4	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	8.4	ND		U	
Chloromethane	CLME	74-87-3	17	ND		U	
Vinyl chloride	VC	75-01-4	8.4	ND		U	
Bromomethane	BRME	74-83-9	8.4	ND		U	
Chloroethane	CLEA	75-00-3	17	ND		U	
Trichlorofluoromethane	FC11	75-69-4	8.4	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	8.4	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	8.4	ND		U	
Acetone	ACE	67-64-1	42	ND		U	
Dichloromethane	MTLNCL	75-09-2	8.4	37		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	8.4	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	8.4	18		=	
Vinyl acetate	VA	108-05-4	42	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	8.4	ND		U	
2-Butanone	MEK	78-93-3	42	ND		U	
Chloroform	TCLME	67-66-3	8.4	400		=	
1,1,1-Trichloroethane	TCA111	71-55-6	8.4	ND		U	
Carbon tetrachloride	CTCL	56-23-5	8.4	1100		=	
1,2-Dichloroethane	DCA12	107-06-2	8.4	ND		U	
Benzene	BZ	71-43-2	8.4	ND		U	
Trichloroethene	TCE	79-01-6	8.4	320		=	
1,2-Dichloropropane	DCPA12	78-87-5	8.4	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	8.4	ND		U	
Toluene	BZME	108-88-3	8.4	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	8.4	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	42	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	8.4	ND		U	
Tetrachloroethene	PCE	127-18-4	8.4	ND		U	
1,2-Dibromoethane	EDB	106-93-4	8.4	ND		U	
Chlorobenzene	CLBZ	108-90-7	8.4	ND		U	
Ethylbenzene	EBZ	100-41-4	8.4	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	8.4	ND		U	
o-Xylene	XYLO	95-47-6	8.4	ND		U	
Styrene	STY	100-42-5	8.4	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	8.4	ND		U	
Benzyl chloride	BZLCL	100-44-7	42	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	8.4	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	8.4	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	8.4	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0006-SA
Time Analyzed:	14:02	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	270		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	300		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	400		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	920		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	270		=	
Trichloroethene	TCE	79-01-6	200	17000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	QD05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0006-SA
Time Analyzed:	14:02	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/15/97
Test Start Time: 13:45
Sample Date: 1/15/97

Test #: 6
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 47 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1.75	(in. Hg.)
Temperature	55	(deg F)
dP	-1.850	(in. W.C.)
Flow Rate	45	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-06	
Sample Time	NA	
Pressure	-6	(in. Hg)
Temperature	93	(deg F)
dP	-1.1	(in. W.C.)
Flow Rate	46	(scfm)
Relative Humidity	20	(%)
Estimated Moisture (%)	1	
Est. Dry Gas Rate (dscfm)	45	

INFLUENT (PCOI)
Sample #: OPTA-06
Sample Time: NA Vacuum: -1.75 (in. Hg) Temperature: 55 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	45	0	45	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.26	0.000178	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.071	0.000043	0.018	0.000011	74.59%
cis-1,2-dichloroethene	DCE12C	97	0.43	0.000294	0	0.000000	NC
Chloroform	TCLME	119.4	0.93	0.000783	0.046	0.000039	95.04%
Carbon Tetrachloride	CTCL	153.84	1.4	0.001519	0.92	0.001001	34.13%
1,2-Dichloroethane	DCA12	98.96	0.081	0.000057	0	0.000000	NC
Benzene	BZ	78	0.76	0.000418	0	0.000000	NC
Trichloroethene	TCE	131.4	20	0.018536	0.042	0.000039	99.79%
Tetrachloroethene	PCE	165.85	0.062	0.000073	0.0036	0.000004	94.18%
Total Target List VOCs			23.99	0.021900	1.03	0.001093	95.01%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	16:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	250		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	340		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	740		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	230		=	
Trichloroethene	TCE	79-01-6	200	15000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra
Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	16:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	U Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	40	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:43	Sample Vol. (ML):	
Dilution Factor:	3.5	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	7.0	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	7.0	ND		U	
Chloromethane	CLME	74-87-3	14	ND		U	
Vinyl chloride	VC	75-01-4	7.0	ND		U	
Bromomethane	BRME	74-83-9	7.0	ND		U	
Chloroethane	CLEA	75-00-3	14	ND		U	
Trichlorofluoromethane	FC11	75-69-4	7.0	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	7.0	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	7.0	ND		U	
Acetone	ACE	67-64-1	35	39		=	
Dichloromethane	MTLNCL	75-09-2	7.0	36		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	7.0	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	7.0	ND		U	
Vinyl acetate	VA	108-05-4	35	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	7.0	ND		U	
2-Butanone	MEK	78-93-3	35	ND		U	
Chloroform	TCLME	67-66-3	7.0	280		=	
1,1,1-Trichloroethane	TCA111	71-55-6	7.0	ND		U	
Carbon tetrachloride	CTCL	56-23-5	7.0	990		=	
1,2-Dichloroethane	DCA12	107-06-2	7.0	ND		U	
Benzene	BZ	71-43-2	7.0	ND		U	
Trichloroethene	TCE	79-01-6	7.0	200		=	
1,2-Dichloropropane	DCPA12	78-87-5	7.0	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	7.0	ND		U	
Toluene	BZME	108-88-3	7.0	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	7.0	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	35	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	7.0	ND		U	
Tetrachloroethene	PCE	127-18-4	7.0	ND		U	
1,2-Dibromoethane	EDB	106-93-4	7.0	ND		U	
Chlorobenzene	CLBZ	108-90-7	7.0	ND		U	
Ethylbenzene	EBZ	100-41-4	7.0	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	7.0	ND		U	
o-Xylene	XYLO	95-47-6	7.0	ND		U	
Styrene	STY	100-42-5	7.0	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	7.0	ND		U	
Benzyl chloride	BZLCL	100-44-7	35	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	7.0	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	7.0	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	7.0	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:43	Sample Vol. (ML):	
Dilution Factor:	3.5	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	7.0	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	7.0	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	70	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	14	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	48	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/15/97
Test Start Time: 14:45
Sample Date: 1/15/97

Test #: 7
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 47 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1	(in. Hg.)
Temperature	54	(deg F)
dP	-1.000	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-07	
Sample Time	15:29 8021, 15:26 TO14	
Pressure	-3.6	(in. Hg)
Temperature	93	(deg F)
dP	-0.8	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	30	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: OPTA-07
Sample Time: 15:23 Vacuum: -1.0 (in. Hg) Temperature: 54 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	0	47	0	49	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.29	0.000207	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.073	0.000046	0.0084	0.000005	88.15%
cis-1,2-dichloroethene	DCE12C	97	0.43	0.000307	0	0.000000	NC
Chloroform	TCLME	119.4	1	0.000878	0.023	0.000021	97.63%
Carbon Tetrachloride	CTCL	153.84	1.3	0.001470	0.92	0.001072	27.09%
1,2-Dichloroethane	DCA12	98.96	0.079	0.000057	0	0.000000	NC
Benzene	BZ	78	0.65	0.000373	0	0.000000	NC
Trichloroethene	TCE	131.4	20	0.019316	0.0097	0.000010	99.95%
Tetrachloroethene	PCE	165.85	0.066	0.000080	0	0.000000	NC
Total Target List VOCs			23.89	0.022733	0.96	0.001108	95.13%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3352
Sample Type: AIR / TEDLAR
Date Sampled: 15-Jan-97
Date Received: 15-Jan-97
Date Analyzed: 15-Jan-97
Time Analyzed: 1618
Date Reported: 15-Jan-97
Dilution Factor: 16.70
Concentration Units: PPBV

Field ID #: OPTA-07
Site #: PCO
Sample Delivery Group: 8D211
Lab Sample ID: 8D21115
Sample Volume (ml): 3
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0115A1
Data Filename: 008F0101.D
Electronic Filename: 108D0115.HAL
SACODE: *
PVCCODE: PR

Analyte	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	67.00	0	U		
Chloromethane	CLME	74-87-3	67.00	0	U		
Vinyl chloride	VC	75-01-4	67.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	50.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	170.00	290.00	=		
Trichlorotrifluoroethane	FC113	76-13-1	170.00	0	U		
Methylene chloride	MTLNCL	75-09-2	50.00	73.00	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	67.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	67.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	50.00	430.00	=		
Chloroform	TCLME	67-66-3	67.00	1000.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	67.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	50.00	1300.00	=		
1,2-Dichloroethane	DCA12	107-06-2	50.00	79.00	=		
Benzene	BZ	71-43-2	330.00	650.00	=		
Trichloroethene	TCE	79-01-6	50.00	20000.00	=		
Toluene	BZME	108-88-3	330.00	0	U		
Tetrachloroethene	PCE	127-18-4	50.00	66.00	=		
Chlorobenzene	CLBZ	108-90-7	67.00	0	U		
Ethylbenzene	EBZ	100-41-4	420.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	840.00	0	U		
o-Xylene	XYLO	95-47-6	420.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	84.86			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	77.24			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analyte not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply no actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in terms of percent recovery with control limits: 65 to 135%.

E UZ 1/15/97

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

Approved By: _____ Date: _____

DRAFT

Analytical Laboratory Report

EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3352
Sample Type: AIR / TEDLAR
Date Sampled: 15-Jan-97
Date Received: 15-Jan-97
Date Analyzed: 15-Jan-97
Time Analyzed: 1631
Date Reported: 15-Jan-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: OPTE-07
Site #: PCO
Sample Delivery Group: 8D211
Lab Sample ID: 8D21116
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0115A2
Data Filename: 007F0101.D
Electronic Filename: 207D0115.HAL
SACODE: *
PVCCODE: PR ✓

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	8.40	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	0	U		
Chloroform	TCLME	67-66-3	4.00	23.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	920.00	=		
1,2-Dichloroethane	DCA12	107-06-2	3.00	0	U		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	9.70	=		
Toluene	BZME	108-88-3	20.00	78.00	=		
Tetrachloroethene	PCE	127-18-4	3.00	0	U		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	88.95			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	89.71			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply no actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E LZ 1/15/97

Approved By: _____ Date: _____

1-6
Cover and QC info

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3353
Sample Type: AIR / TEDLAR
Date Sampled: 15-Jan-97
Date Received: 15-Jan-97
Date Analyzed: 15-Jan-97
Time Analyzed: 1716
Date Reported: 15-Jan-97
Dilution Factor: 16.70
Concentration Units: PPBV

Field ID #: OPTA-08
Site #: PCO
Sample Delivery Group: 8D211
Lab Sample ID: 8D21117
Sample Volume (ml): 3
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0115A1
Data Filename: 009F0101.D
Electronic Filename: 109D0115.HAL
SACODE: •
PVCCODE: PR ✓

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	67.00	0	U		
Chloromethane	CLME	74-87-3	67.00	0	U		
Vinyl chloride	VC	75-01-4	67.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	50.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	170.00	270.00	=		
Trichlorotrifluoroethane	FC113	76-13-1	170.00	0	U		
Methylene chloride	MTLNCL	75-09-2	50.00	88.00	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	67.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	67.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	50.00	460.00	=		
Chloroform	TCLME	67-66-3	67.00	950.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	67.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	50.00	1500.00	=		
1,2-Dichloroethane	DCA12	107-06-2	50.00	86.00	=		
Benzene	BZ	71-43-2	330.00	810.00	=		
Trichloroethene	TCE	79-01-6	50.00	22000.00	=		
Toluene	BZME	108-88-3	330.00	0	U		
Tetrachloroethene	PCE	127-18-4	50.00	60.00	=		
Chlorobenzene	CLBZ	108-90-7	67.00	0	U		
Ethylbenzene	EBZ	100-41-4	420.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	840.00	0	U		
o-Xylene	XYLO	95-47-6	420.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	86.99 ✓			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	78.77 ✓			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits 65 to 135%.

E VE 1/15/97

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

Approved By: _____ Date: _____

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3353
Sample Type: AIR / TEDLAR
Date Sampled: 15-Jan-97
Date Received: 15-Jan-97
Date Analyzed: 15-Jan-97
Time Analyzed: 1703
Date Reported: 15-Jan-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: OPTE-08
Site #: PCO
Sample Delivery Group: 8D211
Lab Sample ID: 8D21118
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0115A2
Data Filename: 008F0101.D
Electronic Filename: 208D0115.HAL
SACODE: *
PVCCODE: PR ✓

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	28.00	-		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	0	U		
Chloroform	TCLME	67-66-3	4.00	100.00	-		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	970.00	-		
1,2-Dichloroethane	DCA12	107-06-2	3.00	24.00	-		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	7.20	-		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	0	U		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	89.20			
1,4-Dichlorobenzene	DCBTA14	118-56-5	0	91.59			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E VZ 1/15/97

Approved By: _____ Date: _____

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/15/97
Test Start Time: 15:40
Sample Date: 1/15/97

Test #: 8
Path #: 2
Dilution: 0%
Ozone: N
Ambient Temp: 47 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1	(in. Hg.)
Temperature	54	(deg F)
dP	-1.000	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-08	
Sample Time	16:22	
Pressure	-3.6	(in. Hg)
Temperature	92	(deg F)
dP	-0.8	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	31	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: OPTA-08
Sample Time: 16:16 Vacuum: -1.0 (in. Hg) Temperature: 54 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	0	47	0	49	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.27	0.000192	0	0.000000	NC
Methylene chloride	MTLNCL	85	0.088	0.000055	0.028	0.000018	67.18%
cis-1,2-dichloroethene	DCE12C	97	0.46	0.000328	0	0.000000	NC
Chloroform	TCLME	119.4	0.95	0.000834	0.1	0.000091	89.14%
Carbon Tetrachloride	CTCL	153.84	1.5	0.001696	0.97	0.001131	33.30%
1,2-Dichloroethane	DCA12	98.96	0.086	0.000063	0.024	0.000018	71.21%
Benzene	BZ	78	0.81	0.000464	0	0.000000	NC
Trichloroethene	TCE	131.4	22	0.021248	0.0072	0.000007	99.97%
Tetrachloroethene	PCE	165.85	0.06	0.000073	0	0.000000	NC
Total Target List VOCs			26.22	0.024953	1.13	0.001265	94.93%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/24/97
Test Start Time: 07:50
Sample Date: 1/24/97

Test #: 9
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 48.2 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1	(in. Hg.)
Temperature	51	(deg F)
dP	0.950	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-09	
Sample Time	09:01	
Pressure	-3.75	(in. Hg)
Temperature	86	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	54	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	1	
Est. Dry Gas Rate (dscfm)	53	

INFLUENT (PCOI)
Sample #: OPTA-09
Sample Time: 08:47 Vacuum: 1.0 (in. Hg) Temperature: 51 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	49	0	53	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.2	0.000148	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.0086	0.000006	NC
cis-1,2-dichloroethene	DCE12C	97	0.21	0.000155	0	0.000000	NC
Chloroform	TCLME	119.4	0.36	0.000327	0.0076	0.000008	97.71%
Carbon Tetrachloride	CTCL	153.84	0.54	0.000633	0.64	0.000814	-28.73%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.24	0.000143	0	0.000000	NC
Trichloroethene	TCE	131.4	11	0.011008	0.034	0.000037	99.66%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			12.55	0.012414	0.69	0.000865	93.03%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Volatile Organics by GCMS - EPA TO14

PCOI

Client:	URS Greiner, Inc.	URS Sample #:	OPTA09
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0005-SA
Time Analyzed:	10:38	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	81	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	81	ND		U	
Chloromethane	CLME	74-87-3	160	ND		U	
Vinyl chloride	VC	75-01-4	81	ND		U	
Bromomethane	BRME	74-83-9	81	ND		U	
Chloroethane	CLEA	75-00-3	160	ND		U	
Trichlorofluoromethane	FC11	75-69-4	81	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	81	200		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	81	ND		U	
Acetone	ACE	67-64-1	400	ND		U	
Dichloromethane	MTLNCL	75-09-2	81	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	81	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	81	ND		U	
Vinyl acetate	VA	108-05-4	400	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	81	210		=	
2-Butanone	MEK	78-93-3	400	1100		=	
Chloroform	TCLME	67-66-3	81	360		=	
1,1,1-Trichloroethane	TCA111	71-55-6	81	ND		U	
Carbon tetrachloride	CTCL	56-23-5	81	540		=	
1,2-Dichloroethane	DCA12	107-06-2	81	ND		U	
Benzene	BZ	71-43-2	81	240		=	
Trichloroethene	TCE	79-01-6	81	11000		=	
1,2-Dichloropropane	DCPA12	78-87-5	81	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	81	ND		U	
Toluene	BZME	108-88-3	81	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	81	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	400	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	81	ND		U	
Tetrachloroethene	PCE	127-18-4	81	ND		U	
1,2-Dibromoethane	EDB	106-93-4	81	ND		U	
Chlorobenzene	CLBZ	108-90-7	81	ND		U	
Ethylbenzene	EBZ	100-41-4	81	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	81	ND		U	
o-Xylene	XYLO	95-47-6	81	ND		U	
Styrene	STY	100-42-5	81	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	81	ND		U	
Benzyl chloride	BZLCL	100-44-7	400	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	81	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	81	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	81	ND		U	

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	OPTA09
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0005-SA
Time Analyzed:	10:38	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	81	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	81	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	810	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	160	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	51	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	46	50

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client:	URS Greiner, Inc.	URS Sample #:	OPTA09
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0005-SA
Time Analyzed:	10:38	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual.	PARVQ	URS Rev
No Peaks Found				--		TI	

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/24/97
Test Start Time: 09:15
Sample Date: 1/24/97

Test #: 10
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 49 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1	(in. Hg.)
Temperature	56	(deg F)
dP	1.050	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-10	
Sample Time	09:49	
Pressure	3.6	(in. Hg)
Temperature	86	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	34	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	1	
Est. Dry Gas Rate (dscfm)	34	

INFLUENT (PCOI)
Sample #: OPTA-10
Sample Time: 09:43 Vacuum: 1.0 (in. Hg) Temperature: 56 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	49	0	34	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.24	0.000176	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.017	0.000008	NC
cis-1,2-dichloroethene	DCE12C	97	0.3	0.000220	0	0.000000	NC
Chloroform	TCLME	119.4	0.49	0.000443	0.03	0.000019	95.73%
Carbon Tetrachloride	CTCL	153.84	0.72	0.000838	0.84	0.000682	18.66%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.32	0.000189	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014916	0.059	0.000041	99.73%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			17.07	0.016783	0.95	0.000749	95.54%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Volatile Organics by GCMS - EPA TO14

PCOI

Client:	URS Greiner, Inc.	URS Sample #:	OPTA10
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0007-SA
Time Analyzed:	11:05	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	240		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	300		=	
2-Butanone	MEK	78-93-3	1000	ND		=	
Chloroform	TCLME	67-66-3	200	490		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	720		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	320		=	
Trichloroethene	TCE	79-01-6	200	15000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	OPTA10
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0007-SA
Time Analyzed:	11:05	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	52	50
Toluene-d8	BZMED8	2037-26-5	52	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client:	URS Greiner, Inc.	URS Sample #:	OPTA10
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0007-SA
Time Analyzed:	11:05	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
No Peaks Found				--		TI	

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/24/97
Test Start Time: 10:00
Sample Date: 1/24/97

Test #: 11
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 53 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	56	(deg F)
dP	1.000	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-11	
Sample Time	10:36	
Pressure	3.6	(in. Hg)
Temperature	91	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	35	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	34	

INFLUENT (PCOI)
Sample #: OPTA-11
Sample Time: 10:50 Vacuum: 1.0 (in. Hg) Temperature: 56 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	47	0	34	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.26	0.000186	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.014	0.000006	NC
cis-1,2-dichloroethene	DCE12C	97	0.29	0.000208	0	0.000000	NC
Chloroform	TCLME	119.4	0.46	0.000406	0.016	0.000010	97.51%
Carbon Tetrachloride	CTCL	153.84	0.73	0.000829	0.82	0.000667	19.60%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.33	0.000190	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014558	0.056	0.000039	99.73%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			17.07	0.016377	0.91	0.000722	95.59%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Volatile Organics by GCMS - EPA TO14

PCOL

Client:	URS Greiner, Inc.	URS Sample #:	OPTA11
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	30 JAN 97	Lab Sample #:	0001-SA
Time Analyzed:	19:57	Sample Vol. (ML):	
Dilution Factor:	20	QC Batch (Lablotctl):	G970130A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	40	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	40	ND		U	
Chloromethane	CLME	74-87-3	81	ND		U	
Vinyl chloride	VC	75-01-4	40	ND		U	
Bromomethane	BRME	74-83-9	40	ND		U	
Chloroethane	CLEA	75-00-3	81	ND		U	
Trichlorofluoromethane	FC11	75-69-4	40	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	40	270		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	40	ND		U	
Acetone	ACE	67-64-1	200	ND		U	
Dichloromethane	MTLNCL	75-09-2	40	47		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	40	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	40	ND		U	
Vinyl acetate	VA	108-05-4	200	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	40	280		=	
2-Butanone	MEK	78-93-3	200	570		=	
Chloroform	TCLME	67-66-3	40	450		=	
1,1,1-Trichloroethane	TCA111	71-55-6	40	ND		U	
Carbon tetrachloride	CTCL	56-23-5	40	700		=	
1,2-Dichloroethane	DCA12	107-06-2	40	ND		U	
Benzene	BZ	71-43-2	40	320		=	
Trichloroethene	TCE	79-01-6	~~40~~ 81	~~13000~~	E	~~E~~ 15000	
1,2-Dichloropropane	DCPA12	78-87-5	40	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	40	ND		U	
Toluene	BZME	108-88-3	40	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	40	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	200	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	40	ND		U	
Tetrachloroethene	PCE	127-18-4	40	ND		U	
1,2-Dibromoethane	EDB	106-93-4	40	ND		U	
Chlorobenzene	CLBZ	108-90-7	40	ND		U	
Ethylbenzene	EBZ	100-41-4	40	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	40	ND		U	
o-Xylene	XYLO	95-47-6	40	ND		U	
Styrene	STY	100-42-5	40	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	40	ND		U	
Benzyl chloride	BZLCL	100-44-7	200	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	40	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	40	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	OPTA11
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	30 JAN 97	Lab Sample #:	0001-SA
Time Analyzed:	19:57	Sample Vol. (ML):	
Dilution Factor:	20	QC Batch (Lablotctl):	G970130A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,3-Dichlorobenzene	DCBZ13	541-73-1	40	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	40	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	40	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	400	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	81	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	46	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	44	50

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client:	URS Greiner, Inc.	URS Sample #:	OPTA11
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	30 JAN 97	Lab Sample #:	0001-SA
Time Analyzed:	19:57	Sample Vol. (ML):	
Dilution Factor:	20	QC Batch (Lablotctl):	G970130A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
No Peaks Found				--		TI	

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/24/97
Test Start Time: 10:40
Sample Date: 1/24/97

Test #: 12
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 53 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	57	(deg F)
dP	1.000	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	OPTE-12	
Sample Time	11:15	
Pressure	3.6	(in. Hg)
Temperature	91	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	34	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	34	

INFLUENT (PCOI)
Sample #: OPTA-12
Sample Time: 11:15 Vacuum: 1.0 (in. Hg) Temperature: 52 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	47	0	34	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.28	0.000200	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.011	0.000005	NC
cis-1,2-dichloroethene	DCE12C	97	0.28	0.000200	0	0.000000	NC
Chloroform	TCLME	119.4	0.49	0.000432	0.013	0.000008	98.12%
Carbon Tetrachloride	CTCL	153.84	0.76	0.000863	0.79	0.000637	26.19%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.32	0.000184	0	0.000000	NC
Trichloroethene	TCE	131.4	16	0.015512	0.038	0.000026	99.83%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			18.13	0.017391	0.85	0.000676	96.11%

Phosgene Concentration: ND at 0.25 (ppm)

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Volatile Organics by GCMS - EPA TO14

PCOL

Client:	URS Greiner, Inc.	URS Sample #:	OPTA12
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0003-SA
Time Analyzed:	10:11	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	81	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	81	ND		U	
Chloromethane	CLME	74-87-3	160	ND		U	
Vinyl chloride	VC	75-01-4	81	ND		U	
Bromomethane	BRME	74-83-9	81	ND		U	
Chloroethane	CLEA	75-00-3	160	ND		U	
Trichlorofluoromethane	FC11	75-69-4	81	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	81	280		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	81	ND		U	
Acetone	ACE	67-64-1	400	ND		U	
Dichloromethane	MTLNCL	75-09-2	81	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	81	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	81	ND		U	
Vinyl acetate	VA	108-05-4	400	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	81	280		=	
2-Butanone	MEK	78-93-3	400	460		=	
Chloroform	TCLME	67-66-3	81	490		=	
1,1,1-Trichloroethane	TCA111	71-55-6	81	ND		U	
Carbon tetrachloride	CTCL	56-23-5	81	760		=	
1,2-Dichloroethane	DCA12	107-06-2	81	ND		U	
Benzene	BZ	71-43-2	81	320		=	
Trichloroethene	TCE	79-01-6	81	16000		=	
1,2-Dichloropropane	DCPA12	78-87-5	81	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	81	ND		U	
Toluene	BZME	108-88-3	81	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	81	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	400	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	81	ND		U	
Tetrachloroethene	PCE	127-18-4	81	ND		U	
1,2-Dibromoethane	EDB	106-93-4	81	ND		U	
Chlorobenzene	CLBZ	108-90-7	81	ND		U	
Ethylbenzene	EBZ	100-41-4	81	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	81	ND		=	
o-Xylene	XYLO	95-47-6	81	ND		U	
Styrene	STY	100-42-5	81	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	81	ND		U	
Benzyl chloride	BZLCL	100-44-7	400	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	81	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	81	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	81	ND		U	

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	OPTA12
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0003-SA
Time Analyzed:	10:11	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	81	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	81	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	810	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	160	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	52	50
Toluene-d8	BZMED8	2037-26-5	52	50
Bromofluorobenzene	BR4FBZ	460-00-4	44	50

Tentatively Identified Compounds (TICs)
Method EPA TO-14

Client:	URS Greiner, Inc.	URS Sample #:	OPTA12
Date Sampled:	24 JAN 97	Site #:	PCO
Date Received:	28 JAN 97	Lab Project #:	124359
Date Analyzed:	31 JAN 97	Lab Sample #:	0003-SA
Time Analyzed:	10:11	Sample Vol. (ML):	
Dilution Factor:	40	QC Batch (Lablotctl):	G970131A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
No Peaks Found				--		TI	

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

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APPENDIX D

COMPARISON OF METHOD 8021
vs.
METHOD TO-14 RESULTS

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/05/97	DA	A-03	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/05/97	DA	A-03	-	-		OK
Chloromethane	CLME	02/05/97	DA	A-03	-	-		OK
Vinyl Chloride	VC	02/05/97	DA	A-03	-	-		OK
Bromoethane	BRME	02/05/97	DA	A-03	-	-		OK
Chloroethane	CLEA	02/05/97	DA	A-03	-	-		OK
Trichlorofluoromethane	FC11	02/05/97	DA	A-03	-	-		OK
1,1-Dichloroethene	DCE11	02/05/97	DA	A-03	<.170	0.25	NC	OK
Trichlorotrifluoroethane	FC113	02/05/97	DA	A-03	-	-		OK
Acetone	ACE	02/05/97	DA	A-03	-	-		OK
Methylene Chloride	MTLNCL	02/05/97	DA	A-03	-	-		OK
trans-1,2-Dichloroethene	DCE12T	02/05/97	DA	A-03	-	-		OK
1,1-Dichloroethane	DCA11	02/05/97	DA	A-03	-	-		OK
Vinyl acetate	VA	02/05/97	DA	A-03	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/05/97	DA	A-03	0.29	0.31	-6.67	OK
2-Butanone	MEK	02/05/97	DA	A-03	-	-		OK
Chloroform	TCLME	02/05/97	DA	A-03	0.77	0.47	48.39	OK
1,1,1-Trichloroethane	TCA111	02/05/97	DA	A-03	-	-		OK
Carbon Tetrachloride	CTCL	02/05/97	DA	A-03	0.96	0.9	6.45	OK
1,2-Dichloroethane	DCA12	02/05/97	DA	A-03	-	-		OK
Benzene	BZ	02/05/97	DA	A-03	0.35	0.31	12.12	OK
Trichloroethene	TCE	02/05/97	DA	A-03	15	18	-18.18	OK
1,2-Dichloropropane	DCPA12	02/05/97	DA	A-03	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/05/97	DA	A-03	-	-		OK
Toluene	BZME	02/05/97	DA	A-03	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/05/97	DA	A-03	-	-		OK
4-Methyl-2-pentanone	MIBK	02/05/97	DA	A-03	-	-		OK
1,1,2-Trichloroethane	TCA112	02/05/97	DA	A-03	-	-		OK
Tetrachloroethene	PCE	02/05/97	DA	A-03	-	-		OK
1,2-Dibromoethane	EDB	02/05/97	DA	A-03	-	-		OK
Chlorobenzene	CLBZ	02/05/97	DA	A-03	-	-		OK
Ethylbenzene	EBZ	02/05/97	DA	A-03	-	-		OK
m,p-Xylene	XYLMP	02/05/97	DA	A-03	-	-		OK
o-Xylene	XYLO	02/05/97	DA	A-03	-	-		OK
Styrene	STY	02/05/97	DA	A-03	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/05/97	DA	A-03	-	-		OK
Benzyl Chloride	BZLCL	02/05/97	DA	A-03	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/05/97	DA	A-03	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/05/97	DA	A-03	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/05/97	DA	A-03	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/05/97	DA	A-03	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/05/97	DA	A-03	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/05/97	DA	A-03	-	-		OK
Hexachlorobutadiene	HCBU	02/05/97	DA	A-03	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/05/97	DE	E-03	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/05/97	DE	E-03	-	-		OK
Chloromethane	CLME	02/05/97	DE	E-03	-	-		OK
Vinyl Chloride	VC	02/05/97	DE	E-03	-	-		OK
Bromoethane	BRME	02/05/97	DE	E-03	-	-		OK
Chloroethane	CLEA	02/05/97	DE	E-03	-	-		OK
Trichlorofluoromethane	FC11	02/05/97	DE	E-03	-	-		OK
1,1-Dichloroethene	DCE11	02/05/97	DE	E-03	<.010	0.0043	NC	OK
Trichlorotrifluoroethane	FC113	02/05/97	DE	E-03	-	-		OK
Acetone	ACE	02/05/97	DE	E-03	-	-		OK
Methylene Chloride	MTLNCL	02/05/97	DE	E-03	0.027	0.039	-36.36	OK
trans-1,2-Dichloroethene	DCE12T	02/05/97	DE	E-03	-	-		OK
1,1-Dichloroethane	DCA11	02/05/97	DE	E-03	0.013	0.019	-37.50	OK
Vinyl acetate	VA	02/05/97	DE	E-03	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/05/97	DE	E-03	0.0045	0.0081	-57.14	Noncompliant
2-Butanone	MEK	02/05/97	DE	E-03	-	-		OK
Chloroform	TCLME	02/05/97	DE	E-03	0.36	0.44	-20.00	OK
1,1,1-Trichloroethane	TCA111	02/05/97	DE	E-03	-	-		OK
Carbon Tetrachloride	CTCL	02/05/97	DE	E-03	0.7	0.91	-26.09	OK
1,2-Dichloroethane	DCA12	02/05/97	DE	E-03	0.031	0.0087	112.34	Noncompliant
Benzene	BZ	02/05/97	DE	E-03	<.020	0.0058	NC	OK
Trichloroethene	TCE	02/05/97	DE	E-03	0.32	0.37	-14.49	OK
1,2-Dichloropropane	DCPA12	02/05/97	DE	E-03	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/05/97	DE	E-03	-	-		OK
Toluene	BZME	02/05/97	DE	E-03	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/05/97	DE	E-03	-	-		OK
4-Methyl-2-pentanone	MIBK	02/05/97	DE	E-03	-	-		OK
1,1,2-Trichloroethane	TCA112	02/05/97	DE	E-03	-	-		OK
Tetrachloroethene	PCE	02/05/97	DE	E-03	0.0094	<.0042	NC	OK
1,2-Dibromoethane	EDB	02/05/97	DE	E-03	-	-		OK
Chlorobenzene	CLBZ	02/05/97	DE	E-03	-	-		OK
Ethylbenzene	EBZ	02/05/97	DE	E-03	-	-		OK
m,p-Xylene	XYLMP	02/05/97	DE	E-03	-	-		OK
o-Xylene	XYLO	02/05/97	DE	E-03	-	-		OK
Styrene	STY	02/05/97	DE	E-03	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/05/97	DE	E-03	-	-		OK
Benzyl Chloride	BZLCL	02/05/97	DE	E-03	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/05/97	DE	E-03	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/05/97	DE	E-03	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/05/97	DE	E-03	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/05/97	DE	E-03	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/05/97	DE	E-03	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/05/97	DE	E-03	-	-		OK
Hexachlorobutadiene	HCBU	02/05/97	DE	E-03	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/06/97	DA	A-04	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/06/97	DA	A-04	-	-		OK
Chloromethane	CLME	02/06/97	DA	A-04	-	-		OK
Vinyl Chloride	VC	02/06/97	DA	A-04	-	-		OK
Bromoethane	BRME	02/06/97	DA	A-04	-	-		OK
Chloroethane	CLEA	02/06/97	DA	A-04	-	-		OK
Trichlorofluoromethane	FC11	02/06/97	DA	A-04	-	-		OK
1,1-Dichloroethene	DCE11	02/06/97	DA	A-04	0.15	0.24	-46.15	OK
Trichlorotrifluoroethane	FC113	02/06/97	DA	A-04	-	-		OK
Acetone	ACE	02/06/97	DA	A-04	-	-		OK
Methylene Chloride	MTLNCL	02/06/97	DA	A-04	-	-		OK
trans-1,2-Dichloroethene	DCE12T	02/06/97	DA	A-04	-	-		OK
1,1-Dichloroethane	DCA11	02/06/97	DA	A-04	-	-		OK
Vinyl acetate	VA	02/06/97	DA	A-04	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/06/97	DA	A-04	0.27	0.25	7.69	OK
2-Butanone	MEK	02/06/97	DA	A-04	-	-		OK
Chloroform	TCLME	02/06/97	DA	A-04	0.66	0.38	53.85	Noncompliant
1,1,1-Trichloroethane	TCA111	02/06/97	DA	A-04	-	-		OK
Carbon Tetrachloride	CTCL	02/06/97	DA	A-04	1	0.81	20.99	OK
1,2-Dichloroethane	DCA12	02/06/97	DA	A-04	0.065	<.200	NC	OK
Benzene	BZ	02/06/97	DA	A-04	0.29	0.24	18.87	OK
Trichloroethene	TCE	02/06/97	DA	A-04	15	16	-6.45	OK
1,2-Dichloropropane	DCPA12	02/06/97	DA	A-04	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/06/97	DA	A-04	-	-		OK
Toluene	BZME	02/06/97	DA	A-04	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/06/97	DA	A-04	-	-		OK
4-Methyl-2-pentanone	MIBK	02/06/97	DA	A-04	-	-		OK
1,1,2-Trichloroethane	TCA112	02/06/97	DA	A-04	-	-		OK
Tetrachloroethene	PCE	02/06/97	DA	A-04	0.047	<.200	NC	OK
1,2-Dibromoethane	EDB	02/06/97	DA	A-04	-	-		OK
Chlorobenzene	CLBZ	02/06/97	DA	A-04	-	-		OK
Ethylbenzene	EBZ	02/06/97	DA	A-04	-	-		OK
m,p-Xylene	XYLMP	02/06/97	DA	A-04	-	-		OK
o-Xylene	XYLO	02/06/97	DA	A-04	-	-		OK
Styrene	STY	02/06/97	DA	A-04	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/06/97	DA	A-04	-	-		OK
Benzyl Chloride	BZLCL	02/06/97	DA	A-04	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/06/97	DA	A-04	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/06/97	DA	A-04	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/06/97	DA	A-04	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/06/97	DA	A-04	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/06/97	DA	A-04	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/06/97	DA	A-04	-	-		OK
Hexachlorobutadiene	HCBU	02/06/97	DA	A-04	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/06/97	DE	E-04	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/06/97	DE	E-04	-	-		OK
Chloromethane	CLME	02/06/97	DE	E-04	-	-		OK
Vinyl Chloride	VC	02/06/97	DE	E-04	-	-		OK
Bromoethane	BRME	02/06/97	DE	E-04	-	-		OK
Chloroethane	CLEA	02/06/97	DE	E-04	-	-		OK
Trichlorofluoromethane	FC11	02/06/97	DE	E-04	-	-		OK
1,1-Dichloroethene	DCE11	02/06/97	DE	E-04	-	-		OK
Trichlorotrifluoroethane	FC113	02/06/97	DE	E-04	-	-		OK
Acetone	ACE	02/06/97	DE	E-04	-	-		OK
Methylene Chloride	MTLNCL	02/06/97	DE	E-04	0.024	0.029	-18.87	OK
trans-1,2-Dichloroethene	DCE12T	02/06/97	DE	E-04	-	-		OK
1,1-Dichloroethane	DCA11	02/06/97	DE	E-04	0.0093	0.013	-33.18	OK
Vinyl acetate	VA	02/06/97	DE	E-04	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/06/97	DE	E-04	0.0039	<.0067	NC	OK
2-Butanone	MEK	02/06/97	DE	E-04	-	-		OK
Chloroform	TCLME	02/06/97	DE	E-04	0.27	0.27	0.00	OK
1,1,1-Trichloroethane	TCA111	02/06/97	DE	E-04	-	-		OK
Carbon Tetrachloride	CTCL	02/06/97	DE	E-04	0.72	0.88	-20.00	OK
1,2-Dichloroethane	DCA12	02/06/97	DE	E-04	0.024	0.0068	111.69	Noncompliant
Benzene	BZ	02/06/97	DE	E-04	-	-		OK
Trichloroethene	TCE	02/06/97	DE	E-04	0.33	0.33	0.00	OK
1,2-Dichloropropane	DCPA12	02/06/97	DE	E-04	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/06/97	DE	E-04	-	-		OK
Toluene	BZME	02/06/97	DE	E-04	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/06/97	DE	E-04	-	-		OK
4-Methyl-2-pentanone	MIBK	02/06/97	DE	E-04	-	-		OK
1,1,2-Trichloroethane	TCA112	02/06/97	DE	E-04	-	-		OK
Tetrachloroethene	PCE	02/06/97	DE	E-04	0.0056	<.0067	NC	OK
1,2-Dibromoethane	EDB	02/06/97	DE	E-04	-	-		OK
Chlorobenzene	CLBZ	02/06/97	DE	E-04	-	-		OK
Ethylbenzene	EBZ	02/06/97	DE	E-04	-	-		OK
m,p-Xylene	XYLMP	02/06/97	DE	E-04	-	-		OK
o-Xylene	XYLO	02/06/97	DE	E-04	-	-		OK
Styrene	STY	02/06/97	DE	E-04	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/06/97	DE	E-04	-	-		OK
Benzyl Chloride	BZLCL	02/06/97	DE	E-04	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/06/97	DE	E-04	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/06/97	DE	E-04	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/06/97	DE	E-04	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/06/97	DE	E-04	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/06/97	DE	E-04	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/06/97	DE	E-04	-	-		OK
Hexachlorobutadiene	HCBU	02/06/97	DE	E-04	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/07/97	DA	A-05	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/07/97	DA	A-05	-	-		OK
Chloromethane	CLME	02/07/97	DA	A-05	-	-		OK
Vinyl Chloride	VC	02/07/97	DA	A-05	-	-		OK
Bromoethane	BRME	02/07/97	DA	A-05	-	-		OK
Chloroethane	CLEA	02/07/97	DA	A-05	-	-		OK
Trichlorofluoromethane	FC11	02/07/97	DA	A-05	-	-		OK
1,1-Dichloroethene	DCE11	02/07/97	DA	A-05	0.18	0.28	-43.48	OK
Trichlorotrifluoroethane	FC113	02/07/97	DA	A-05	-	-		OK
Acetone	ACE	02/07/97	DA	A-05	-	-		OK
Methylene Chloride	MTLNCL	02/07/97	DA	A-05	-	-		OK
trans-1,2-Dichloroethene	DCE12T	02/07/97	DA	A-05	-	-		OK
1,1-Dichloroethane	DCA11	02/07/97	DA	A-05	-	-		OK
Vinyl acetate	VA	02/07/97	DA	A-05	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/07/97	DA	A-05	0.32	0.27	16.95	OK
2-Butanone	MEK	02/07/97	DA	A-05	-	-		OK
Chloroform	TCLME	02/07/97	DA	A-05	0.68	0.39	54.21	Noncompliant
1,1,1-Trichloroethane	TCA111	02/07/97	DA	A-05	-	-		OK
Carbon Tetrachloride	CTCL	02/07/97	DA	A-05	1.2	0.9	28.57	OK
1,2-Dichloroethane	DCA12	02/07/97	DA	A-05	0.072	<.200	NC	OK
Benzene	BZ	02/07/97	DA	A-05	0.34	0.27	22.95	OK
Trichloroethene	TCE	02/07/97	DA	A-05	17	17	0.00	OK
1,2-Dichloropropane	DCPA12	02/07/97	DA	A-05	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/07/97	DA	A-05	-	-		OK
Toluene	BZME	02/07/97	DA	A-05	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/07/97	DA	A-05	-	-		OK
4-Methyl-2-pentanone	MIBK	02/07/97	DA	A-05	-	-		OK
1,1,2-Trichloroethane	TCA112	02/07/97	DA	A-05	-	-		OK
Tetrachloroethene	PCE	02/07/97	DA	A-05	0.054	<0.200	NC	OK
1,2-Dibromoethane	EDB	02/07/97	DA	A-05	-	-		OK
Chlorobenzene	CLBZ	02/07/97	DA	A-05	-	-		OK
Ethylbenzene	EBZ	02/07/97	DA	A-05	-	-		OK
m,p-Xylene	XYLMP	02/07/97	DA	A-05	-	-		OK
o-Xylene	XYLO	02/07/97	DA	A-05	-	-		OK
Styrene	STY	02/07/97	DA	A-05	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/07/97	DA	A-05	-	-		OK
Benzyl Chloride	BZLCL	02/07/97	DA	A-05	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/07/97	DA	A-05	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/07/97	DA	A-05	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/07/97	DA	A-05	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/07/97	DA	A-05	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/07/97	DA	A-05	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/07/97	DA	A-05	-	-		OK
Hexachlorobutadiene	HCBU	02/07/97	DA	A-05	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

8021 versus TO-14 PRECISION ASSESSMENT Only hits are shown
McAFB PCO Treatability Study IC 29

Analyte Name	Analyte	Date Sampled	Sample Location	Sample IDs	8021 Result (ppmv)	TO-14 Result (ppmv)	RPD (%)	Status
Dichlorodifluoromethane	FC12	02/11/97	DE	E-06	-	-		OK
Dichlorotetrafluoroethane	DCTFA12	02/11/97	DE	E-06	-	-		OK
Chloromethane	CLME	02/11/97	DE	E-06	-	-		OK
Vinyl Chloride	VC	02/11/97	DE	E-06	-	-		OK
Bromoethane	BRME	02/11/97	DE	E-06	-	-		OK
Chloroethane	CLEA	02/11/97	DE	E-06	-	-		OK
Trichlorofluoromethane	FC11	02/11/97	DE	E-06	-	-		OK
1,1-Dichloroethene	DCE11	02/11/97	DE	E-06	-	-		OK
Trichlorotrifluoroethane	FC113	02/11/97	DE	E-06	-	-		OK
Acetone	ACE	02/11/97	DE	E-06	-	0.039	NC	OK
Methylene Chloride	MTLNCL	02/11/97	DE	E-06	0.025	0.036	-36.07	OK
trans-1,2-Dichloroethene	DCE12T	02/11/97	DE	E-06	-	-		OK
1,1-Dichloroethane	DCA11	02/11/97	DE	E-06	0.0092	<.007	NC	OK
Vinyl acetate	VA	02/11/97	DE	E-06	-	-		OK
cis-1,2-Dichloroethene	DCE12C	02/11/97	DE	E-06	-	-		OK
2-Butanone	MEK	02/11/97	DE	E-06	-	-		OK
Chloroform	TCLME	02/11/97	DE	E-06	0.25	0.28	-11.32	OK
1,1,1-Trichloroethane	TCA111	02/11/97	DE	E-06	-	-		OK
Carbon Tetrachloride	CTCL	02/11/97	DE	E-06	0.69	0.99	-35.71	OK
1,2-Dichloroethane	DCA12	02/11/97	DE	E-06	0.027	<.007	NC	OK
Benzene	BZ	02/11/97	DE	E-06	-	-		OK
Trichloroethene	TCE	02/11/97	DE	E-06	0.21	0.2	4.88	OK
1,2-Dichloropropane	DCPA12	02/11/97	DE	E-06	-	-		OK
trans-1,3-Dichloropropene	DCP13T	02/11/97	DE	E-06	-	-		OK
Toluene	BZME	02/11/97	DE	E-06	-	-		OK
cis-1,3-Dichloropropene	DCP13C	02/11/97	DE	E-06	-	-		OK
4-Methyl-2-pentanone	MIBK	02/11/97	DE	E-06	-	-		OK
1,1,2-Trichloroethane	TCA112	02/11/97	DE	E-06	-	-		OK
Tetrachloroethene	PCE	02/11/97	DE	E-06	0.0055	<.007	NC	OK
1,2-Dibromoethane	EDB	02/11/97	DE	E-06	-	-		OK
Chlorobenzene	CLBZ	02/11/97	DE	E-06	-	-		OK
Ethylbenzene	EBZ	02/11/97	DE	E-06	-	-		OK
m,p-Xylene	XYLMP	02/11/97	DE	E-06	-	-		OK
o-Xylene	XYLO	02/11/97	DE	E-06	-	-		OK
Styrene	STY	02/11/97	DE	E-06	-	-		OK
1,1,2,2-Tetrachloroethane	PCA	02/11/97	DE	E-06	-	-		OK
Benzyl Chloride	BZLCL	02/11/97	DE	E-06	-	-		OK
1,3,5-Trimethylbenzene	TMB135	02/11/97	DE	E-06	-	-		OK
1,2,4-Trimethylbenzene	TMB124	02/11/97	DE	E-06	-	-		OK
1,3-Dichlorobenzene	DCBZ13	02/11/97	DE	E-06	-	-		OK
1,4-Dichlorobenzene	DCBZ14	02/11/97	DE	E-06	-	-		OK
1,2-Dichlorobenzene	DCBZ12	02/11/97	DE	E-06	-	-		OK
1,2,4-Trichlorobenzene	TCB124	02/11/97	DE	E-06	-	-		OK
Hexachlorobutadiene	HCBU	02/11/97	DE	E-06	-	-		OK

Notes: NC - Not calculated. All dashes represent either non detections or analytes not included in the method.
<2 - Analyte not detected at the listed detection limit.

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

ANON ENON ACON ECON

AR CATEGORY ___ ___ . ___ ___

Originals Maintained at McClellan AFB EM

APPENDIX E

RESULTS OF OPERATION PHASE AT IC 29

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/29/97
Test Start Time: 07:45
Sample Date: 1/29/97

Test #: D1
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 64 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1.6	(in. Hg.)
Temperature	63	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-01	
Sample Time	12:37	
Pressure	3.6	(in. Hg)
Temperature	92	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity		(%)
Estimated Moisture (%)	0	
Est. Dry Gas Rate (dscfm)	50	

INFLUENT (PCOI)
Sample #: A-01
Sample Time: 12:32 Vacuum: -1.6 (in. Hg) Temperature: 63 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	0	49	0	50	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.23	0.000169	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.03	0.000020	NC
cis-1,2-dichloroethene	DCE12C	97	0.27	0.000199	0.0043	0.000003	98.35%
Chloroform	TCLME	119.4	0.44	0.000399	0.18	0.000169	57.66%
Carbon Tetrachloride	CTCL	153.84	0.7	0.000817	0.81	0.000978	-19.75%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0.0039	0.000003	NC
Benzene	BZ	78	0.32	0.000189	0.0062	0.000004	97.99%
Trichloroethene	TCE	131.4	16	0.015952	0.27	0.000279	98.25%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			17.96	0.017725	1.30	0.001456	91.79%

Phosgene Concentration: NC (ppm) HCL and Chlorine Concentration: ND

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:11	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	230		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	270		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	440		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	700		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	320		=	
Trichloroethene	TCE	79-01-6	200	16000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:11	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:41	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	3.4	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	3.4	ND		U	
Chloromethane	CLME	74-87-3	6.7	ND		U	
Vinyl chloride	VC	75-01-4	3.4	ND		U	
Bromomethane	BRME	74-83-9	3.4	ND		U	
Chloroethane	CLEA	75-00-3	6.7	ND		U	
Trichlorofluoromethane	FC11	75-69-4	3.4	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	3.4	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	3.4	ND		U	
Acetone	ACE	67-64-1	17	20		=	
Dichloromethane	MTLNCL	75-09-2	3.4	.030		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	3.4	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	3.4	9.2		=	
Vinyl acetate	VA	108-05-4	17	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	3.4	.004.3		=	
2-Butanone	MEK	78-93-3	17	ND		U	
Chloroform	TCLME	67-66-3	3.4	.180		=	
1,1,1-Trichloroethane	TCA111	71-55-6	3.4	ND		U	
Carbon tetrachloride	CTCL	56-23-5	3.4	.730	E	E	
1,2-Dichloroethane	DCA12	107-06-2	3.4	.003.9		=	
Benzene	BZ	71-43-2	3.4	.006.2		=	
Trichloroethene	TCE	79-01-6	3.4	.270		=	
1,2-Dichloropropane	DCPA12	78-87-5	3.4	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	3.4	ND		U	
Toluene	BZME	108-88-3	3.4	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	3.4	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	17	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	3.4	ND		U	
Tetrachloroethene	PCE	127-18-4	3.4	ND		U	
1,2-Dibromoethane	EDB	106-93-4	3.4	ND		U	
Chlorobenzene	CLBZ	108-90-7	3.4	ND		U	
Ethylbenzene	EBZ	100-41-4	3.4	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	3.4	ND		U	
o-Xylene	XYLO	95-47-6	3.4	ND		U	
Styrene	STY	100-42-5	3.4	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	3.4	ND		U	
Benzyl chloride	BZLCL	100-44-7	17	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	3.4	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	3.4	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E01
Date Sampled:	29 JAN 97	Site #:	PCO
Date Received:	31 JAN 97	Lab Project #:	124403
Date Analyzed:	06 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:41	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970206A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
1,3-Dichlorobenzene	DCBZ13	541-73-1	3.4	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	3.4	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	3.4	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	34	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	6.7	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	17:08	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	46	50
Toluene-d8	BZMED8	2037-26-5	48	50
Bromofluorobenzene	BR4FBZ	460-00-4	40	50

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Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:46	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	3.4	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	3.4	ND		U	
Chloromethane	CLME	74-87-3	6.7	ND		U	
Vinyl chloride	VC	75-01-4	3.4	ND		U	
Bromomethane	BRME	74-83-9	3.4	ND		U	
Chloroethane	CLEA	75-00-3	6.7	ND		U	
Trichlorofluoromethane	FC11	75-69-4	3.4	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	3.4	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	3.4	ND		U	
Acetone	ACE	67-64-1	17	18		=	
Dichloromethane	MTLNCL	75-09-2	3.4	29		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	3.4	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	3.4	9.7		=	
Vinyl acetate	VA	108-05-4	17	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	3.4	ND		U	
2-Butanone	MEK	78-93-3	17	ND		U	
Chloroform	TCLME	67-66-3	3.4	210		=	
1,1,1-Trichloroethane	TCA111	71-55-6	3.4	ND		U	
Carbon tetrachloride	CTCL	56-23-5	3.4	770	E	E	
1,2-Dichloroethane	DCA12	107-06-2	3.4	64.5		=	
Benzene	BZ	71-43-2	3.4	ND		U	
Trichloroethene	TCE	79-01-6	3.4	200		=	
1,2-Dichloropropane	DCPA12	78-87-5	3.4	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	3.4	ND		U	
Toluene	BZME	108-88-3	3.4	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	3.4	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	17	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	3.4	ND		U	
Tetrachloroethene	PCE	127-18-4	3.4	ND		U	
1,2-Dibromoethane	EDB	106-93-4	3.4	ND		U	
Chlorobenzene	CLBZ	108-90-7	3.4	ND		U	
Ethylbenzene	EBZ	100-41-4	3.4	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	3.4	ND		U	
o-Xylene	XYLO	95-47-6	3.4	ND		U	
Styrene	STY	100-42-5	3.4	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	3.4	ND		U	
Benzyl chloride	BZLCL	100-44-7	17	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	3.4	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	3.4	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	17:46	Sample Vol. (ML):	
Dilution Factor:	1.7	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,3-Dichlorobenzene	DCBZ13	541-73-1	3.4	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	3.4	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	3.4	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	34	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	6.7	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	48	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	15:22	Sample Vol. (ML):	
Dilution Factor:	10	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	U Rev
Dichlorodifluoromethane	FC12	75-71-8	20	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	20	ND		U	
Chloromethane	CLME	74-87-3	40	ND		U	
Vinyl chloride	VC	75-01-4	20	ND		U	
Bromomethane	BRME	74-83-9	20	ND		U	
Chloroethane	CLEA	75-00-3	40	ND		U	
Trichlorofluoromethane	FC11	75-69-4	20	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	20	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	20	ND		U	
Acetone	ACE	67-64-1	100	ND		U	
Dichloromethane	MTLNCL	75-09-2	20	31		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	20	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	20	ND		U	
Vinyl acetate	VA	108-05-4	100	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	20	ND		U	
2-Butanone	MEK	78-93-3	100	ND		U	
Chloroform	TCLME	67-66-3	20	210		=	
1,1,1-Trichloroethane	TCA111	71-55-6	20	ND		U	
Carbon tetrachloride	CTCL	56-23-5	20	900		=	
1,2-Dichloroethane	DCA12	107-06-2	20	ND		U	
Benzene	BZ	71-43-2	20	ND		U	
Trichloroethene	TCE	79-01-6	20	180		=	
1,2-Dichloropropane	DCPA12	78-87-5	20	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	20	ND		U	
Toluene	BZME	108-88-3	20	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	20	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	100	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	20	ND		U	
Tetrachloroethene	PCE	127-18-4	20	ND		U	
1,2-Dibromoethane	EDB	106-93-4	20	ND		U	
Chlorobenzene	CLBZ	108-90-7	20	ND		U	
Ethylbenzene	EBZ	100-41-4	20	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	20	ND		U	
o-Xylene	XYLO	95-47-6	20	ND		U	
Styrene	STY	100-42-5	20	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	20	ND		U	
Benzyl chloride	BZLCL	100-44-7	100	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	20	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	20	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	20	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E02
Date Sampled:	04 FEB 97	Site #:	PCO
Date Received:	07 FEB 97	Lab Project #:	124530
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	15:22	Sample Vol. (ML):	
Dilution Factor:	10	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	20	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	20	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	200	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	40	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	44	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 13:30
Sample Date: 2/5/97

Test #: D3
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 62 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	0.8	(in. Hg.)
Temperature	76	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	46	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-03	
Sample Time	14:24	
Pressure	4	(in. Hg)
Temperature	103	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	36	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: A-03
Sample Time: 14:12 Vacuum: 1.4 (in. Hg) Temperature: 73 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	NM	46	NM	49	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.25	0.000175	0.0043	0.000003	98.20%
Methylene chloride	MTLNCL	85	0	0.000000	0.039	0.000025	NC
cis-1,2-dichloroethene	DCE12C	97	0.31	0.000217	0.0081	0.000006	97.27%
Chloroform	TCLME	119.4	0.47	0.000406	0.44	0.000397	2.21%
Carbon Tetrachloride	CTCL	153.84	0.9	0.001001	0.91	0.001058	-5.62%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0.0087	0.000007	NC
Benzene	BZ	78	0.31	0.000175	0.0058	0.000003	98.05%
Trichloroethene	TCE	131.4	18	0.017106	0.37	0.000367	97.85%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			20.24	0.019081	1.79	0.001866	90.22%

Phosgene Concentration: NM (ppm) HCL - ND, Chlorine Concentration estimated at 10 PPM

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

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Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	18:12	Sample Vol. (ML):	
Dilution Factor:	51	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	100	ND	U		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	100	ND	U		
Chloromethane	CLME	74-87-3	200	ND	U		
Vinyl chloride	VC	75-01-4	100	ND	U		
Bromomethane	BRME	74-83-9	100	ND	U		
Chloroethane	CLEA	75-00-3	200	ND	U		
Trichlorofluoromethane	FC11	75-69-4	100	ND	U		
1,1-Dichloroethene	DCE11	75-35-4	100	250	=		
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	100	ND	U		
Acetone	ACE	67-64-1	510	ND	U		
Dichloromethane	MTLNCL	75-09-2	100	ND	U		
trans-1,2-Dichloroethene	DCE12T	156-60-5	100	ND	U		
1,1-Dichloroethane	DCA11	75-34-3	100	ND	U		
Vinyl acetate	VA	108-05-4	510	ND	U		
cis-1,2-Dichloroethene	DCE12C	156-59-2	100	310	=		
2-Butanone	MEK	78-93-3	510	ND	U		
Chloroform	TCLME	67-66-3	100	470	=		
1,1,1-Trichloroethane	TCA111	71-55-6	100	ND	U		
Carbon tetrachloride	CTCL	56-23-5	100	900	=		
1,2-Dichloroethane	DCA12	107-06-2	100	ND	U		
Benzene	BZ	71-43-2	100	310	=		
Trichloroethene	TCE	79-01-6	100	18000	=		
1,2-Dichloropropane	DCPA12	78-87-5	100	ND	U		
trans-1,3-Dichloropropene	DCP13T	10061-02-6	100	ND	U		
Toluene	BZME	108-88-3	100	ND	U		
cis-1,3-Dichloropropene	DCP13C	10061-01-5	100	ND	U		
4-Methyl-2-pentanone	MIBK	108-10-1	510	ND	U		
1,1,2-Trichloroethane	TCA112	79-00-5	100	ND	U		
Tetrachloroethene	PCE	127-18-4	100	ND	U		
1,2-Dibromoethane	EDB	106-93-4	100	ND	U		
Chlorobenzene	CLBZ	108-90-7	100	ND	U		
Ethylbenzene	EBZ	100-41-4	100	ND	U		
m- & p-Xylene(s)	XYLMP	1330-20-7	100	ND	U		
o-Xylene	XYLO	95-47-6	100	ND	U		
Styrene	STY	100-42-5	100	ND	U		
1,1,2,2-Tetrachloroethane	PCA	79-34-5	100	ND	U		
Benzyl chloride	BZLCL	100-44-7	510	ND	U		
1,3,5-Trimethylbenzene	TMB135	108-67-8	100	ND	U		
1,2,4-Trimethylbenzene	TMB124	95-63-6	100	ND	U		
1,3-Dichlorobenzene	DCBZ13	541-73-1	100	ND	U		

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Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	18:12	Sample Vol. (ML):	
Dilution Factor:	51	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	100	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	100	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	1000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	200	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	18:40	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	4.2	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	4.2	ND		U	
Chloromethane	CLME	74-87-3	8.4	ND		U	
Vinyl chloride	VC	75-01-4	4.2	ND		U	
Bromomethane	BRME	74-83-9	4.2	ND		U	
Chloroethane	CLEA	75-00-3	8.4	ND		U	
Trichlorofluoromethane	FC11	75-69-4	4.2	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	4.2	4.3		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	4.2	ND		U	
Acetone	ACE	67-64-1	21	ND		U	
Dichloromethane	MTLNCL	75-09-2	4.2	39		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	4.2	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	4.2	19		=	
Vinyl acetate	VA	108-05-4	21	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	4.2	8.1		=	
2-Butanone	MEK	78-93-3	21	ND		U	
Chloroform	TCLME	67-66-3	4.2	440		=	
1,1,1-Trichloroethane	TCA111	71-55-6	4.2	ND		U	
Carbon tetrachloride	CTCL	56-23-5	4.2	940	E	E	
1,2-Dichloroethane	DCA12	107-06-2	4.2	8.7		=	
Benzene	BZ	71-43-2	4.2	5.8		=	
Trichloroethene	TCE	79-01-6	4.2	370		=	
1,2-Dichloropropane	DCPA12	78-87-5	4.2	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	4.2	ND		U	
Toluene	BZME	108-88-3	4.2	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	4.2	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	21	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	4.2	ND		U	
Tetrachloroethene	PCE	127-18-4	4.2	ND		U	
1,2-Dibromoethane	EDB	106-93-4	4.2	ND		U	
Chlorobenzene	CLBZ	108-90-7	4.2	ND		U	
Ethylbenzene	EBZ	100-41-4	4.2	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	4.2	ND		U	
o-Xylene	XYLO	95-47-6	4.2	ND		U	
Styrene	STY	100-42-5	4.2	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	4.2	ND		U	
Benzyl chloride	BZLCL	100-44-7	21	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	4.2	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	4.2	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	18:40	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,3-Dichlorobenzene	DCBZ13	541-73-1	4.2	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	4.2	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	4.2	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	42	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	8.4	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

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Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	14:56	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	21	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	21	ND		U	
Chloromethane	CLME	74-87-3	42	ND		U	
Vinyl chloride	VC	75-01-4	21	ND		U	
Bromomethane	BRME	74-83-9	21	ND		U	
Chloroethane	CLEA	75-00-3	42	ND		U	
Trichlorofluoromethane	FC11	75-69-4	21	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	21	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	21	ND		U	
Acetone	ACE	67-64-1	110	ND		U	
Dichloromethane	MTLNCL	75-09-2	21	35		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	21	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	21	ND		U	
Vinyl acetate	VA	108-05-4	110	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	21	ND		U	
2-Butanone	MEK	78-93-3	110	ND		U	
Chloroform	TCLME	67-66-3	21	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	21	ND		U	
Carbon tetrachloride	CTCL	56-23-5	21	910		=	
1,2-Dichloroethane	DCA12	107-06-2	21	ND		U	
Benzene	BZ	71-43-2	21	ND		U	
Trichloroethene	TCE	79-01-6	21	320		=	
1,2-Dichloropropane	DCPA12	78-87-5	21	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	21	ND		U	
Toluene	BZME	108-88-3	21	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	21	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	110	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	21	ND		U	
Tetrachloroethene	PCE	127-18-4	21	ND		U	
1,2-Dibromoethane	EDB	106-93-4	21	ND		U	
Chlorobenzene	CLBZ	108-90-7	21	ND		U	
Ethylbenzene	EBZ	100-41-4	21	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	21	ND		U	
o-Xylene	XYLO	95-47-6	21	ND		U	
Styrene	STY	100-42-5	21	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	21	ND		U	
Benzyl chloride	BZLCL	100-44-7	110	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	21	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	21	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	21	ND		U	

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Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	14:56	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	21	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	21	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	210	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	42	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	51	50
Bromofluorobenzene	BR4FBZ	460-00-4	47	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	12 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	19:08	Sample Vol. (ML):	
Dilution Factor:	2.1	QC Batch (Lablotctl):	G970212A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	4.2	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	4.2	ND		U	
Chloromethane	CLME	74-87-3	8.4	ND		U	
Vinyl chloride	VC	75-01-4	4.2	4.2		=	
Bromomethane	BRME	74-83-9	4.2	ND		U	
Chloroethane	CLEA	75-00-3	8.4	ND		U	
Trichlorofluoromethane	FC11	75-69-4	4.2	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	4.2	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	4.2	ND		U	
Acetone	ACE	67-64-1	21	ND		U	
Dichloromethane	MTLNCL	75-09-2	4.2	37		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	4.2	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	4.2	18		=	
Vinyl acetate	VA	108-05-4	21	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	4.2	6.7		=	
2-Butanone	MEK	78-93-3	21	ND		U	
Chloroform	TCLME	67-66-3	4.2	420		=	
1,1,1-Trichloroethane	TCA111	71-55-6	4.2	ND		U	
Carbon tetrachloride	CTCL	56-23-5	4.2	910	E	E	
1,2-Dichloroethane	DCA12	107-06-2	4.2	8.8		=	
Benzene	BZ	71-43-2	4.2	5.4		=	
Trichloroethene	TCE	79-01-6	4.2	330		=	
1,2-Dichloropropane	DCPA12	78-87-5	4.2	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	4.2	ND		U	
Toluene	BZME	108-88-3	4.2	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	4.2	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	21	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	4.2	ND		U	
Tetrachloroethene	PCE	127-18-4	4.2	ND		U	
1,2-Dibromoethane	EDB	106-93-4	4.2	ND		U	
Chlorobenzene	CLBZ	108-90-7	4.2	ND		U	
Ethylbenzene	EBZ	100-41-4	4.2	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	4.2	ND		U	
o-Xylene	XYLO	95-47-6	4.2	ND		U	
Styrene	STY	100-42-5	4.2	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	4.2	ND		U	
Benzyl chloride	BZLCL	100-44-7	21	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	4.2	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	4.2	ND		U	

E = Concentration exceeds calibration range. Value is estimated.

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client: URS Greiner, Inc.
Date Sampled: 05 FEB 97
Date Received: 10 FEB 97
Date Analyzed: 12 FEB 97
Time Analyzed: 19:08
Dilution Factor: 2.1
Concentration Units: PPBV

URS Sample #: QD03
Site #: IC 29
Lab Project #: 124540
Lab Sample #: 0003-SA
Sample Vol. (ML):
QC Batch (Lablotctl): G970212A1
SACODE: *

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Rev
1,3-Dichlorobenzene	DCBZ13	541-73-1	4.2	ND		U	
1,4-Dichlorobenzene	DCBZ14	106-46-7	4.2	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	4.2	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	42	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	8.4	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	48	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	15:49	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	21	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	21	ND		U	
Chloromethane	CLME	74-87-3	42	ND		U	
Vinyl chloride	VC	75-01-4	21	ND		U	
Bromomethane	BRME	74-83-9	21	ND		U	
Chloroethane	CLEA	75-00-3	42	ND		U	
Trichlorofluoromethane	FC11	75-69-4	21	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	21	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	21	ND		U	
Acetone	ACE	67-64-1	110	ND		U	
Dichloromethane	MTLNCL	75-09-2	21	33		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	21	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	21	ND		U	
Vinyl acetate	VA	108-05-4	110	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	21	ND		U	
2-Butanone	MEK	78-93-3	110	ND		U	
Chloroform	TCLME	67-66-3	21	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	21	ND		U	
Carbon tetrachloride	CTCL	56-23-5	21	900		=	
1,2-Dichloroethane	DCA12	107-06-2	21	ND		U	
Benzene	BZ	71-43-2	21	ND		U	
Trichloroethene	TCE	79-01-6	21	280		=	
1,2-Dichloropropane	DCPA12	78-87-5	21	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	21	ND		U	
Toluene	BZME	108-88-3	21	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	21	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	110	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	21	ND		U	
Tetrachloroethene	PCE	127-18-4	21	ND		U	
1,2-Dibromoethane	EDB	106-93-4	21	ND		U	
Chlorobenzene	CLBZ	108-90-7	21	ND		U	
Ethylbenzene	EBZ	100-41-4	21	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	21	ND		U	
o-Xylene	XYLO	95-47-6	21	ND		U	
Styrene	STY	100-42-5	21	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	21	ND		U	
Benzyl chloride	BZLCL	100-44-7	110	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	21	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	21	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	21	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	QD03
Date Sampled:	05 FEB 97	Site #:	IC 29
Date Received:	10 FEB 97	Lab Project #:	124540
Date Analyzed:	13 FEB 97	Lab Sample #:	0003-SA
Time Analyzed:	15:49	Sample Vol. (ML):	
Dilution Factor:	11	QC Batch (Lablotctl):	G970213A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	U Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	21	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	21	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	210	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	42	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/6/97

Test #: D4
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 60 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	68	(deg F)
dP	0.800	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-04	
Sample Time	14:12	
Pressure	3.9	(in. Hg)
Temperature	92	(deg F)
dP	0.45	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	38	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	50	

INFLUENT (PCOI)
Sample #: A-04
Sample Time: 14:06 Vacuum: 1.4 (in. Hg) Temperature: 68 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	NM	47	NM	50	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.24	0.000169	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.029	0.000019	NC
cis-1,2-dichloroethene	DCE12C	97	0.25	0.000176	0	0.000000	NC
Chloroform	TCLME	119.4	0.38	0.000330	0.27	0.000249	24.72%
Carbon Tetrachloride	CTCL	153.84	0.81	0.000907	0.88	0.001044	-15.11%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0.0068	0.000005	NC
Benzene	BZ	78	0.24	0.000136	0	0.000000	NC
Trichloroethene	TCE	131.4	16	0.015299	0.33	0.000334	97.81%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			17.92	0.017018	1.52	0.001651	90.30%

Phosgene Concentration: 5 (ppm) HCL - 50-100 PPM, Chlorine Concentration estimated at 10 PPM

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	12:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	240		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	250		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	380		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	810		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	240		=	
Trichloroethene	TCE	79-01-6	200	16000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	12:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	49	50
Bromofluorobenzene	BR4FBZ	460-00-4	47	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client: URS Greiner, Inc.
Date Sampled: 06 FEB 97
Date Received: 11 FEB 97
Date Analyzed: 18 FEB 97
Time Analyzed: 12:43
Dilution Factor: 3.4
Concentration Units: PPBV

URS Sample #: E04
Site #: IC 29
Lab Project #: 124572
Lab Sample #: 0002-SA
Sample Vol. (ML):
QC Batch (Lablotctl): G970218A1
SACODE: *

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	6.7	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	6.7	ND		U	
Chloromethane	CLME	74-87-3	13	ND		U	
Vinyl chloride	VC	75-01-4	6.7	ND		U	
Bromomethane	BRME	74-83-9	6.7	ND		U	
Chloroethane	CLEA	75-00-3	13	ND		U	
Trichlorofluoromethane	FC11	75-69-4	6.7	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	6.7	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	6.7	ND		U	
Acetone	ACE	67-64-1	34	ND		U	
Dichloromethane	MTLNCL	75-09-2	6.7	29		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	6.7	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	6.7	13		=	
Vinyl acetate	VA	108-05-4	34	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	6.7	ND		U	
2-Butanone	MEK	78-93-3	34	ND		U	
Chloroform	TCLME	67-66-3	6.7	270		=	
1,1,1-Trichloroethane	TCA111	71-55-6	6.7	ND		U	
Carbon tetrachloride	CTCL	56-23-5	6.7	880		=	
1,2-Dichloroethane	DCA12	107-06-2	6.7	6.8		=	
Benzene	BZ	71-43-2	6.7	ND		U	
Trichloroethene	TCE	79-01-6	6.7	330		=	
1,2-Dichloropropane	DCPA12	78-87-5	6.7	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	6.7	ND		U	
Toluene	BZME	108-88-3	6.7	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	6.7	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	34	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	6.7	ND		U	
Tetrachloroethene	PCE	127-18-4	6.7	ND		U	
1,2-Dibromoethane	EDB	106-93-4	6.7	ND		U	
Chlorobenzene	CLBZ	108-90-7	6.7	ND		U	
Ethylbenzene	EBZ	100-41-4	6.7	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	6.7	ND		U	
o-Xylene	XYLO	95-47-6	6.7	ND		U	
Styrene	STY	100-42-5	6.7	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	6.7	ND		U	
Benzyl chloride	BZLCL	100-44-7	34	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	6.7	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	6.7	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	6.7	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E04
Date Sampled:	06 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	12:43	Sample Vol. (ML):	
Dilution Factor:	3.4	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	6.7	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	6.7	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	67	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	13	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	52	50
Toluene-d8	BZMED8	2037-26-5	53	50
Bromofluorobenzene	BR4FBZ	460-00-4	49	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/7/97

Test #: D5
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 64 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	70	(deg F)
dP	0.850	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-05	
Sample Time	11:33	
Pressure	4	(in. Hg)
Temperature	101	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: A-05
Sample Time: 11:06 Vacuum: 1.4 (in. Hg) Temperature: 55 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	NM	47	NM	49	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc: (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.28	0.000197	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.037	0.000024	NC
cis-1,2-dichloroethene	DCE12C	97	0.27	0.000190	0	0.000000	NC
Chloroform	TCLME	119.4	0.39	0.000338	0.4	0.000362	-7.18%
Carbon Tetrachloride	CTCL	153.84	0.9	0.001005	1.1	0.001283	-27.72%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.27	0.000153	0	0.000000	NC
Trichloroethene	TCE	131.4	17	0.016211	0.32	0.000319	98.03%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			19.11	0.018093	1.86	0.001988	89.01%

Phosgene Concentration: 10 (ppm) HCL - 50-100 ppm, Chlorine Concentration estimated at 10 ppm

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0004-SA
Time Analyzed:	13:09	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	280		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	270		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	390		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	900		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	270		=	
Trichloroethene	TCE	79-01-6	200	17000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0004-SA
Time Analyzed:	13:09	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	43	50

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0005-SA
Time Analyzed:	13:35	Sample Vol. (ML):	
Dilution Factor:	4.2	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	8.4	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	8.4	ND		U	
Chloromethane	CLME	74-87-3	17	ND		U	
Vinyl chloride	VC	75-01-4	8.4	ND		U	
Bromomethane	BRME	74-83-9	8.4	ND		U	
Chloroethane	CLEA	75-00-3	17	ND		U	
Trichlorofluoromethane	FC11	75-69-4	8.4	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	8.4	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	8.4	ND		U	
Acetone	ACE	67-64-1	42	ND		U	
Dichloromethane	MTLNCL	75-09-2	8.4	37		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	8.4	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	8.4	18		=	
Vinyl acetate	VA	108-05-4	42	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	8.4	ND		U	
2-Butanone	MEK	78-93-3	42	ND		U	
Chloroform	TCLME	67-66-3	8.4	400		=	
1,1,1-Trichloroethane	TCA111	71-55-6	8.4	ND		U	
Carbon tetrachloride	CTCL	56-23-5	8.4	1100		=	
1,2-Dichloroethane	DCA12	107-06-2	8.4	ND		U	
Benzene	BZ	71-43-2	8.4	ND		U	
Trichloroethene	TCE	79-01-6	8.4	320		=	
1,2-Dichloropropane	DCPA12	78-87-5	8.4	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	8.4	ND		U	
Toluene	BZME	108-88-3	8.4	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	8.4	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	42	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	8.4	ND		U	
Tetrachloroethene	PCE	127-18-4	8.4	ND		U	
1,2-Dibromoethane	EDB	106-93-4	8.4	ND		U	
Chlorobenzene	CLBZ	108-90-7	8.4	ND		U	
Ethylbenzene	EBZ	100-41-4	8.4	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	8.4	ND		U	
o-Xylene	XYLO	95-47-6	8.4	ND		U	
Styrene	STY	100-42-5	8.4	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	8.4	ND		U	
Benzyl chloride	BZLCL	100-44-7	42	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	8.4	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	8.4	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	8.4	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	QD05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0006-SA
Time Analyzed:	14:02	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	270		=	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	300		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	400		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	920		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	270		=	
Trichloroethene	TCE	79-01-6	200	17000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	QD05
Date Sampled:	07 FEB 97	Site #:	IC 29
Date Received:	11 FEB 97	Lab Project #:	124572
Date Analyzed:	18 FEB 97	Lab Sample #:	0006-SA
Time Analyzed:	14:02	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	50	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	45	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/11/97

Test #: D6
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 50 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1.1	(in. Hg.)
Temperature	64	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-06	
Sample Time	09:14	
Pressure	-3.9	(in. Hg)
Temperature	95	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	54	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	53	

INFLUENT (PCOI)
Sample #: A-06
Sample Time: 09:09 Vacuum: -1.4 (in. Hg) Temperature: 62 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	NM	47	NM	53	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method TO14

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0	0.000000	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.036	0.000025	NC
cis-1,2-dichloroethene	DCE12C	97	0.25	0.000177	0	0.000000	NC
Chloroform	TCLME	119.4	0.34	0.000296	0.28	0.000273	7.54%
Carbon Tetrachloride	CTCL	153.84	0.74	0.000829	0.99	0.001245	-50.21%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0	0.000000	NC
Benzene	BZ	78	0.23	0.000131	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014351	0.2	0.000215	98.50%
Tetrachloroethene	PCE	165.85	0	0.000000	0	0.000000	NC
Total Target List VOCs			16.56	0.015782	1.51	0.001758	88.86%

Phosgene Concentration: 1-1.2 (ppm) HCL - 50-100 ppm, Cl - 10 ppm

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	A06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	16:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	200	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	200	ND		U	
Chloromethane	CLME	74-87-3	400	ND		U	
Vinyl chloride	VC	75-01-4	200	ND		U	
Bromomethane	BRME	74-83-9	200	ND		U	
Chloroethane	CLEA	75-00-3	400	ND		U	
Trichlorofluoromethane	FC11	75-69-4	200	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	200	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	200	ND		U	
Acetone	ACE	67-64-1	1000	ND		U	
Dichloromethane	MTLNCL	75-09-2	200	ND		U	
trans-1,2-Dichloroethene	DCE12T	156-60-5	200	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	200	ND		U	
Vinyl acetate	VA	108-05-4	1000	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	200	250		=	
2-Butanone	MEK	78-93-3	1000	ND		U	
Chloroform	TCLME	67-66-3	200	340		=	
1,1,1-Trichloroethane	TCA111	71-55-6	200	ND		U	
Carbon tetrachloride	CTCL	56-23-5	200	740		=	
1,2-Dichloroethane	DCA12	107-06-2	200	ND		U	
Benzene	BZ	71-43-2	200	230		=	
Trichloroethene	TCE	79-01-6	200	15000		=	
1,2-Dichloropropane	DCPA12	78-87-5	200	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	200	ND		U	
Toluene	BZME	108-88-3	200	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	200	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	1000	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	200	ND		U	
Tetrachloroethene	PCE	127-18-4	200	ND		U	
1,2-Dibromoethane	EDB	106-93-4	200	ND		U	
Chlorobenzene	CLBZ	108-90-7	200	ND		U	
Ethylbenzene	EBZ	100-41-4	200	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	200	ND		U	
o-Xylene	XYLO	95-47-6	200	ND		U	
Styrene	STY	100-42-5	200	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	200	ND		U	
Benzyl chloride	BZLCL	100-44-7	1000	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	200	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	200	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	200	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	A06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0001-SA
Time Analyzed:	16:16	Sample Vol. (ML):	
Dilution Factor:	100	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
1,4-Dichlorobenzene	DCBZ14	106-46-7	200	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	200	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	2000	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	400	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	40	50

Quanterra
Environmental Services

Volatile Organics by GCMS - EPA TO14

Client:	URS Greiner, Inc.	URS Sample #:	E06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:43	Sample Vol. (ML):	
Dilution Factor:	3.5	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	URS Rev
Dichlorodifluoromethane	FC12	75-71-8	7.0	ND		U	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	DCTFA12	76-14-2	7.0	ND		U	
Chloromethane	CLME	74-87-3	14	ND		U	
Vinyl chloride	VC	75-01-4	7.0	ND		U	
Bromomethane	BRME	74-83-9	7.0	ND		U	
Chloroethane	CLEA	75-00-3	14	ND		U	
Trichlorofluoromethane	FC11	75-69-4	7.0	ND		U	
1,1-Dichloroethene	DCE11	75-35-4	7.0	ND		U	
1,1,2-Trichloro-1,2,2-trifluoroethane	FC113	76-13-1	7.0	ND		U	
Acetone	ACE	67-64-1	35	39		=	
Dichloromethane	MTLNCL	75-09-2	7.0	36		=	
trans-1,2-Dichloroethene	DCE12T	156-60-5	7.0	ND		U	
1,1-Dichloroethane	DCA11	75-34-3	7.0	ND		U	
Vinyl acetate	VA	108-05-4	35	ND		U	
cis-1,2-Dichloroethene	DCE12C	156-59-2	7.0	ND		U	
2-Butanone	MEK	78-93-3	35	ND		U	
Chloroform	TCLME	67-66-3	7.0	280		=	
1,1,1-Trichloroethane	TCA111	71-55-6	7.0	ND		U	
Carbon tetrachloride	CTCL	56-23-5	7.0	990		=	
1,2-Dichloroethane	DCA12	107-06-2	7.0	ND		U	
Benzene	BZ	71-43-2	7.0	ND		U	
Trichloroethene	TCE	79-01-6	7.0	200		=	
1,2-Dichloropropane	DCPA12	78-87-5	7.0	ND		U	
trans-1,3-Dichloropropene	DCP13T	10061-02-6	7.0	ND		U	
Toluene	BZME	108-88-3	7.0	ND		U	
cis-1,3-Dichloropropene	DCP13C	10061-01-5	7.0	ND		U	
4-Methyl-2-pentanone	MIBK	108-10-1	35	ND		U	
1,1,2-Trichloroethane	TCA112	79-00-5	7.0	ND		U	
Tetrachloroethene	PCE	127-18-4	7.0	ND		U	
1,2-Dibromoethane	EDB	106-93-4	7.0	ND		U	
Chlorobenzene	CLBZ	108-90-7	7.0	ND		U	
Ethylbenzene	EBZ	100-41-4	7.0	ND		U	
m- & p-Xylene(s)	XYLMP	1330-20-7	7.0	ND		U	
o-Xylene	XYLO	95-47-6	7.0	ND		U	
Styrene	STY	100-42-5	7.0	ND		U	
1,1,2,2-Tetrachloroethane	PCA	79-34-5	7.0	ND		U	
Benzyl chloride	BZLCL	100-44-7	35	ND		U	
1,3,5-Trimethylbenzene	TMB135	108-67-8	7.0	ND		U	
1,2,4-Trimethylbenzene	TMB124	95-63-6	7.0	ND		U	
1,3-Dichlorobenzene	DCBZ13	541-73-1	7.0	ND		U	

Quanterra Environmental Services

Volatile Organics by GCMS - EPA TO14 (cont.)

Client:	URS Greiner, Inc.	URS Sample #:	E06
Date Sampled:	11 FEB 97	Site #:	IC 29
Date Received:	13 FEB 97	Lab Project #:	124593
Date Analyzed:	18 FEB 97	Lab Sample #:	0002-SA
Time Analyzed:	16:43	Sample Vol. (ML):	
Dilution Factor:	3.5	QC Batch (Lablotctl):	G970218A1
Concentration Units:	PPBV	SACODE:	*

Parameter	Parlabel	CAS	RL	Result	Qual	PARVQ	UR Re
1,4-Dichlorobenzene	DCBZ14	106-46-7	7.0	ND		U	
1,2-Dichlorobenzene	DCBZ12	95-50-1	7.0	ND		U	
1,2,4-Trichlorobenzene	TCB124	120-82-1	70	ND		U	
Hexachlorobutadiene	HCBU	87-68-3	14	ND		U	

Surrogate	Parlabel	CAS	Result	Expected
1,2-Dichloroethane-d4	DCA12D4	17060-07-0	49	50
Toluene-d8	BZMED8	2037-26-5	50	50
Bromofluorobenzene	BR4FBZ	460-00-4	48	50

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 1/29/97
Test Start Time: 07:45
Sample Date: 1/29/97

Test #: D1
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 64 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	-1.6	(in. Hg.)
Temperature	63	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	49	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-01	
Sample Time	12:37	
Pressure	3.6	(in. Hg)
Temperature	92	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity		(%)
Estimated Moisture (%)	0	
Est. Dry Gas Rate (dscfm)	50	

INFLUENT (PCOI)
Sample #: A-01
Sample Time: 12:32 Vacuum: -1.6 (in. Hg) Temperature: 63 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	(Note 2)
Total NMOC as Methane by EPA 18	0	49	0	50	NC

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	(Note 3)
1,1-Dichloroethene	DCE11	97	0.17	0.000125	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.022	0.000015	NC
cis-1,2-dichloroethene	DCE12C	97	0.26	0.000191	0	0.000000	NC
Chloroform	TCLME	119.4	0.64	0.000580	0.19	0.000178	69.28%
Carbon Tetrachloride	CTCL	153.84	0.91	0.001062	0.72	0.000870	18.12%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0.024	0.000019	NC
Benzene	BZ	78	0.36	0.000213	0	0.000000	NC
Trichloroethene	TCE	131.4	14	0.013958	0.28	0.000289	97.93%
Tetrachloroethene	PCE	165.85	0	0.000000	0.0045	0.000006	NC
Total Target List VOCs			16.34	0.016130	1.24	0.001376	91.47%

Phosgene Concentration: NC (ppm) HCL and Chlorine Concentration: ND

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

RUN D1

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3299
Sample Type: AIR / TEDLAR
Date Sampled: 29-Jan-97
Date Received: 29-Jan-97
Date Analyzed: 29-Jan-97
Time Analyzed: 1541
Date Reported: 29-Jan-97
Dilution Factor: 16.70
Concentration Units: PPBV

Field ID #: A-01
Site #: PCO
Sample Delivery Group: 8D216
Lab Sample ID: 8D21603
Sample Volume (ml): 3
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0129A2
Data Filename: 003F0101.D
Electronic Filename: 203D0129.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	67.00	0	U		
Chloromethane	CLME	74-87-3	67.00	0	U		
Vinyl chloride	VC	75-01-4	67.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	50.00	0	U		
1,1-Dichloroethane	DCE11	75-35-4	170.00	170.00	=		
Trichlorotrifluoroethane	FC113	76-13-1	170.00	0	U		
Methylene chloride	MTLNCL	75-09-2	50.00	0	U		
trans-1,2-dichloroethene	DCE12T	156-60-5	67.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	67.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	50.00	260.00	=		
Chloroform	TCLME	67-66-3	67.00	640.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	67.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	50.00	910.00	=		
1,2-Dichloroethane	DCA12	107-06-2	50.00	0	U		
Benzene	BZ	71-43-2	330.00	360.00	=		
Trichloroethene	TCE	79-01-6	50.00	14000.00	=		
Toluene	BZME	108-88-3	330.00	0	U		
Tetrachloroethene	PCE	127-18-4	50.00	0	U		
Chlorobenzene	CLBZ	108-90-7	67.00	0	U		
Ethylbenzene	EBZ	100-41-4	420.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	840.00	0	U		
o-Xylene	XYLO	95-47-6	420.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	89.04			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	91.40			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

EVZ 1/30/97
JM 1/30/97

Approved By: _____ Date: _____

Omnia Environmental Laboratories, Inc.
5500 Bonnell Common, Fremont, CA 94538
Tel: (510) 490-8571 Fax: (510) 490-8572

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3310
Sample Type: AIR / TEDLAR
Date Sampled: 04-Feb-97
Date Received: 04-Feb-97
Date Analyzed: 04-Feb-97
Time Analyzed: 1641
Date Reported: 04-Feb-97
Dilution Factor: 11.10
Concentration Units: PPBV

Field ID #: A-02 PCOI
Site #: PCO
Sample Delivery Group: 8D218
Lab Sample ID: 8D21801
Sample Volume (ml): 4.5
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0204A1
Data Filename: 004F0101.D
Electronic Filename: 104D0204.HAL
SACODE: *
PVCCODE: PR ✓

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	44.00	0	U		
Chloromethane	CLME	74-87-3	44.00	0	U		
Vinyl chloride	VC	75-01-4	44.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	33.00	0	U		
1,1-Dichloroethane	DCE11	75-35-4	110.00	160.00	-		
Trichlorotrifluoroethane	FC113	76-13-1	110.00	0	U		
Methylene chloride	MTLNCL	75-09-2	33.00	0	U		
trans-1,2-dichloroethane	DCE12T	156-60-5	44.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	44.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	33.00	290.00	-		
Chloroform	TCLME	67-66-3	44.00	740.00	-		
1,1,1-Trichloroethane	TCA111	71-55-6	44.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	33.00	1000.00	-		
1,2-Dichloroethane	DCA12	107-06-2	33.00	77.00	-		
Benzene	BZ	71-43-2	220.00	290.00	-		
Trichloroethene	TCE	79-01-6	33.00	16000.00	-		
Toluene	BZME	108-88-3	220.00	0	U		
Tetrachloroethene	PCE	127-18-4	33.00	57.00	-		
Chlorobenzene	CLBZ	108-90-7	44.00	0	U		
Ethylbenzene	EBZ	100-41-4	280.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	560.00	0	U		
o-Xylene	XYLO	95-47-6	280.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	87.59 ✓			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	85.56 ✓			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E LZ 2/5/97
✓ JM 2/5/97

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Approved By: _____ Date: _____

Ocean Environmental Laboratories, Inc. 5300 Boswell Common, Fremont, CA 94538 Tel: (510) 490-8571 Fax: (510) 490-8572

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3310
Sample Type: AIR / TEDLAR
Date Sampled: 04-Feb-97
Date Received: 04-Feb-97
Date Analyzed: 04-Feb-97
Time Analyzed: 1607
Date Reported: 04-Feb-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: E-02 PCOE
Site #: PCO
Sample Delivery Group: 8D218
Lab Sample ID: 8D21802
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0204A1
Data Filename: 003F0101.D
Electronic Filename: 103D0204.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	17.00	-		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	4.00	-		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	0	U		
Chloroform	TCLME	67-66-3	4.00	190.00	-		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	650.00	-		
1,2-Dichloroethane	DCA12	107-06-2	3.00	26.00	-		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	200.00	-		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	7.60	-		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	76.03 ✓			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	80.38 ✓			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E LZ 2/5/97
✓ JM 2/5/97

COPY

Approved By: _____ Date: _____

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 13:30
Sample Date: 2/5/97

Test #: D3
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 62 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	0.8	(in. Hg.)
Temperature	76	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	46	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-03	
Sample Time	14:24	
Pressure	4	(in. Hg)
Temperature	103	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	36	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: A-03
Sample Time: 14:12 Vacuum: 1.4 (in. Hg) Temperature: 73 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	NM	46	NM	49	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0	0.000000	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.027	0.000017	NC
cis-1,2-dichloroethene	DCE12C	97	0.29	0.000203	0.0045	0.000003	98.38%
Chloroform	TCLME	119.4	0.77	0.000665	0.36	0.000325	51.16%
Carbon Tetrachloride	CTCL	153.84	0.96	0.001068	0.7	0.000814	23.83%
1,2-Dichloroethane	DCA12	98.96	0	0.000000	0.031	0.000023	NC
Benzene	BZ	78	0.35	0.000197	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014255	0.32	0.000318	97.77%
Tetrachloroethene	PCE	165.85	0	0.000000	0.0094	0.000012	NC
Total Target List VOCs			17.37	0.016389	1.45	0.001512	90.78%

Phosgene Concentration: NM (ppm) HCL - ND, Chlorine Concentration estimated at 10 PPM

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3313
Sample Type: AIR / TEDLAR
Date Sampled: 05-Feb-97
Date Received: 05-Feb-97
Date Analyzed: 05-Feb-97
Time Analyzed: 1546
Date Reported: 05-Feb-97
Dilution Factor: 16.70
Concentration Units: PPBV

Field ID #: A-03
Site #: PCO
Sample Delivery Group: 8D218
Lab Sample ID: 8D21819
Sample Volume (ml): 3
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0205A2
Data Filename: 012F0101.D
Electronic Filename: 212D0205.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URE USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	67.00	0	U		
Chloromethane	CLME	74-87-3	67.00	0	U		
Vinyl chloride	VC	75-01-4	67.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	50.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	170.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	170.00	0	U		
Methylene chloride	MTLNCL	75-09-2	50.00	0	U		
trans-1,2-dichloroethene	DCE12T	156-60-5	67.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	67.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	50.00	290.00	=		
Chloroform	TCLME	67-66-3	67.00	770.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	67.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	50.00	960.00	=		
1,2-Dichloroethane	DCA12	107-06-2	50.00	0	U		
Benzene	BZ	71-43-2	330.00	350.00	=		
Trichloroethene	TCE	79-01-6	50.00	15000.00	=		
Toluene	BZME	108-88-3	330.00	0	U		
Tetrachloroethene	PCE	127-18-4	50.00	0	U		
Chlorobenzene	CLBZ	108-90-7	67.00	0	U		
Ethylbenzene	EBZ	100-41-4	420.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	840.00	0	U		
o-Xylene	XYLO	95-47-6	420.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	86.25			
1,4-Dichlorobenzene	DCBTA14	118-56-5	0	85.17			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analyte not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E CE 2/10/97
✓ JM 2/10/97

Approved By: _____ Date: _____

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3313
Sample Type: AIR / TEDLAR
Date Sampled: 05-Feb-97
Date Received: 05-Feb-97
Date Analyzed: 05-Feb-97
Time Analyzed: 1531
Date Reported: 05-Feb-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: E-03
Site #: PCO
Sample Delivery Group: 8D218
Lab Sample ID: 8D21820
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0205A1
Data Filename: 012F0101.D
Electronic Filename: 112D0205.HAL
SACODE: *
FVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / FD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	27.00	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	13.00	=		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	4.50	=		
Chloroform	TCLME	67-66-3	4.00	360.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	700.00	=		
1,2-Dichloroethane	DCA12	107-06-2	3.00	31.00	=		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	320.00	=		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	9.40	=		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylene	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	78.65			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	79.67			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
FD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits 65 to 135%.

PROCEDURE:
This analysis was performed using EPA Method 8021 and EPA Method 5000.

E VZ 2/10/97
✓ JM 2/10/97

Approved By: _____ Date: _____

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/6/97

Test #: D4
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 60 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	68	(deg F)
dP	0.800	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-04	
Sample Time	14:12	
Pressure	3.9	(in. Hg)
Temperature	92	(deg.F)
dP	0.45	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	38	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	50	

INFLUENT (PCOI)
Sample #: A-04
Sample Time: 14:06 Vacuum: 1.4 (in. Hg) Temperature: 68 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	NM	47	NM	50	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.15	0.000106	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.024	0.000016	NC
cis-1,2-dichloroethene	DCE12C	97	0.27	0.000191	0.0039	0.000003	98.47%
Chloroform	TCLME	119.4	0.66	0.000573	0.27	0.000249	56.66%
Carbon Tetrachloride	CTCL	153.84	1	0.001119	0.72	0.000854	23.71%
1,2-Dichloroethane	DCA12	98.96	0.065	0.000047	0.024	0.000018	60.88%
Benzene	BZ	78	0.29	0.000165	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014343	0.33	0.000334	97.67%
Tetrachloroethene	PCE	165.85	0.047	0.000057	0.0056	0.000007	87.38%
Total Target List VOCs			17.48	0.016601	1.38	0.001481	91.08%

Phosgene Concentration: 5 (ppm) HCL - 50-100 PPM, Chlorine Concentration estimated at 10 PPM

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3317
Sample Type: AIR / TEDLAR
Date Sampled: 06-Feb-97
Date Received: 06-Feb-97
Date Analyzed: 06-Feb-97
Time Analyzed: 1651
Date Reported: 06-Feb-97
Dilution Factor: 12.50
Concentration Units: PPBV

Field ID #: A-04
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21901
Sample Volume (ml): 4
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0206A1
Data Filename: 005F0101.D
Electronic Filename: 105D0206.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	50.00	0	U		
Chloromethane	CLME	74-87-3	50.00	0	U		
Vinyl chloride	VC	75-01-4	50.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	38.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	130.00	150.00	=		
Trichlorotrifluoroethane	FC113	76-13-1	130.00	0	U		
Methylene chloride	MTLNCL	75-09-2	38.00	0	U		
trans-1,2-dichloroethene	DCE12T	156-60-5	50.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	50.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	38.00	270.00	=		
Chloroform	TCLME	67-66-3	50.00	660.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	50.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	38.00	1000.00	=		
1,2-Dichloroethane	DCA12	107-06-2	38.00	65.00	=		
Benzene	BZ	71-43-2	250.00	290.00	=		
Trichloroethene	TCE	79-01-6	38.00	15000.00	=		
Toluene	BZMK	108-88-3	250.00	0	U		
Tetrachloroethene	PCE	127-18-4	38.00	47.00	=		
Chlorobenzene	CLBZ	108-90-7	50.00	0	U		
Ethylbenzene	EBZ	100-41-4	310.00	0	U		
m+p-Xylene	XYLMP	1330-20-7	630.00	0	U		
o-Xylene	XYLO	95-47-6	310.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	84.25			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	82.35			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply no actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E 2/10/97
JM 2/10/97

Approved By: _____ Date: _____

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3317
Sample Type: AIR / TEDLAR
Date Sampled: 06-Feb-97
Date Received: 06-Feb-97
Date Analyzed: 06-Feb-97
Time Analyzed: 1658
Date Reported: 06-Feb-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: E-04
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21902
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0206A2
Data Filename: 005F0101.D
Electronic Filename: 205D0206.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	PC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethane	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	24.00	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	9.30	=		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	3.90	=		
Chloroform	TCLME	67-66-3	4.00	270.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	720.00	=		
1,2-Dichloroethane	DCA12	107-06-2	3.00	24.00	=		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	330.00	=		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	5.60	=		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	84.58			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	86.20			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E LE 2/10/97
✓ JM 2/10/97

Approved By: _____ Date: _____

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/7/97

Test #: D5
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 64 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1	(in. Hg.)
Temperature	70	(deg F)
dP	0.850	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-05	
Sample Time	11:33	
Pressure	4	(in. Hg)
Temperature	101	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	50	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	49	

INFLUENT (PCOI)
Sample #: A-05
Sample Time: 11:06 Vacuum: 1.4 (in. Hg) Temperature: 55 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	NM	47	NM	49	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.18	0.000127	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.028	0.000018	NC
cis-1,2-dichloroethene	DCE12C	97	0.32	0.000225	0.0043	0.000003	98.60%
Chloroform	TCLME	119.4	0.68	0.000589	0.37	0.000335	43.14%
Carbon Tetrachloride	CTCL	153.84	1.2	0.001340	0.75	0.000875	34.69%
1,2-Dichloroethane	DCA12	98.96	0.072	0.000052	0.026	0.000020	62.26%
Benzene	BZ	78	0.34	0.000192	0	0.000000	NC
Trichloroethene	TCE	131.4	17	0.016211	0.29	0.000289	98.22%
Tetrachloroethene	PCE	165.85	0.054	0.000065	0.0066	0.000008	87.23%
Total Target List VOCs			19.85	0.018801	1.47	0.001548	91.77%

Phosgene Concentration: 10 (ppm) HCL - 50-100 ppm, Chlorine Concentration estimated at 10 ppm

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3359
Sample Type: AIR / TEDLAR
Date Sampled: 07-Feb-97
Date Received: 07-Feb-97
Date Analyzed: 07-Feb-97
Time Analyzed: 1259
Date Reported: 07-Feb-97
Dilution Factor: 12.50
Concentration Units: PPBV

Field ID #: A-05
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21904
Sample Volume (ml): 4
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0207A1
Data Filename: 003F0101.D
Electronic Filename: 103D0207.HAL
SACODE: *
PVCCODE: PR

Analyte	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	50.00	0	U		
Chloromethane	CLME	74-87-3	50.00	0	U		
Vinyl chloride	VC	75-01-4	50.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	38.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	130.00	180.00	-		
Trichlorotrifluoroethane	FC113	76-13-1	130.00	0	U		
Methylene chloride	MTLNCL	75-09-2	38.00	0	U		
trans-1,2-dichloroethene	DCE12T	156-60-5	50.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	50.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	38.00	320.00	-		
Chloroform	TCLME	67-66-3	50.00	680.00	-		
1,1,1-Trichloroethane	TCA111	71-55-6	50.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	38.00	1200.00	-		
1,2-Dichloroethane	DCA12	107-06-2	38.00	72.00	-		
Benzene	BZ	71-43-2	250.00	340.00	-		
Trichloroethene	TCE	79-01-6	38.00	17000.00	-		
Toluene	BZME	108-88-3	250.00	0	U		
Tetrachloroethene	PCE	127-18-4	38.00	54.00	-		
Chlorobenzene	CLBZ	108-90-7	50.00	0	U		
Ethylbenzene	EBZ	100-41-4	310.00	0	U		
m+p-Xylene	XYLMP	1330-20-7	630.00	0	U		
o-Xylene	XYLO	95-47-6	310.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	83.70			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	81.06			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analyte was detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in terms of percent recovery with control limits: 65 to 135%.

E LE 2/10/97
gm 2/10/97

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

Approved By: _____ Date: _____

Onsite Environmental Laboratories, Inc. 5500 Bonwell Commons, Fremont, CA 94538 Tel: (510) 490-8571 Fax: (510) 490-8572

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3359
Sample Type: AIR / TEDLAR
Date Sampled: 07-Feb-97
Date Received: 07-Feb-97
Date Analyzed: 07-Feb-97
Time Analyzed: 1309
Date Reported: 07-Feb-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: E-05
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21905
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0207A2
Data Filename: 003F0101.D
Electronic Filename: 203D0207.HAL
SACODE: *
PVCCODE: PR ✓

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	28.00	=		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	13.00	=		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	4.30	=		
Chloroform	TCLME	67-66-3	4.00	370.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	750.00	=		
1,2-Dichloroethane	DCA12	107-06-2	3.00	26.00	=		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	290.00	=		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	6.60	=		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	XBZ	100-41-4	25.00	0	U		
m+p-Xylene	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	85.05			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	88.00			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analyte not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents no tentatively identified result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

VE LE 2/10/97
✓ JM 2/10/97

Approved By: _____ Date: _____

PHOTOCATALYTIC OXIDATION TECHNICAL DEMONSTRATION DRE
McAFB SVE System
Site IC 29

Test Start Date: 2/5/97
Test Start Time: 12:30
Sample Date: 2/11/97

Test #: D6
Path #: 2
Dilution: 0%
Ozone: Y
Ambient Temp: 50 (deg F)

AIR STRIPPER FLOW DATA		
Pressure	1.1	(in. Hg.)
Temperature	64	(deg F)
dP	0.900	(in. W.C.)
Flow Rate	47	(scfm)
Relative Humidity	100	(% @ deg F

EFFLUENT DATA (PCOE) (Note 1)		
Sample #	E-06	
Sample Time	09:14	
Pressure	-3.9	(in. Hg)
Temperature	95	(deg F)
dP	0.5	(in. W.C.)
Flow Rate	54	(scfm)
Relative Humidity	35	(%)
Estimated Moisture (%)	2	
Est. Dry Gas Rate (dscfm)	53	

INFLUENT (PCOI)
Sample #: A-06
Sample Time: 09:09 Vacuum: -1.4 (in. Hg) Temperature: 62 (deg F)

Method EPA 18

Compound	Influent		Effluent		DRE (Note 2)
	C Conc. (ppmv)	Q Flow Rate (scfm)	C Conc. (ppmv)	Q Flow Rate (dscfm)	
Total NMOC as Methane by EPA 18	NM	47	NM	53	ERR

Calculation: DRE = [1 - (C effluent)*(Q effluent)/(C influent)*(Q influent)] * 100

Method 8021

Target List Compound	Abbrev.	Mol.Wt	Influent		Effluent		DRE (Note 3)
			Conc. (ppmv)	Mass Emission Rate (lb/hr)	Conc. (ppmv)	Mass Emission Rate (lb/hr)	
1,1-Dichloroethene	DCE11	97	0.14	0.000099	0	0.000000	NC
Methylene chloride	MTLNCL	85	0	0.000000	0.025	0.000017	NC
cis-1,2-dichloroethene	DCE12C	97	0.27	0.000191	0	0.000000	NC
Chloroform	TCLME	119.4	0.58	0.000504	0.25	0.000244	51.61%
Carbon Tetrachloride	CTCL	153.84	1	0.001120	0.69	0.000868	22.53%
1,2-Dichloroethane	DCA12	98.96	0.064	0.000046	0.027	0.000022	52.63%
Benzene	BZ	78	0.27	0.000153	0	0.000000	NC
Trichloroethene	TCE	131.4	15	0.014351	0.21	0.000226	98.43%
Tetrachloroethene	PCE	165.85	0.045	0.000054	0.0055	0.000007	86.28%
Total Target List VOCs			17.37	0.016518	1.21	0.001384	91.62%

Phosgene Concentration: 1-1.2 (ppm) HCL - 50-100 ppm, Cl - 10 ppm

Notes:
1. At the effluent, the dry gas flow rate is used to calculate mass emission rates. Most moisture is condensed in the sampling train and impingers, resulting in a nearly dry gas sample. The moisture content in the process gas at the effluent is estimated based on the relative humidity measured at the outlet. At the influent, a whole gas sample is collected without condensation, therefore no moisture correction is required.
2. The DRE for Total NMOC as methane assumes the influent molecular weight factor to be equivalent to the effluent molecular weight factor.
3. Total DREs are not calculated for the total target list VOC because all contributors to the total influent mass could not be accurately quantified.

PCOI: Photocatalytic Oxidizer Influent
PCOE: Photocatalytic Oxidizer Effluent (Scrubber Influent)
VOC: Volatile Organic Compounds
NMOC: Non-Methane Organic Compounds

DRE: Destruction and Removal Efficiency
NC : Not Calculated
NM: Not Measured
NA: Not Applicable
ND: Not Detected

DRAFT

Analytical Laboratory Report
EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3361
Sample Type: AIR / TEDLAR
Date Sampled: 11-Feb-97
Date Received: 11-Feb-97
Date Analyzed: 11-Feb-97
Time Analyzed: 1156
Date Reported: 11-Feb-97
Dilution Factor: 13.20
Concentration Units: PPBV

Field ID #: A-06
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21907
Sample Volume (ml): 3.8
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0211A1
Data Filename: 003F0101.D
Electronic Filename: 103D0211.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	53.00	0	U		
Chloromethane	CLME	74-87-3	53.00	0	U		
Vinyl chloride	VC	75-01-4	53.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	40.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	130.00	140.00	=		
Trichlorotrifluoroethane	FC113	76-13-1	130.00	0	U		
Methylene chloride	MTLNCL	75-09-2	40.00	0	U		
trans-1,2-dichloroethene	DCE12T	156-60-5	53.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	53.00	0	U		
cis-1,2-dichloroethene	DCE12C	156-59-2	40.00	270.00	=		
Chloroform	TCLME	67-66-3	53.00	580.00	=		
1,1,1-Trichloroethane	TCA111	71-55-6	53.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	40.00	1000.00	=		
1,2-Dichloroethane	DCA12	107-06-2	40.00	64.00	=		
Benzene	BZ	71-43-2	260.00	270.00	=		
Trichloroethene	TCE	79-01-6	40.00	15000.00	=		
Toluene	BZME	108-88-3	260.00	0	U		
Tetrachloroethene	PCE	127-18-4	40.00	45.00	=		
Chlorobenzene	CLBZ	108-90-7	53.00	0	U		
Ethylbenzene	EBZ	100-41-4	330.00	0	U		
m+p-Xylene	XYLMP	1330-20-7	660.00	0	U		
o-Xylene	XYLO	95-47-6	330.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	88.54			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	83.80			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analyte not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in units of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

E 2/11/97

Approved By: _____ Date: _____

DRAFT

Analytical Laboratory Report

EPA Methods 8021

Project #: 62400
Client: URS Consultants, Inc.
Chain-of Custody #: 3361
Sample Type: AIR / TEDLAR
Date Sampled: 11-Feb-97
Date Received: 11-Feb-97
Date Analyzed: 11-Feb-97
Time Analyzed: 1304
Date Reported: 11-Feb-97
Dilution Factor: 1.00
Concentration Units: PPBV

Field ID #: E-06
Site #: PCO
Sample Delivery Group: 8D219
Lab Sample ID: 8D21908
Sample Volume (ml): 50
Initial Calibration Date: 21-Oct-96
QC Batch Code: 8D0211A1
Data Filename: 005F0101.D
Electronic Filename: 105D0211.HAL
SACODE: *
PVCCODE: PR

Analytes	PARLABEL	CASNUM	MQL	Results	PARVQ	URS USE	RPD / PD
Dichlorodifluoromethane	FC12	75-71-8	4.00	0	U		
Chloromethane	CLME	74-87-3	4.00	0	U		
Vinyl chloride	VC	75-01-4	4.00	0	U		
Trichlorofluoromethane	FC11	75-69-4	3.00	0	U		
1,1-Dichloroethene	DCE11	75-35-4	10.00	0	U		
Trichlorotrifluoroethane	FC113	76-13-1	10.00	0	U		
Methylene chloride	MTLNCL	75-09-2	3.00	25.00	-		
trans-1,2-dichloroethene	DCE12T	156-60-5	4.00	0	U		
1,1-Dichloroethane	DCA11	75-34-3	4.00	9.20	-		
cis-1,2-dichloroethene	DCE12C	156-59-2	3.00	0	U		
Chloroform	TCLME	67-66-3	4.00	250.00	-		
1,1,1-Trichloroethane	TCA111	71-55-6	4.00	0	U		
Carbon tetrachloride	CTCL	56-23-5	3.00	690.00	-		
1,2-Dichloroethane	DCA12	107-06-2	3.00	27.00	-		
Benzene	BZ	71-43-2	20.00	0	U		
Trichloroethene	TCE	79-01-6	3.00	210.00	-		
Toluene	BZME	108-88-3	20.00	0	U		
Tetrachloroethene	PCE	127-18-4	3.00	5.50	-		
Chlorobenzene	CLBZ	108-90-7	4.00	0	U		
Ethylbenzene	EBZ	100-41-4	25.00	0	U		
m+p-Xylenes	XYLMP	1330-20-7	50.00	0	U		
o-Xylene	XYLO	95-47-6	25.00	0	U		
Bromochloromethane	BRCLME	74-97-5	0	82.20			
1,4-Dichlorobutane	DCBTA14	110-56-5	0	83.55			

NOTES:
R - Data rejected.
E - Data estimated due to exceedance of calibration range.
D - Dilution.
B - Blank contamination.
U - Analytes not detected at, or above the stated detection limit.
Q - parameter is out of control limits.
0 - A result of zero represents an undetected result at the MQL reported and does not imply an actual value.
PPBV - Parts per billion volume.
MQL - Method quantitation limit.
PD - Percent difference.
RPD - Relative percent difference.
Surrogate results are in terms of percent recovery with control limits: 65 to 135%.

PROCEDURES:
This analysis was performed using EPA Method 8021 and EPA Method 5030.

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APPENDIX F

PHOSGENE LETTER AND PUBLICATION

Dräger

February 13, 1997

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Tel.: (905) 821-8988
Fax: (905) 821-2565

Doug Garside
Metrics Photocatalytic Eng
General Headquarters
22 Pegler Street
London, ON N5Z 2B5

Dear Doug :

Chlorine and Hydrochloric Acid Measurements in High Humidities

In regard to our phone conversation today, we would like to confirm the following information:

As you described to me, you measured with our detector tubes Chlorine 0.3/b, Hydrochloric Acid 50/a and Phosgene 0.25/b in high temperature and high humidity conditions. The actual temperature was at 85 to 110 °F (30 to 43 °C) and the humidity at approximately 30 to 35 mg H2O/L.

The tubes you have used are not specified for this high humidities and temperatures. At these humidities Hydrochloric Acid will already be in the aerosol form/little droplets and not in gas form. A detection with tubes is no longer feasible. Chlorine and Phosgene will also be trapped in the water droplets.

Additionally the gases of note at these temperatures and humidities will be trapped in the prelayer of our detector tubes. This may result in a higher or lower reading on the tube.

For further measurements we do not recommend the "dry" chemist method which is used in tubes. Try to detect with a wet chemist method (washing bottle).

Please feel free to contact us should you have any additional questions.

Yours sincerely,

Alfred Müller
Market Manager

Vacuum Photocatalytic Oxidation of Trichloroethylene

RAO ANNAPRAGADA, ROBERT LEET, RAJNISH CHANGRANI, AND GREGORY B. RAUPP*

Department of Chemical, Bio & Materials Engineering, Arizona State University, Tempe, Arizona 85287-6006

The combination of physical removal methods such as soil vapor vacuum extraction or vacuum air stripping with gas–solid heterogeneous photocatalytic oxidation of the off-gases produced may be an effective remediation technology for a variety of soil and water contamination problems, particularly those involving chlorinated ethylenes. To test the hypothesis that reduced pressure operation of the photocatalytic unit could enhance reactor performance, a bench-scale annular photocatalytic reactor operating in the vacuum range was designed, built, and evaluated. The reactor inner wall was coated with sol–gel-derived titania to provide a uniform, adherent, photocatalytically active thin film. Photocatalytic oxidation of trichloroethylene (TCE) in humid airstreams was employed as a model chemistry. Reduction of the operating pressure at fixed feed conditions and molar feed rate significantly enhanced PCO performance as measured by the observed TCE conversion. Higher conversions were obtained in spite of a reduction in the residence time accompanying the lower pressure operation. The greatest enhancements in the TCE destruction efficiency occurred for low TCE feed concentrations and high water vapor levels. The performance enhancement appears to be linked to reduction in the absolute water vapor concentration and competition between TCE and water vapor for adsorption sites on the catalyst.

Introduction

Gas–solid heterogeneous photocatalytic oxidation (PCO) has been shown to be effective in its ability to oxidize dilute volatile chlorinated organics (*1–3*) as well as other volatile organic compounds (VOCs) (*4–8*) in humid airstreams. A candidate application for this technology is incorporation of a PCO reactor downstream of an air stripper at a groundwater remediation pump-and-treat site to completely oxidize the organics in the air stripper off-gases (*9*). Unfortunately, several factors make the air stripper application less than ideal. First, air strippers generally employ large air:water flow ratios, leading to a relatively high air flow to treat for the volume of water remediated. Second, a high level of water vapor in the air significantly inhibits the photocatalytic oxidation rate for several classes of VOCs (*1, 2, 4, 6, 8*), including the chlorinated ethylenes. This rate inhibition forces the design of larger, and hence more costly, PCO reactors to achieve the desired VOC destruction and removal efficiency (DRE).

In air stripping of VOC-contaminated water streams, reduction of the stripper operating pressure below atmospheric can significantly reduce the air:water ratio while achieving the same VOC removal achieved in atmospheric pressure operation (*10*). This new technology, known as vacuum air stripping, offers a significant advantage for PCO, or any air abatement technique for that matter, since a lower volume of air needs to be treated. We are therefore interested in exploring the technical viability of *vacuum* photocatalytic oxidation for direct integration with vacuum air stripping. Vacuum PCO could also be employed in association with soil vapor vacuum extraction in which the contaminants in the soil are volatilized by means of convective forces generated by an applied vacuum (*11*). One can imagine a number of other applications in which vacuum capability would be advantageous. For example, consider a VOC control system incorporating physical adsorption beds and downstream PCO. The adsorption beds (*e.g.*, activated carbon) capture VOCs during cyclical or intermittent operation of a chemical process emitting VOCs. During thermal regeneration of the beds, a vacuum is applied and the off-gases are treated in the PCO unit. Through cyclical operation/regeneration of several adsorption beds "load-leveling" is achieved, allowing design of a PCO unit for moderate to low VOC levels rather than the occasional high VOC levels emitted by the process.

A bench-scale reactor was designed, built, and tested in our laboratory to investigate the effectiveness of vacuum PCO. TCE was selected as the test contaminant because it is a water and soil pollutant of great environmental concern and because it has been studied extensively in gas-phase photocatalytic reactors previously (*1–3, 9, 12–14*). In addition, it is known that TCE converts fairly rapidly, thus providing a rigorous test of operation at reduced pressures.

Experimental Section

Conversion Apparatus and Data Collection Procedures. Dilute TCE in water is oxidized according to the following stoichiometric reaction as proposed by Pruden and Ollis (*15*):

$$Cl_2C=CHCl + \frac{3}{2}O_2 + H_2O \xrightarrow{h\nu} 2CO_2 + 3HCl$$

In air, the reaction requires the simultaneous presence of TCE, oxygen, and water vapor. Under dry conditions, alternative stoichiometries control, producing such incomplete oxidation products as dichloroacetyl chloride and phosgene (*12*). Berman and Dong (*16*) have shown that operation under reasonable humidity levels (*e.g.*, 50% RH) and with sufficient residence time leads to essentially the complete oxidation stoichiometry listed above.

The flow system is illustrated schematically in Figure 1. Trichloroethylene (495 ppm in nitrogen, Alphagaz), ultra-high-purity nitrogen (99.999%, Liquid Air) and oxygen (99.999% Liquid Air) were supplied from gas cylinders. All flows were controlled by mass flow controllers (Tylan). The relative humidity of the feed gas stream was controlled by varying the amount of nitrogen passing through a water bubbler. The relative humidity of the gas stream entering the reactor was measured using a calibrated relative humidity meter (Vaisala). The concentration of TCE was varied by diluting it with nitrogen and oxygen. Nitrogen and oxygen flows were always maintained in the ratio of 79:21. Most of the fittings in the vacuum system were Cajon VCR fittings; the tubing was 316 stainless steel. All runs were conducted at ambient temperature (ca. 27 °C). The reactor pressure was measured using a 0–50 psia pressure transducer (Omega). The vacuum pump was a dry (oil-free) type rotary vane pump (Process Physics, Inc.). This type of pump was employed so that no VOCs would be internally generated from vacuum

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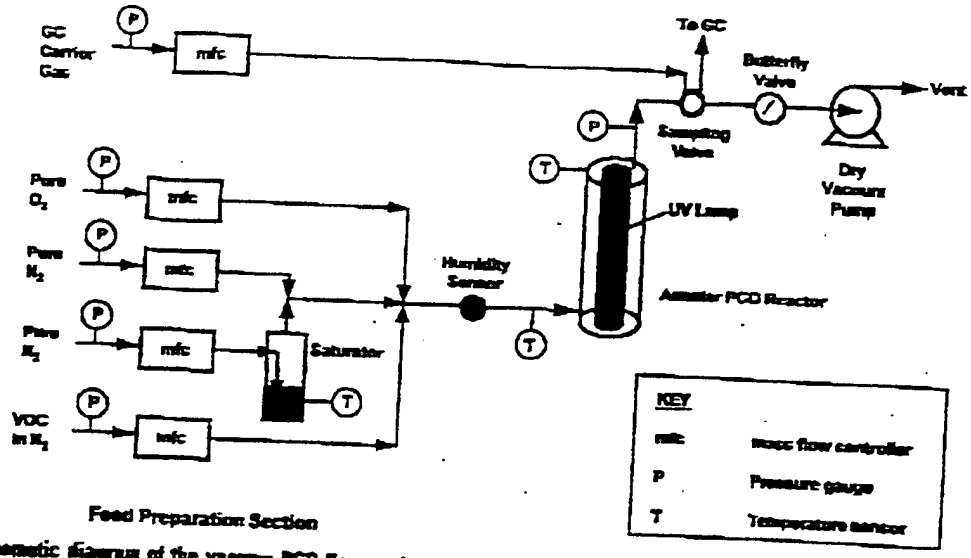

FIGURE 1. Schematic diagram of the vacuum PCO flow and analysis apparatus.

pump oil. The vacuum level was controlled by varying the position of the downstream butterfly valve. Gas sampling was achieved by means of a manual six-port Valco sampling valve equipped with a 0.5-cm^3 gas sampling loop. The gas samples were analyzed periodically with a Varian 3700 gas chromatograph equipped with a 0.1% SP-1000/Carbopack C column (Supelco) and flame ionization detector (FID). Chromatographic data were acquired and analyzed with Hewlett Packard Chemstation II software. All pressure, flow, and relative humidity data were logged on a PC using Labtech data acquisition software. Measurements were made until steady-state conditions were achieved (typically less than 15 min on stream), and all reported conversions are steady-state values. For a given set of one factor at a time experiments, runs were randomized.

Reactor Specifications. An annular photoreactor configuration was chosen for several reasons. First, this configuration provides for good conductance (low resistance to flow) and relatively high gas throughputs. Second, this design yields a relatively uniform irradiation of the photocatalyst along the axial direction, simplifying the analysis and interpretation of data as well as ultimate quantitative modeling efforts. A concern is potential macroscopic gas-phase mass transfer limitations to the catalyst surface. For this reason, the annular space was designed to be relatively small.

The reactor is shown schematically in Figure 2. The reactor had an outer carbon steel shell (20.0 cm long and 3.175 cm i.d.) into which a quartz glass insert (14 cm long and 3.036 cm i.d.) was placed. The inside surface of the quartz insert was coated with sol–gel titania as described below. A separate inner quartz tube, the same length as the carbon steel shell with ends flared out to meet the inner edges of the steel shell, served as the inner reactor body. To protect the carbon steel shell from exposure to reactive gases and to provide a volatile organic-free vacuum, Torr-Seal was used to seal the inner quartz tube to the carbon steel shell. This configuration yielded an annular spacing between the quartz liners of 0.293 cm. The titania catalyst was irradiated by a 4-W blacklight fluorescent UV lamp (General Electric F4T5-BLB) inserted in the inner tube concentrically. The output wavelength spectrum of this lamp ranges from 300 to 500 nm, with the maximum near 390 nm.

Catalyst Preparation. The procedure for coating the quartz insert with sol–gel titania was adapted from Yoldas [17]. Titanium tetraisopropoxide (TTIP) was employed as the sol–gel precursor. A mixture in the ratio of 13.44 mL of

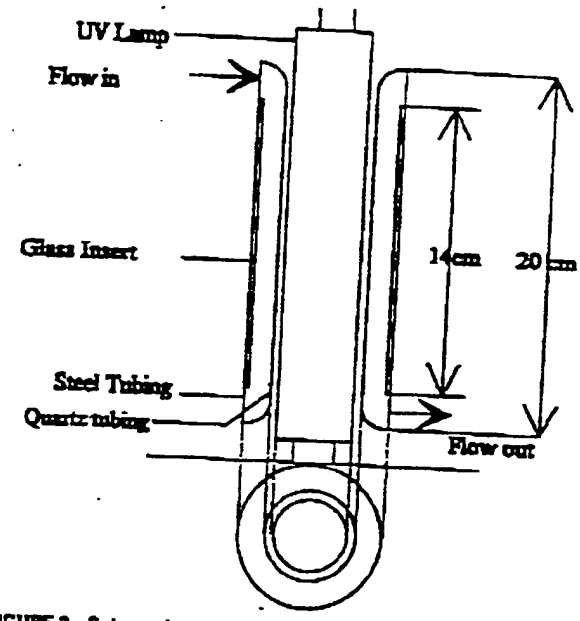

FIGURE 2. Schematic diagram of the vacuum PCO annular photoreactor.

isopropyl alcohol (IPA) to 1 mL of TTIP (equivalent to 4 L of IPA/mol of TTIP) was prepared and then coated onto the glass tube while spinning the tube and allowing excess liquid to drain out. This coated precursor solution was then contacted with a hydrolysis solution containing nitric acid (0.02 molar ratio to TTIP) and water (1 molar ratio to TTIP) to induce hydrolysis and condensation reactions and form titania films on the glass insert. The titania thus formed is mostly amorphous in nature. The glass substrate was then baked in a furnace at a temperature of 500 °C for 10 min to convert most of the amorphous titania to anatase, the catalyst structure known to be most effective. On flat glass substrates, this preparation procedure produces uniform titania films of 1.0 ± 0.05 μm thickness as determined using Rutherford backscattering spectroscopy (RBS) and scanning electron microscopy (SEM) [18]. The coating procedure was repeated 14 times to yield an adherent, optically dense (UV transmission < 1%), uniform TiO_2 thin film. This catalyst exhibited reproducible, steady activity over the course of the experiments reported in this paper.

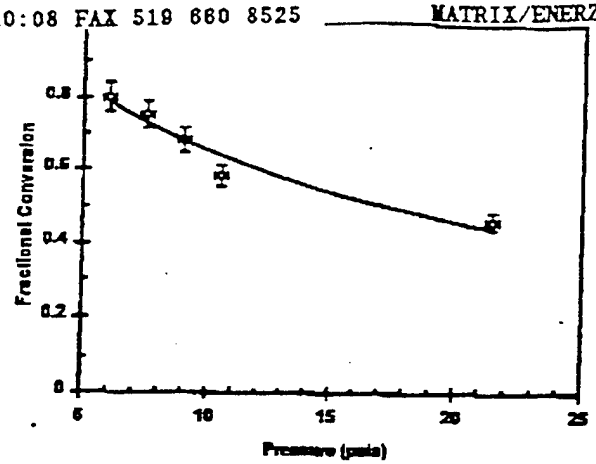

FIGURE 3. TCE fractional conversion versus reactor pressure. Total flow rate was 1.09 L(STP)/min. TCE concentration was 19.5 ppm$_v$. Atmospheric pressure relative humidity was 73%.

Results

Experiments were carried out at different flow rates, TCE concentrations, and relative humidities to study the operation of the vacuum PCO reactor and to compare its performance with atmospheric pressure operation. Under conditions of low flow, low TCE concentration, and low relative humidity, the photoreactor is capable of completely destroying the TCE. For example, complete TCE conversion was obtained at a contaminated air feed rate of 0.5 L(STP)/min, TCE concentration of 10 ppm$_v$, and relative humidity at 36% for reactor operating pressures ranging from 5 to 20 psia. Subsequent experiments were conducted at higher flows (lower residence times), higher TCE concentrations, and higher relative humidities so that conversions were below 100% and the effects of vacuum operation could be assessed.

Figure 3 shows the dependence of TCE fractional conversion on operating pressure at a fixed flow rate of 1.09 L(STP)/min and inlet TCE concentration of 19.5 ppm$_v$. The relative humidity measured at atmospheric pressure was 73%. As the operating pressure is decreased, the TCE conversion increases. A relatively greater percentage enhancement in performance is realized as the pressure is decreased from 10 to 6 psia than is realized upon decreasing the pressure from 21 to 10 psia. Note that the enhanced performance is achieved in spite of the fact that the residence time of the gas in the reactor is decreased by reduced pressure operation, since the experiments were conducted under conditions of fixed mass flow (actual volumetric rate increases with decreasing pressure).

Figure 4 shows the dependence of TCE conversion on total gas feed rate at fixed pressure, inlet TCE concentration, and water vapor content. For both 19 and 9 psia operation, TCE conversion increases as the feed rate is decreased, reflecting increased residence time accompanying decreased total flow rate. For 19 psia operation, the data shown span a Reynolds number range from 13 to 27. Thus, the flow is laminar, and no observable effects can be attributed to dramatic shifts in the flow pattern. The gas linear velocity ranges from 3.8 to 7.7 cm/s. For this doubling of the velocity, the apparent global reaction rate (mol/s) is constant within ±4%, showing that the data are not constrained by external mass transport limitations. However, these data were collected for a limited set of conditions. For conditions that yield an intrinsically higher surface reaction rate (e.g., higher UV intensity and/or lower water vapor concentrations), mass transport limitations may become important.

Figure 5 shows the dependence of TCE conversion on relative humidity at fixed total flow rate and vacuum level of 10.6 psia for two levels of TCE feed concentration. The data

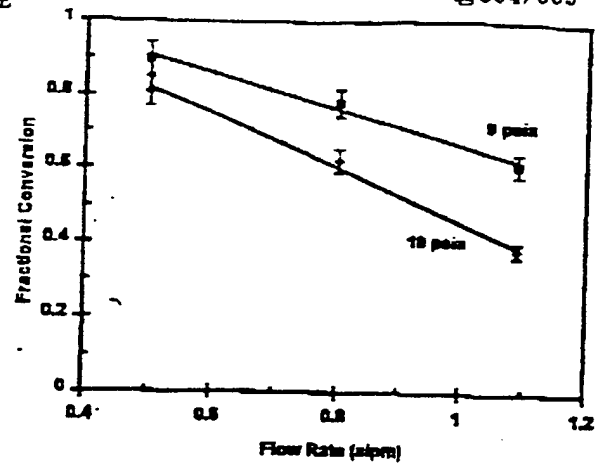

FIGURE 4. TCE fractional conversion versus feed flow rate at two reactor pressures: 19 psia (diamonds) and 9 psia (squares). TCE concentration was 23 ppm$_v$. Atmospheric pressure relative humidity was 78%.

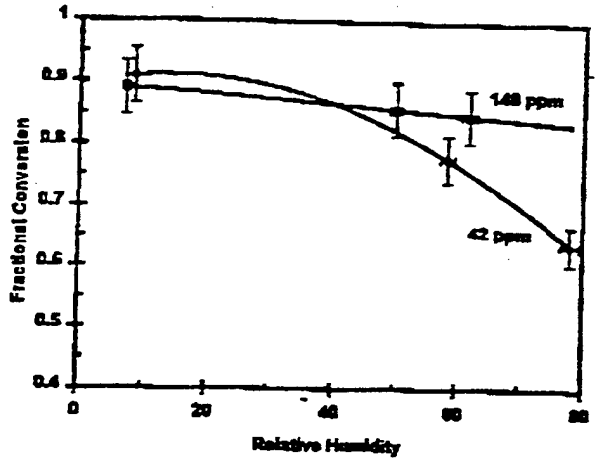

FIGURE 5. TCE fractional conversion versus atmospheric pressure relative humidity at two TCE concentrations: 42 ppm$_v$ (diamonds) and 148 ppm$_v$ (squares). Reactor pressure was 10.6 psia.

are consistent with the well-known TCE photocatalytic rate inhibition by the presence of water vapor (*1*). However, the data clearly show a much more dramatic inhibition of the rate at the lower inlet TCE concentration of 42 ppm$_v$ than at the higher concentration of 148 ppm$_v$. This type of behavior is consistent with a surface reaction model in which water vapor and TCE compete for active sites on the catalyst surface. As TCE concentration is increased, the TCE should be able to more effectively compete for sites, enhancing the observed photocatalytic oxidation rate.

Certainly a direct effect of pressure reduction is proportional reduction in the gas-phase concentrations of TCE and water vapor. A series of experimental runs were designed to test the hypothesis that a principal effect of reduction in pressure is a more favorable adsorption pseudo-equilibrium of TCE and water vapor on the active titania surface as a result of this proportional concentration reduction. In these experiments, a series of runs was performed at 21.5 psia, with feed TCE and water vapor concentrations chosen so that their values mimicked those realized by reducing the pressure. For example, a 120 ppm$_v$ TCE and 73% RH condition at 21.5 psia and 298 K corresponds to approximately 1.6 μmol of TCE/L and 320 μmol of H_2O/L at 4.9 psia. Thus conditions were selected at 21.5 psia operation to yield these *equivalent* feed concentrations, and the measured steady-state conversion was compared to that obtained at 4.9 psia. Table 1

TABLE 1. Comparison of TCE Conversion at Reduced Pressure with TCE Conversion at 21.5 psia with TCE and Water Vapor Concentrations Equivalent to Those at Reduced Pressure[a]

pressure (psia)	C_{TCE} (μmol/L)	C_{H_2O} (μmol/L)	conversion at P	conversion at 21.5 psia
21.5	7.2	1400	0.59	0.59
10.7	3.6	700	0.75	0.70
7.8	2.6	510	0.80	0.88
4.9	1.6	320	0.85	0.90

[a] At atmospheric pressure (14.7 psia) and 298 K, equivalent TCE and water vapor concentrations would be equal to 4.9 and 980 μmol/L, respectively.

summarizes the outcome of three experiments conducted in this manner. Although TCE conversions at 21.5 psia are not identical to the corresponding reduced pressure conversions, the qualitative trends (higher conversions for reduced concentrations) are quite similar. The TCE conversions for the 21.5 psia operation run higher than those for reduced pressure operation because no attempt was made to run at identical residence times, *i.e.*, the residence times for the high-pressure operation are higher.

Discussion

The data described above demonstrate unequivocally that reduced pressure operation can yield substantially improved PCO performance relative to atmospheric pressure operation under certain conditions. Greatest relative improvements are observed at low TCE concentrations, high humidity levels, and low residence times.

Reduction in the reactor operating pressure at otherwise fixed conditions of temperature, total flow, and feed composition leads directly to a reduction in the volumetric concentration of all species, including VOC, water vapor, and O_2, and a reduction in the gas residence time in the reactor since the actual volumetric flow rate increases. If the airstream follows ideal gas behavior, these reductions are directly proportional to the pressure reduction. Since the local reaction rates depend on the local conditions experienced in the reactor, one expects to observe a change in reactor performance.

If the reactor operates under the diffusional mass transfer limited regime at atmospheric pressure, reducing the system pressure will increase the reactant diffusivity, thereby increasing the flux of reactant to the surface and enhancing the reaction rate. Based on the data in Figure 4 and Table 1, we conclude that mass transport limitations are not significant under conditions that generally yield slow reaction rates, *i.e.*, low to moderate UV intensity and high water vapor concentrations. Moreover, the experiments summarized in Table 1 suggest that the principal effect of reduction in pressure is not enhanced mass transfer rates to the surface, since equivalent reductions in TCE and water vapor concentrations enhanced conversion even at constant total pressure.

For most of the data described above, we favor an explanation based on some form of competitive adsorption between TCE and water vapor. Based on our intrinsic kinetics results (*1*), we know that, at low TCE concentrations and high water vapor concentrations, the kinetically controlled surface reaction rate is first order in TCE concentration and strongly inhibited by water vapor (perhaps as strongly as water vapor concentration to the −3 power). These results suggest that the surface is largely covered by water molecules under these conditions, leading to less than optimal reaction rates. Proportional reductions in the TCE and water vapor concentrations, as can be realized by overall pressure reduction, lead to a significant reduction in the inhibiting effect of water vapor and an overall higher reaction rate. Physically, this rate improvement implies a shift in the competition between water molecules and TCE toward a more favorable balance.

The inhibitory effect of water vapor includes, but probably extends beyond, simple Langmuir–Hinshelwood–Hougen–Watson site exclusion. Anpo *et al.* (*19*) found that the adsorption of water on titania causes a decrease in the upward band bending at the gas–solid interface. This decrease implies an increase in the recombination efficiency of photogenerated holes and electrons. The adsorbed water can therefore be regarded as an effective electron hole recombination center.

In summary, we have demonstrated that operation of a PCO reactor under vacuum conditions significantly enhances DRE performance, particularly for airstreams containing low levels of VOC contamination and high water vapor contents. The source of the performance enhancement lies in enhanced gas-phase diffusivity for mass transfer limited reactors or a favorable shift in adsorption competition between the VOC and water vapor for kinetically controlled reactors. Regardless of the exact origin of the effect, successful demonstration of vacuum PCO at the bench scale indicates that the technology may represent a new viable alternative to the treatment of dilute VOCs in humid airstreams. Key unresolved issues to be explored in future work include the potential formation of incompletely oxidized volatile intermediates, long-term catalyst activity maintenance, and process integration with vacuum stripping operations.

Acknowledgments

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[a] Abstract published in *Advance ACS Abstracts*, April 1, 1997.

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APPENDIX G

SOURCE TEST RESULTS

Acurex Environmental Technical Report TR-97-114

EMISSIONS TEST REPORT: PCO UNIT SOIL VAPOR EXTRACTION SYSTEM, McCLELLAN AIR FORCE BASE, SACRAMENTO, CALIFORNIA

Test Date: February 11, 1997
Report Date: March 13, 1997

Acurex Project No. 6797.005
URS Consultants Contract No. SC-96-A-0423
Delivery Order No. AE

Prepared For

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By

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Jeff Rudd, Source Test Engineer

William Johnston, Project Manager

SECTION 1

INTRODUCTION

URS Consultants, Inc., (URS) is responsible for removal actions at McClellan Air Force Base (MAFB) under a contract with the U.S. Environmental Protection Agency (EPA). MAFB is an active facility on the northern outskirts of Sacramento, California. Volatile organic compound (VOC) contamination of soils and groundwater has occurred onsite during the operation of this facility resulting from the storage and use of various fuels, solvents, and other organic compounds. In support of its contract with the EPA, URS is operating soil vapor extraction (SVE) systems located at various remediation sites within MAFB.

Acurex Environmental was hired by URS to perform compliance emission source testing and data reduction for SVE systems located within MAFB. Acurex is certified by the California Air Resources Board (ARB) as an independent contractor to conduct compliance source testing. Acurex is performing the work under URS Contract No. SC-96-A-0423. Acurex and its subcontracted analytical laboratories — Sequoia Analytical in Redwood City, California, and Alta Analytical Laboratories, Inc., in El Dorado Hills, California — qualify as independent testing laboratories (no conflict of interest).

Acurex tested the Photocatalytic Oxidation (PCO) system for criteria pollutants. The testing was performed at two locations on the PCO system. The locations are identified as the Photocatalytic Oxidizer Influent (PCOI), the Photocatalytic Oxidizer Effluent (PCOE).

All testing was performed in accordance with the source test plan (Revision 1, dated August 26, 1996) prepared by Acurex and submitted to URS. Messrs. Jeff Rudd and Justin Compton, of

Acurex Environmental, performed the testing on February 11, 1997. Mr. Kurt Anderson of URS coordinated the test program.

The test matrix is presented in Table 1-1. Table 1-2 summarizes the test results for Site PCO. All testing was performed in accordance with EPA and/or ARB methods.

Table 1-1. Test matrix for PCO Unit

Source	Parameter	Test Method	Analytical Method	Duration (min)	Test Runs
PCOI	Flowrate	EPA 1 through 4	NA[a]	NA	3
PCOE	Particulate	ARB 5	Gravimetric	60	3
	NO_X, CO, SO_2	ARB 100	CEM[b]	60	3

[a]NA = Not applicable.
[b]CEM = Continuous emissions monitoring.

Table 1-2. Test results for PCO Unit, February 11, 1997

Source	Parameter	Value	Units
PCOI	Flowrate	65	dscfm
PCOE	Particulate	0.36×10^{-3}	gr/dscf
		0.17×10^{-3}	lb/hr
	NO_X	1.5	ppmv
	CO	11	ppmv
	SO_2[a]	< 1.0	ppmv
	NO_X	0.60×10^{-3}	lb/hr
	CO	2.6×10^{-3}	lb/hr
	SO_2[a]	$<0.55 \times 10^{-3}$	lb/hr

[a]Full detection limit is used to calculate emissions reported as non-detect (<).

START
NEW DOCUMENT

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APPENDIX H

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Risk Characterization. Risks are characterized by combining the outputs of the exposure and toxicity sections. The probability of human receptors developing cancer (cancer risk) is calculated by multiplying the calculated doses by the cancer slope factors. Noncarcinogenic effects are evaluated using the quotient method, which compares each calculated dose to the appropriate reference dose. If the ratio is less than 1.0, adverse effects are unlikely to occur.

Uncertainty Evaluation. Uncertainties exist in many steps of the risk assessment process. Uncertainties and assumptions that could have a significant effect on the calculated risks are presented in this evaluation, which is primarily qualitative.

4.3.6 Applicable or Relevant and Appropriate Requirements Evaluation

Early identification of potential ARARs allows better planning of field activities.

The CERCLA guidance requires that Applicable or Relevant and Appropriate Requirements (ARARs) be identified for remediation strategies. ARARs are cleanup standards and related regulatory requirements that may be relevant or appropriate for the remedial action. Potential ARARs are identified for consideration when analytical and physical data are collected for use in designing remedial action alternatives. These ARARs can also be used as screening levels during data collection. Early identification of potential ARARs allows better planning of field activities. Because the RI/FS process is evolving, ARARs identification continues throughout that process as more information is obtained on site conditions, site contaminants, and remedial action alternatives. Figure 4-12 illustrates how ARARs evaluation is integrated into the RI/FS process.

Other existing requirements, while not meeting the definition of ARARs, may still be useful in determining what actions to take at a site. These nonpromulgated advisories are called "To Be Considered" (TBC) requirements.

The concept of ARARs is broad and includes standards, requirements, criteria, and limitations, as described briefly below. The three general categories of ARARs are chemical-specific, location-specific, and action-specific requirements.

Chemical-specific ARARs are typically health-based or risk-based numerical limits or methodologies that, when applied to site-specific conditions, result in the establishment of numerical limits. These limits, in turn, establish the acceptable amount or concentration of a chemical that may be found in, or result from, the selected remedial action.

Location-specific ARARs restrict activities that are used to manage hazardous constituents or that are conducted during remedial actions because of the specific location of these activities at McClellan AFB. Examples of sensitive locations that may have location-specific standards associated with them include wetlands, floodplains, historic areas, and wildlife refuges.

Action-specific ARARs are technology- or activity-based requirements that may be triggered by the remedial activities chosen. They may set controls or restrictions on the particular treatment or disposal activities selected to manage hazardous constituents. Action-specific ARARs do not in themselves determine

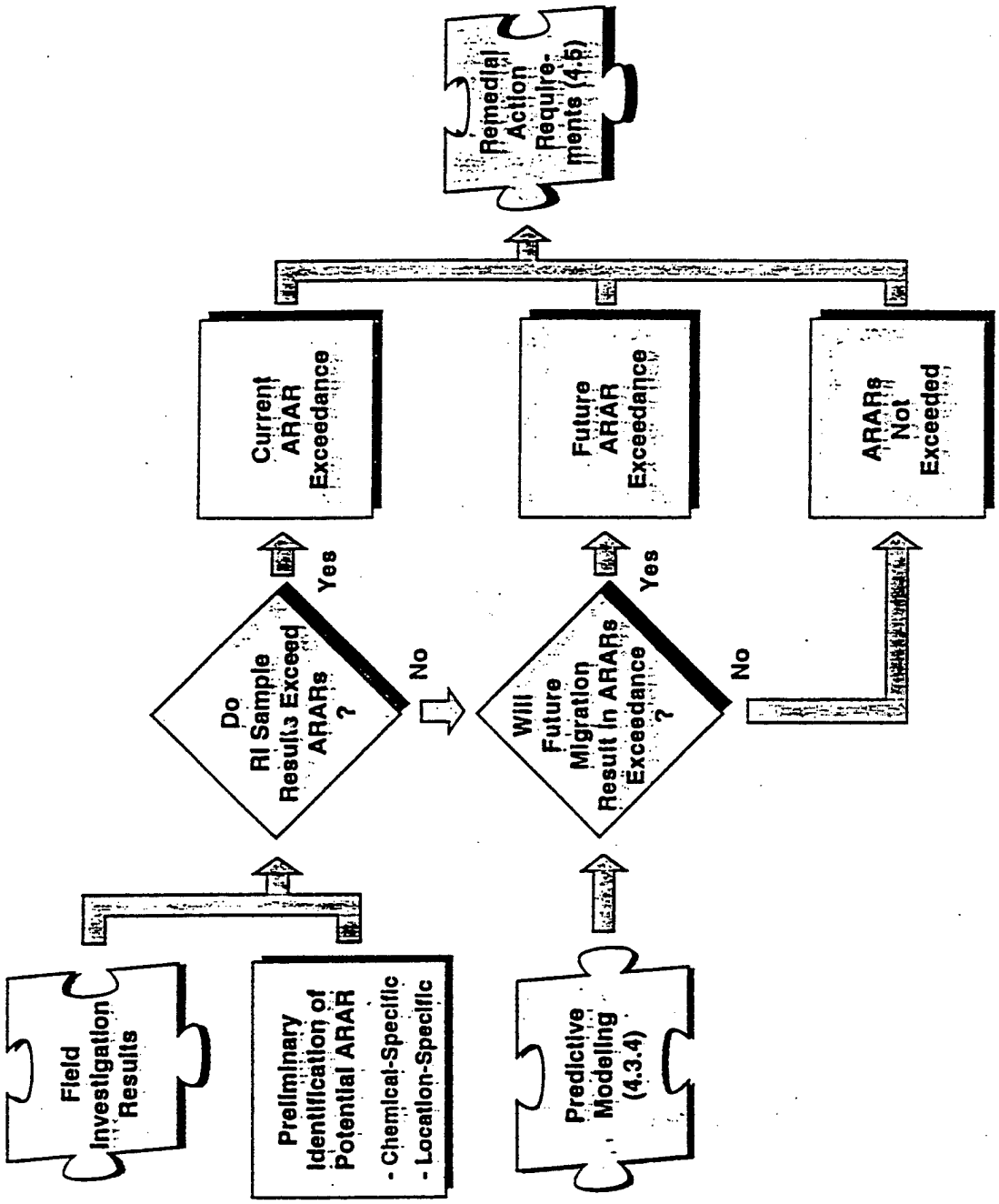

Figure 4-12. ARARs Evaluation Process

the remedial alternative; rather, they place restrictions on the manner in which a selected alternative may be achieved. Generally, remedial actions under CERCLA must meet only the substantive, not the administrative, requirements of the ARAR.

The potential ARARs for the McClellan AFB Interim Basewide RI Report are described in Appendix D and were identified in accordance with *CERCLA Compliance with Other Laws Manual* (U.S. EPA, 1988/89) and *Guidance for Conducting Remedial Investigations Under CERCLA, Interim Final* (U.S. EPA, 1988). These potential ARARs will be reassessed, expanded, or refined as needed. Ultimately, the preferred remedial action alternative will be assessed against the CERCLA cleanup criteria, including attainment of or compliance with ARARs. Listed below are the primary ARARs that should be considered for McClellan AFB:

- Nondegradation of groundwater policy established by the State Water Resources Control Board (SWRCB) (Resolution 68-16);
- State and federal maximum contaminant levels (MCLs) for groundwater;
- U.S. EPA water quality criteria and criteria found in the National Toxics Rule for surface waters;
- Sacramento Air Quality Management District air emission control requirements;
- Water Quality Control Plan for the Central Valley Regional Water Quality Control Board, establishing water quality objectives;
- SWRCB resolution No. 92-49, stating requirements for abatement of discharges that threaten water quality;
- U.S. EPA's *Guide on Remedial Actions for Superfund Sites with PCB Contamination* (a TBC criterion) for PCB cleanup levels in soil (U.S. EPA, 1990); and
- The U.S. EPA's Region IX *Preliminary Remedial Goals* (PRGs) (a TBC criterion) specifying constituent concentrations for soil and groundwater (U.S. EPA, 1996c) that can be used as screening concentrations, "triggers" for further investigation, or initial cleanup levels.

4.3.7 Conceptual Site Model

The conceptual site model is the framework for decision making constructed from site data, physical measurements, contaminant distributions, demographic information, and ecologic information. Completing the framework (i.e., putting all of the pieces together) provides the model of the location. The framework is initially an open structure constructed from limited site-specific data, assumptions regarding sources and contaminants, and information about possible exposure pathways and human or ecological receptors. The structure of the model is then filled in and refined through data collection and evaluation in the RI until the model is complete enough to make a remediation recommendation (Figure 4-13).

Travis AFB NEWIOU
Potential State ARARs
Waste Transfer, Treatment, and Storage and Disposal Requirements

Source	Section	Type	Description	Remarks
Title 22 CCR Chap 12, Art 1	66262.11	Applicable	Requires a facility to make a determination as to whether waste is hazardous	Applicable to wastes excavated or resulting from treatment processes.
Title 22 CCR Chap 14 Art 6	66264.94	Applicable	Establishes general groundwater monitoring requirements and concentration limits.	Sections in this article are applicable to permitted hazardous waste facilities. Also applicable to sites containing surface impoundments, waste piles, land treatment units or landfills that received hazardous waste after July 26, 1982 for purposes of detecting, characterizing, and responding to releases to groundwater, surface water or the unsaturated zone.
	66264.96(c)	Applicable	Establishes monitoring requirements upon removal of all waste and contaminated material from a management unit. Requires monitoring showing all levels in compliance with water quality standards for three consecutive years.	
	66264.97	Applicable	Establishes groundwater monitoring requirements during the closure and post-closure periods.	
	66264.100	Applicable	Establishes requirements for establishment of corrective management programs for owners and operators of regulated units	

Title 22 CCR Chap 14, Art 7	66264.111	Applicable	Establishes closure standards for a permitted hazardous waste facility. Specifically, closure should minimize the need for maintenance of the facility, and control, minimized or eliminate the emission of hazardous chemicals into the environment.	Sections in this article are applicable to closure of a permitted hazardous waste facility. However, it is unlikely that a hazardous waste facility will be constructed for CERCLA activities that will later require closure.
	66264.112	Applicable	Establishes content requirements for a closure plan of a hazardous waste facility.	The substantive portions section 66264.112, paragraphs (a) and (b) [except permit and reporting requirements of (a)(1) and (a)(2) which are procedural] provide the contents and requirements of the closure plan portion of the remedial documents.
	66264.114	Applicable	Establishes requirements for the disposal or decontamination of equipment, structures, and soils at a closing hazardous waste facility.	
	66264.117	Applicable	Establishes requirements for post closure care and property use of a closing hazardous waste facility to include requirements for continued monitoring and maintenance.	
	66264.118	Applicable	Establishes closure standards to minimize the need for maintence and to minimize emissions of hazardous chemicals into the environment.	The substantive portions of section 66264.118, paragraphs (a), (b) and (c) [except permitting and reporting requirements of (a) which are procedural] are applicable to provide the content and requirements of the closure plan portion of the remedial documents.

Title 22 CCR Chap 14, Art 9	66264.171	Applicable	Sets standards for containers holding hazardous waste for chemicals recovered from sediments, surface soils, or groundwater.	Sections in this article are applicable to sites or actions where waste containers are used.
	66264.172	Applicable	Requires use of containers that are compatable with the recovered material for the storage of that material.	
	66264.173	Applicable	Requires that containers used to transport material must be closed during transport and that waste be handled to minimize damage to containers.	
	66264.174	Applicable	Establishes requirements for inspecting containers weekly.	
	66264.175	Applicable	Establishes requirement for adequate secondary containment for stored waste.	
	66264.176	Applicable	Requires isolating waste from sources of ignition if waste is ignitable.	
	66264.177	Applicable	Requires segregation of waste from incompatable waste.	
	66264.178	Applicable	Establishes the requirement remove all hazardous waste and waste residue at closure.	Section 66264.178 is applicable to all sites where closure of containment systems will occur.

Title 22 CCR Chap 14, Art 10	66264.193	Applicable	Delineates requirements for tank systems inlcuding containment and detection of releases.	Sections in this article are applicable to any site or alternative where tanks or tank systems are used.
	66264.194	Applicable	Delineates requirements for tank systems including general operating requirements.	
	66264.195	Applicable	Delineates requirements for tank systems including inspections	
	66264.196	Applicable	Delineates requirements for tank systems including response to leaks or spills.	
	66264.197	Applicable	Delineates requirements for tank systems including closure and post-closure care.	Section 66264.197, paragraphs (a), (c)(3) and (c)(4) are not applicable with respect to the requirements for cost estimates and financial responsiblility requirements.
	66264.198	Applicable	Delineates requirements for tank systems including special care requirements for reactive wastes.	Section 66264.198 is applicable to sites with ignitable wastes [i.e., free product] or reactive waste [ultraviolet oxidation or catalytic oxidation] from water or air remediation activities.
	66264.199	Applicable	Delineates requirements for tank systems including special requirements for incompatiable wastes.	

Title 22 CCR, Chap 14, Art 12	66264.251	Applicable	Establishes the requirement for management of waste piles and includes design and operating requirements.	Applicable to sites where excavated materials are classified as hazardous waste, as identified throught proper characterization processes, and managed in waste piles.
	66264.254	Applicable	Establishes the requirement for management of waste piles including monitoring and inspection requirements .	
	66264.256	Applicable	Establishes the requirement for management of waste piles including special requirements for ignitable or reactive wastes.	
	66264.257	Applicable	Establishes the requirement for management of waste piles including special requirement for incompatable waste.	
	66264.258	Applicable	Establishes the requirement for management of waste piles including the requirements for closure and post-closure care.	
	66264.259	Applicable	Establishes the requirement for management of waste piles including special requirements for hazardous waste F020, F021, F022, F023, F026, and F027.	

Title 22 CCR, Chap 14, Art 14	66264.301	Applicable	Establishes requirements for hazardous waste disposal in a landfill including design and operating requirements.	Applicable to landfills where consolidation activities will occur. However, all Travis AFB landfills predate 1992. Only paragraph (a) applies to Travis. As such, all Travis AFB landfills are exempt from liner requirements.
	66264.303	Applicable	Establishes requirements for hazardous waste disposal in a landfill including monitoring and inspection requirements.	Section 66264.303 is applicable to landfills where consolidation activities will occur. However, consolidation in Travis AFB landfills will occur in existing footprints, and will be exempt with liner requirements in accordance with 66264.301 (a).
	66264.310	Applicable	Establishes requirements for hazardous waste disposal in a landfill including closure and post-closure requirements following final closure of the landfill.	
	66264.312	Applicable	Establishes requirements for hazardous waste disposal in a landfill including special requirements for ignitable wastes.	Applicable for all landfills which accept consolidation wastes.

Title 22 CCR Chap 14, Art 15.5	66264.552	Applicable	Establishes corrective action management unit (CAMU) requirements and defines the classification of remediation waste placed in a CAMU.	Applicable to landfills which consolidate waste from various sites.
	66264.553	Applicable	Establishes CAMU requirements for temporary units.	

Title 22 CCR Chap 14, Art 16	66264.601	Applicable	Specifies performance standards for miscellaneous units that transfer, treat, store or dispose of hazardous waste.	Applicable at Travis AFB sites where miscellaneous units will be created. However, it is unlikely that miscellaneous units will be used as part of remediation actions at Travis AFB. Section 66264.602 requirements related to response and reporting procedures are procedural and do not apply.
	66264.602	Applicable	Establishes analysis, inspection, response, reporting, monitoring and corrective action standards for miscellaneous units.	
	66264.603	Applicable	Establishes maintenance standards for miscellaneous units.	

Title 22 CCR Chap 14, Art 17	66264.702	Relevant and Appropriate	Establishes environmental protection standard limits for hazardous waste facility operations.	Relevant and appropritate to any site where hazardous waste is treated, stored, recycled or disposed, with exception of permitting requirements. Permitting. requirements are not applicable to CERCLA activities
	66264.704	Relevant and Appropriate	requirements for specifying concentration limits for hazardous constituents downwind from the regulated units for soil, soil pore gas and open air	
	66264.705	Relevant and Appropriate	Establishes requirement to specify the points at which monitoring must be conducted by the owner or operator..	
	66264.706	Relevant and Appropriate	Establishes operator requirements for monitoring of air/soil pore gas.	
	66264.707	Relevant and Appropriate	Establishes compliance monitoring requirements for owners and operators	
	66264.708	Relevant and Appropriate	Establishes owner or operator requirements for a corrective action program.	

Title 22 CCR Chap 14, Art 27	66264.1032	Applicable	Establishes emission limits when process vents are used.	Applicable to actions involving closed vent systems. Potentially applicable to all sites with emissions to air, including but not limited to, vapor-phase carbon and catalytic oxidation.
	66264.1033	Applicable	Establishes standards for closed vent systems and control devices.	
	66264.1034	Applicable	Establishes test methods and procedures for closed vent systems.	
	66264.1035	Applicable	Establishes record keeping requirements for closed vent systems and parameters for design analysis and performance.	

Title 22 CCR Chap 14, Art 28	66264.1054	Applicable	Establishes that pressure relief devices in gas/vapor service shall be operated with no detectable emissions.	Applicable to actions involving gas/vapor extraction systems.
	66264.1063	Applicable	Establishes leak detection monitoring requirements.	
	66264.1064	Applicable	Establishes recordkeeping requirements for gas/vapors extraction systems.	

Title 22 CCR Chap 14, Art 29	66264.1101	Applicable	Establishes design and operating standards for containment facilities.	Potential applicable to all sites. However, it is unlikely that a containment building will be constructed at a CERCLA site
	66264.1102	Applicable	Establishes closure procedures for containment buildings.	

Title 22 CCR Chap 18, Art 1	66268.3	Applicable	Establishes land disposal restrictions, including a prohibition of using dilution as a substitute for treatment.	Applicable to sites where hazardous waste sites are disposed/treated in areas not designated as CAMUs or disposed / treated beyond the area of contamination. Section 66268.7, paragraph (a)(1)and (c)(2) are substantive requirements. The remainder of the section is procedural and not ARARs
	66268.7	Applicable	Establishes land disposal restrictions, including requirements for waste analysis and record keeping.	
	66268.9	Applicable	Establishes land disposal restrictions including special rules for wastes that exhibit a characteristic	

Title 22 CCR, Chap 18 Art 3	66268.30	Applicable	Establishes waste specific LDRs	Applicable to sites where excavated material is classified as hazardous waste and disposed of or treated in an area not designated as a CAMU. Requires identification of waste through the proper characterization process.
	66268.31	Applicable	Establishes waste specific prohibitions for wastes containing dioxin.	
	66268.32	Applicable	Establishes land disposal prohibitions for certain hazardous wastes.	
	66268.33	Applicable	Establishes waste specific prohibitions - First Third Wastes.	
	66268.34	Applicable	Establishes waste specific prohibitions - Second Third Wastes.	
	66268.35	Applicable	Establishes waste specific prohibitions - Third Third Wastes.	
	66268.36	Applicable	Prohibits land disposal of newly listed EPA wastes.	
	66268.37	Applicable	Prohibits land disposal of ignitable and corrosive characteristic wastes whose treatment standards were vacated.	
	66268.38	Applicable	Identifies waste specific prohibitions on newly identified organic toxicity characteristic wastes and newly listed coke by-product and chlorotoluene wastes.	

Title 22 CCR Chap 18, Art 10	66268.100	Applicable	Establishes land disposal prohibitions for non-RCRA hazardous wastes.	Applicable to sites where excavated material is classified as a hazardous waste. If waste is identified through the proper characterization process, and managed in waste piles, it will be managed in accordance with these standards.

Title 22 CCR Chap 43	67430.3	Applicable	Establishes requirements for the removal of spilled or improperly deposited wastes..	Applicable to sites with excavated soils classified as extremely hazardous waste.

Title 22 CCR, Chap 45	67450.11	Applicable	Identifies influent waste streams and establishes treatment processes for influent waste streams eligible for treatment pursuant to permit by rule.	Applicable to all sites with identified influent waste streams.

Title 22 CCR Chap 18, Art 2	All Sections	Applicable	Establishes treatment technology for disposal of waste to land for non-RCRA wastes identidied in section 66268.106	Applicable to sites where excavated material is classified as hazardous waste. If waste is identified through the piles, it will be managed in accordance with these standards proper characterization process, and managed as waste
Title 22 CCR Chap 18, Art 3	All Sections	Applicable	Establishes treatment standards for wastes F001 to F005.	
Title 22 CCR Chap 18, Art 4	All Sections	Applicable	Identifies the halogenated organic compounds regulated under section 66268.32	
Title 22 CCR Chap 18, Art 5	All Sections	Applicable	Establishes treatment technology requirements for any disposal to land of wastes identified in section 66268.41	
Title 22 CCR Chap 18, Art 11	All Sections	Applicable	Establishes prohibitions on storage of hazardous wastes restricted under Article 3 of this chapter or RCRA Section 3004 (42 USC 6924).	

Travis AFB NEWIOU
Potential State ARARs
Air Remediation Requirements

Source	Section	Type	Description	Remarks
Regulation 2, Rule 1 (Bay Area Air Quality Management District Regulations)	308	Applicable	Establishes that fugitive emission from equipment or facilities must comply with all applicable requirements.	Applicable to all sites and all actions which may result in fugitive emissions.
	316	Applicable	Establishes levels for various air contaminants at which the permitting requirements 2-1-301 and 2-1-301 become applicable.	Relevant and appropriate to all sites and actions in establishing the level of emissions levels at which applicable substantial requirements trigger. Permit requirements of 2-1-301 and 2-1-302 , as well as APCO procedural requirements, are not ARARs.
	501	Applicable	Establishes emission monitoring requirement.	Applicable to all sites or actions where equipment with potential to release emissions to the air, with respect to substantive provisions in Volume V regarding monitoring.
Regulation 2, Rule 2	112	Applicable	Establishes exemptions from abatement control equipment requirements for secondary pollutants.	Applicable to sites where abatement devices are used. Potentially applicable to all sites.
	301	Applicable	Establishes BACT requirement for certain new sources.	Applicable to all actions with potential to discharge to air. Not applicable for permitting requirements or authority to construct but applicable for determining the applicability of BACT to a new source.
	302	Applicable	Establishes offset requirements for certain new sources	Applicable to all actions with potential to discharge to air. Not applicable for permitting requirements or authority to construct but applicable for determining offset requirements for a new source Currently ,Travis AFB emits <50 tons annually.

Regulation 2, Rule 2 (Cont.)	308	Applicable	Establishes BACT and PSD requirements for new or modified facilities in Class 1 areas.	Applicable to all sites and actions where new sources are implemented. Potential applicability to all sites.
	315	Applicable	Incorporates 40 CFR 51.166 as a part of Rule 2.	Applicable to all sites or action with potential to discharge to the air.
	412	Applicable	Establishes standards upon sources following relaxation of any enforceable limitation.	Applicable with respect to substantive provisions of this or other regulation triggering this section.
	418	Applicable	Establishes criteria for the use of stacks.	Applicable to all sites or actions where a stack is used in the remediation. Potentially applicable to all sites.
	501	Applicable	Establishes pre-construction area monitoring requirements for new sources.	Applicable to all new sources. Potential applicability to all sites and alternative actions. Operation requirements set forth in subsection 501.2 constitute a valid ARAR. Section 501.1 is a procedural requirement and not an ARAR.
	502	Applicable	Establishes post-construction area monitoring requirements for new sources	Applicable to new sources. Potential applicability to all sites and alternative actions. Monitoring requirements constitute a valid ARAR. Provisions regarding permit to operate and authority to construct are procedural and not ARARs.
	601	Applicable	Establishes methodology for ambient air quality monitoring.	Applicable to all sites or alternative actions where a new source is implemented.
	602	Applicable	Establishes criteria for stack height.	Applicable to all sites or actions where a stack is used in the remediation. Potentially applicable to all sites.
	606	Applicable	Establishes emissions calculations for permitting offsets.	Applicable with respect to methodology for calculation of offset credits. Permitting requirements and procedures, and authority to construct procedures, are procedural and not valid ARARs.

Regulation 2, Rule 4	304	Applicable	Establishes limitations for use of bankable deposits.	Applicable to all sites and alternative actions involving the use of a new source.
	305	Applicable	Establishes conditions for withdrawal of bankable deposits.	
	412	Applicable	Establishes withdrawal procedures for banked deposits.	
	601	Applicable	Establishes emission calculation procedures to be used in this rule.	

Regulation 6	301	Applicable	Establishes limitations on visible emissions and opacity.	Applicable to landfill sites, any soil site where excavation occurs, or air-stripping actions.
	302	Applicable	Establishes limitations on emission rates.	Applicable to landfill sites, any soil site where excavation occurs, or air-stripping actions.
	303	Applicable	Establishes limitations on emission rates, concentration, visible emissions and opacity.	Applicable to all sites utilizing internal combustion engines < 25 liters or any site where soldiering, brazing, or welding activities occur.
	305	Applicable	Establishes limitations on visible emissions and opacity.	Applicable to all sites.
	310	Applicable	Establishes limitations on particulate weight from specified sources.	Applicable to all sites. Sections 310.1, 310.2 and 310.3 are not applicable or relevant to remediation activities at Travis AFB.
	311	Applicable	Establishes limitations on emission rates from any emission source.	Applicable to all sites. However, no activities which would trigger this requirement are anticipated at the NEWIOU.
	401	Applicable	Establishes requirement that plant operators recognize appearance of emissions at all times.	Applicable to all sites. However, no activities which would trigger this requirement are anticipated at the NEWIOU.
	501	Applicable	Establishes requirements for sampling facilities and instruments.	Applicable to all sites or actions where emissions occur.

Regulation 8, Rule 34	111	Applicable	Establishes exemptions for certain solid waste disposal sites.	Applicable to NEWIOU landfills.
	113	Applicable	Establishes exemption for periods of inspection and maintenance.	Applicable to NEWIOU landfills.
	301	Applicable	Establishes emission control system gas collection requirements for landfills.	Applicable to NEWIOU landfills sites not meeting the exemption requirements set forth in subsections 111.1, 111.2, or 111.3.
	303	Applicable	Establishes maximum organic compound concentrations at the surface of a landfill.	
	503	Applicable	Establishes quarterly testing requirements.	
	504	Applicable	Establishes criteria for instruments used to measure organic compounds.	
	601	Applicable	Establishes methodology for the determination of emissions.	
	602	Applicable	Establishes leak measurement criteria.	
	603	Applicable	Establishes landfill gas sampling criteria.	
	604	Applicable	Establishes methodology for determining concentrations of methane and nitrogen.	

Regulation 8, Rule 40	110	Applicable	Establishes an exemption for calculation of aeration volumes for exposed surfaces.	Applicable to NEWIOU soil sites.
	111	Applicable	Establishes an exemption for calculation of aeration volumes for exposed surfaces.	
	112	Applicable	Establishes exemption for calculation of aeration volume for soil used in sampling.	
	113	Applicable	Establishes an exemption for calculation of aeration volumes chemicals with boiling point >302 degrees F.	Applicable to all NEWIOU soil sites contaminated with non-volatile hydrocarbon compounds only.
	114	Applicable	Establishes an exemption for calculation of aeration volumes for soil excavated during pipeline leak repairs.	Applicable to water remediation sites where pipelines contain hazardous compounds (i.e. TCE contaminated water).

Regulation 8, Rule 40	301	Applicable	Establishes methodology and rates for soil aeration.	Applicable to soil sites and soil aeration alternatives.
	302	Applicable	Establishes increased aeration rates for organic compounds where the emissions are reduced by at least 90 percent by weight..	
	303	Applicable	Establishes requirements for soil storage piles to minimize emissions to the atmosphere resulting from aeration.	
	310	Applicable	Establishes requirements for removal or replacement of storage tanks which previously contained organic compounds.	Applicable to sites where removal or replacement of USTs will occur. Potentially applicable to all sites, although there are presently no known USTs are NEWIOU remediation sites.
	311	Applicable	Establishes restrictions on vapor freeing a tank.	Applicable to sites or activities where tanks are used as part of the remedial action.
	312	Applicable	Establishes restrictions on ventilating a tank.	
	601	Applicable	Establishes parameters for soil sampling at aeration site.	Applicable to soil sites and soil remediation alternatives.
	602	Applicable	Establishes measurement of organic content requirements for organic compounds in soil.	
	603	Applicable	Establishes parameters for measuring emissions of organic compounds from soils.	

Regulation 8, Rule 47	109	Applicable	Establishes regulatory exemptions for small emissions.	Applicable to air stripping and soil vapor extraction alternatives.
	112	Applicable	Establishes exemptions from this Rule for aeration of contaminated soil and removal of underground storage tanks.	
	113	Applicable	Establishes exemption for air stripping and soil vapor extraction operations less than 1 pound per day.	Section 113 is applicable except for procedural requirements pertaining to APCO and permitting requirements are not ARARs.
	301	Applicable	Establishes air stripping and soil vapor extraction emission control requirements for benzene, vinyl chloride, perchoroethylene, methylene chloride and/or trichloroethylene.	
	302	Applicable	Establishes emission control requirements for air stripping and soil vapor extraction operations with greater than 15 pounds per day emissions.	
	601	Applicable	Establishes methodology for air stripper water sampling.	Applicable to alternatives utilizing air stripping technology.
	602	Applicable	Establishes methodology for the measurement of organic compound concentrations in water.	
	603	Applicable	Establishes methodology for measurement of emissions of organic compounds.	Applicable to air stripping and soil vapor extraction alternatives.

Regulation 11	301	Applicable	Establishes daily emission levels for the discharge of lead or lead compounds.	Applicable to alternative actions which have the potential for emissions of lead or lead compounds into the atmosphere .
	302	Applicable	Establishes daily lead emission levels which impact ground level concentrations.	
	303	Applicable	Establishes limits on lead emission levels by prohibiting emissions which result in average ground level concentrations greater than 1.0 ug/l above background.	
	501	Applicable	Establishes monitoring equipment requirements.	
	601	Applicable	Establishes requirements for calculating ground level emissions of lead or lead compounds.	
	602	Applicable	Requirements for establishing background concentration levels of lead.	
	603	Applicable	Establishes requirements for monitoring concentrations of lead, including atmospheric sampling, siting, and reporting procedures.	Sections 11-1-603 and 11-1-604 `are applicable for substantive portions of the Manual of Procedures, Volume VI, Section 2, only.
	604	Applicable	Requirements for establishing daily emission limits of lead.	

Travis AFB NEWIOU
Potential State ARARs
Landfill Remediation Requirements

Source	Section	Type	Description	Remarks
Title 14 CCR Chap 3 Art 7.3	17636	Applicable	Establishes requirement that the weight or volume of waste accepted must be determined to an accuracy of + or - 10 percent. Applies to sites defined by PRC 40122	Applicable to consolidation landfill sites with respect to consolidation materials.
	17637	Applicable	Establishes that the length and depth of any cuts made in natural terrain where fill will be placed and the depth to groundwater must be determined and documented. Applies to sites defined by PRC 40122.	
Title 14 CCR Chap 3, Art 7.4	17658	Applicable	Establishes that the perimeter of the landfill must be secured through barriers or topographic constraints to discourage unauthorized entry.	Applicable to landfill sites with consolidation activities or other activities where wastes will be uncovered or moved.
	17659	Applicable	Requires landfill roads to be reasonably smooth to minimize dust or tracking of materials on public roads.	
Title 14 CCR Chap 3, Art 7.5	17676	Applicable	Requires initiating unloading area, controlling windblown materials, and deposition at toe of fill.	
	17677	Applicable	Requires spreading and compacting of refuse in layers	

Title 14 CCR Chap 3, Art 7.5 (Cont.)	17678	Applicable	Requires that the slope of the working face shall be maintained at a ratio which will allow effective compaction of the wastes. Requires the depth of the cuts and slopes of trench sides not exceed specified horizontal to vertical ratios.	Applicable to landfill sites with consolidation activities or other activities where wastes will be uncovered or moved.
	17680	Applicable	Requires stockpiled cover material and unacceptable native material be placed so as not to cause problems or interference with site operations.	
	17684	Applicable	Requires cover on fill where no additional refuse will be deposited within 180 days.	
	17686	Applicable	Establishes a prohibition on scavenging at a disposal site.	
	17687	Applicable	Establishes that salvaging is permitted in a planned and controlled manner.	
	17688	Applicable	Authorizes volume reduction and energy recovery in a planned and controlled manner.	
	17689	Applicable	Requires processing to be confined to the smallest area possible.	
	17690	Applicable	Requires salvage material to be safely isolated for storage.	
	17691	Applicable	Requires the storage time for salvage material be limited to a safe duration	
	17692	Applicable	Establishes that items capable of impairing public health not be salvaged without prior approval by enforcement /local health agencies.	

Title 14 CCR Chap 3, Art 7.6	17701	Applicable	Requires that each site shall be operated and maintained so as to not create a nuisance.	Applicable to landfill sites with consolidation activities or other activities wastes will be uncovered or moved.
	17704	Applicable	The operator shall take adequate steps to monitor, collect, treat, and effectively dispose of leachates.	Section 17704 is applicable as applied consistent with the requirements of 22 CCR 66264.301
	17705	Applicable	Establishes requirements for landfill gas control based on monitoring.	Applicable to all unclosed landfill sites.
	17706	Applicable	Requires operators take adequate measures to minimize dust.	
	17707	Applicable	Requires the operator control or prevent the propagation, harborage, or attraction of flies, rodents, or other vectors, and to minimize bird problems.	
	17708	Applicable	Requires adequate drainage to be provided. Effects of erosion shall be promptly repaired and steps taken to prevent further occurrence.	
	17709	Applicable	Requires that no solid waste be deposited in contact with surface or ground water.	Applicable to landfill sites with consolidation activities or other activities where wastes will be uncovered or moved
	17710	Applicable	Requires covered surfaces of the disposal area be graded to promote run-off and prevent ponding, accounting for future settlement.	
	17711	Applicable	Requires litter/loose materials to be routinely collected and disposed.	
	17713	Applicable	Requires that the disposal site shall not be a source of odor nuisances.	
	17714	Applicable	Requires that burning wastes shall be extinguished.	

Title 14 CCR Chap 3, Art 7.8	17766	Applicable	Establishes a requirement to maintain a written emergency response plan.	Applicable to landfill sites with consolidation activities or other activities where wastes will be uncovered or moved
	17767	Relevant and Appropriate	Establishes security requirements and closure procedure for open landfills.	Section 17767, paragraphs (c) through (f) are relevant requirements. Paragraph (a) is not applicable per paragraph (b). Paragraphs (f) and (g) are procedural and therefore not ARARs.
	17773	Applicable	Establishes criteria for a final cover on the landfill.	Applicable to landfill sites where a final cover will be constructed. Section 17773, paragraphs (b) through (e) are applicable substantive requirements.
	17774	Applicable	Establishes construction quality assurance parameters for final cover.	Section 17774, paragraphs (a) and (c) through (h) are applicable substantive requirements.
	17776	Applicable	Establishes final grading requirements for the final cover.	Section 17776, paragraphs (a) and (c) through (f) are applicable substantive requirement.
	17777	Applicable	Establishes final site face requirements for the final cover.	
	17778	Applicable	Establishes final drainage requirements for the final cover.	Section 17778, paragraphs (a) and (c) through (j) are applicable substantive requirements.
	17779	Applicable	Requires that the design and construction of the slopes must protect the integrity of the final cover and minimize soil erosion.	Section 17779, paragraphs (a) and (c) through (i) are applicable substantive requirement.
	17781	Applicable	Leachate must be monitored, collected, treated, and discarded appropriately.	Applicable to landfill sites which will be closed at part of the remedial action. Section 17781, paragraphs (a) (b) (c) & (e) are applicable substantive requirements. Paragraph (c) and (d) are not ARARs with respect to reporting requirements.

Title 14 CCR Chap 3, Art 7.8 (Cont.)	17783	Applicable	Requires landfill gas to be collected & analyzed; concentration of combustible gas at the landfill boundary must be =<5%. Trace gases must not be at levels that cause adverse health/environmental impact	Applicable to landfill sites which will be closed at part of the remedial action. Section 17781, paragraphs (a) (b) (c) & (e) are applicable substantive requirements. Paragraph (c) and (d) are not ARARs with respect to reporting requirements
	17788	Applicable	Requires the landfill to be maintained and monitored for no less than 30 years following closure.	
	17796	Applicable	Establishes requirements for use of landfill following closure.	
Title 14 CCR Chap 5, Art 3.2	18222	Relevant and Appropriate	Establishes the planning requirements necessary to ensure solid waste is handled and disposed in manners that protect public health and safety and the environment must be conducted.	Applies to sites where consolidation activities will occur. Relevant and appropriate to establish format for contents of the remedial action documents.
Title 14 CCR Chap 5, Art 3.4	18262.3	Relevant and Appropriate	Establishes contents of the final closure plan.	Relevant and appropriate at landfill closure site for content requirement of the closure plan. Section 18262.3, paragraphs a(1) to (a)(5) are relevant and appropriate to consolidation sites; paragraphs (a)(6) to (a)(8) are procedural and not ARARs.
	18265.3	Relevant and Appropriate	Establishes post closure maintenance plan requirements for solid waste disposal sites.	
	18275	Relevant and Appropriate	Establishes a requirement to submit certification of final closure to local agencies.	Relevant and appropriate at landfill closure site

Travis AFB NEWIOU
Potential State ARARs
Fish and Game Requirements

Source	Section	Type	Description	Remarks
California Fish and Game Code	1600 et seq	To Be Considered	Establishes coordination requirements between the lead agency and the Department of Fish and Game	Section 1600 et seq will be considered consistent during remediation activities. Federal requirements which rise to the level of ARARs also require coordination between the state and lead agency.
	1908	Applicable	Establishes a prohibition on the import, taking or possession of rare or endangered native plants.	Applicable to all sites.
	2080	Applicable	Establishes a prohibition on the import, taking or sale of threatened or endangered native plants	
	2090	Relevant and Appropriate	Requires state lead agencies to consult with the Dept of Fish and Game to ensure authorized actions will not jeopardized endangered or threatened species.	Relevant and appropriate for federal agencies at all sites where endangered or threatened species are located.
	2091	Relevant and Appropriate	Requires state agencies to use alternative actions where impact to threatened or endangered species or habitat is found.	
	2092	Relevant and Appropriate	Requires state agencies to adopt reasonable alternative actions where project would result in the extinction of a species.	

California Fish and Game Code (Cont)	3005	Applicable	Prohibits the taking of birds or animals with net, pound, cage, trap, set line, wire, or poison.	Applicable to all sites.
	3511	Applicable	Prohibits taking of birds identified as "fully protected."	
	3513	Applicable	Prohibits taking or possession of mammals identified as "fully protected."	
	5050	Applicable	Prohibits taking or possession of reptiles and amphibians identified as "fully protected."	
	5515	Applicable	Prohibits taking or possession of fish identified as "fully protected."	
	5650	Applicable	Prohibits deposit or placement of specified materials and substances into places where is can pass into the waters of the state.	

California Fish and Game Commission Policies	Management and Utilization of Fish and Wildlife on Federal Lands	To Be Considered	Establishes management policies and defines methodologies used in the protecting all fish, wildlife, and threatened and endangered species.	Although these policies are not promulgated regulations and therefore, cannot be legally defined as ARARs, these policies do contain substantive provisions which will be considered in the decision process, consistent with applicable federal laws and statutes.
	Wetlands Resource Policy	To Be Considered		

Title 14 CCR	40.00	Applicable	Prohibits the taking of possession of native reptiles and amphibians	Applicable to all site and action alternatives.
	40.10	Applicable	Prohibits the taking of possession of native reptiles and amphibians	
	460	Applicable	Prohibits the taking of certain fur bearing mammals at any time.	
	640	To Be Considered	Establishes requirement for fish and wildlife planning to optimize fish and wildlife resources	Section 640 will be considered to the extent feasible and consistent with CERCLA planning documents.
	670.2	Applicable	Establishes species, subspecies, and varieties of native California plants as endangered, threatened, or rare.	
	670.5	Applicable	Establishes species, subspecies, and varieties of native California plants as endangered, threatened, or rare.	

Travis AFB NEWIOU
Potential State ARARs
Regional Water Quality Control Board

Source	Section	Type	Description	Remarks
California Water Code (CWC) (Porter-Cologne Water Quality Control Act - CWC section 13000 et seq)	13243	Applicable	Authorizes regional boards to specify certain conditions or areas where the discharge of waste, or certain types of wastes, will not be permitted	Applicable to action where potential discharges will occur.
	13267(b)	Applicable	Authorizes regional boards to require persons who have discharged or will discharge to furnish, technical or monitoring program reports which the regional board requires.	Applicable to sites or actions where potential discharges will occur
	13304(a)	Applicable	Requires dischargers of or those who have caused the discharge of waste into the waters of this state in violation of any waste discharge requirement or other order or prohibition issued by a regional board or the state board, to clean up the waste or abate the effects of the waste, or, in the case of threatened pollution or nuisance, take other necessary remedial action, including, but not limited to, overseeing cleanup and abatement efforts.	
	13375	Applicable	Prohibits the discharge of any radiological, chemical, or biological warfare agent into the waters of the state is hereby prohibited.	

Porter Cologne Water Act; CWC Sections 13000, 13140, 13240,	State Water Board Resolution 88-63	Applicable	Designates all ground and surface water of the state as drinking water with certain exceptions (TDS>3000 ppm, well yield<200 gpd, geothermic resources, waste water conveyance facility, or can't be reasonably treated for domestic use.	Applies to sites affected by waste discharge to groundwater or surface water. State primary MCLs are relevant and appropriate; however, the most stringent federal or state standard will be the ARAR for remedial action. (See 22 CCR 66435, 64444.5, 64473).
Porter Cologne Water Act; CWC Sections 13140, 13240, 13260, 13263, 13267, 13300, 13304, 13307	State Water Board Resolution 92-49	Relevant and Appropriate	Establishes a requirement for the regional boards to apply certain policies and proceedures for the oversight of investigations and cleanup and abatement activities resulting from discharges of waste which affect or threaten water quality. Also requires the application of Title 23 CCR, Division 3, Chapter 15, to cleanups.	Paragraph IIIG is relevant and appropriate to all NEWIOU sites where the discharges of wastes threatens or may affect the quality of ground or surface water. (See remarks in the main text.)

Porter Cologne Water Act; California Water Code Sections 13240, 13241, 13242, 13243	San Francisco Bay Water Quality Control Plan (Basin Plan)	Applicable	Describes the basins in the region, establishes beneficial uses of the ground and surface waters, establishes water quality objectives, protects beneficil uses, and incorporates state wide water quality control plans and policies.	Applicable to all sites and actions where remediation of ground or surface water will occur, or actions which have potential impact on surface water or groundwater
	Central Valley Water Quality Control Board	To Be Considered	The designated level methodology for waste classification and cleanup level determination.	To Be Considered requirement for all water remediation sites and for all actions with the potential to discharge to or otherwise impact ground or surface water.

Title 23 CCR (Porter Cologne Water Quality Control Act - CWC Sections 13140 - 13147 13172, 13260, 13263, 13267, 13304)	Division 3, Chapter 15	Applicable or Relevant and Appropriate (See Individual Sections)	Establishes waste management requirements and waste and site classifications for waste treatment, storage, or disposal in landfills, surface impoundments, waste piles, and land treatment facilities.	See sections below for the application of specific sections of Chapter 15. Not applicable to CERCLA remediation for sites where unintentional or unauthorized discharges have occured per exemption in section 2511(d).
	2510(d)	Applicable	Requires closure of existing waste management units IAW Chapter 15, Article 8. Applies to all areas where waste has been discharged to land on or before Nov 27, 1984, but were not closed, abandoned, or inactive prior to that date.	Applicable to existing waste management units.
	2510(g)	Applicable	Requires parties responsible for discharges at waste management units which were closed, abandoned, or inactive on the effective date of these regulations to develop and implement a monitoring program.	Applicable to closed, abandoned or inactive waste management units.
	2511(d)	Applicable or Relevant and Appropriate	Establishes exemption from provisions of this subsection for unintentional or unauthorized releases of waste or pollutants to the environment. Requires wastes, or contaminated materials removed from the immediate place of release to be discharged according to Article 2. Remedial actions intended to contain wastes at the place of release shall implement provisions of this subchapter to the extent feasible.	Applicable to waste management units in operation after November 27, 1984 and relevant and appropriate for units whose actions ceased prior to that date. Wastes, pollutants, or contaminated materials removed from the immediate place of release shall be discharged according to Article 2.

Title 23 CCR (Cont)	2522	Applicable	Requires that designated wastes be discharged to class I or II management units. Applies to designated waste (nonhazardous waste that could cause degradation of surface or ground water) to land for treatment, storage, or disposal.	Applicable to wastes being removed from landfills and bioremediation units.
	2523	Applicable	Requires that non-hazardous solid waste be discharged to a classified waste management unit.	Applicable to landfill consolidation activities.
	2550.4	Relevant and Appropriate	Requires that if actual concentration of of a constituent is lower than associated cleanup levels, the cleanup level shall be lowered to reflect the existing water quality. Specifies factors considered in setting cleanup levels above background levels.	Relevant and Appropriate in setting groundwater cleanup levels for discharges to land.
	2550.6	Applicable	Requires monitoring for compliance with remedial action objectives for three years from the date of achieving cleanup objectives.	Applicable to groundwater remediation sites where waste has been discharged to land.
	2550.7	Applicable	Requires general soil, surface water, and ground water monitoring.	
	2550.9	Applicable	Applies to sites where monitoring results show statistically significant evidence of a release. Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent.	

Title 23 CCR (Cont)	2550.10	Applicable	Requires implementation of corrective action measures to ensure that cleanup levels are achieved. Also requires monitoring to determine the effectiveness of the corrective actions.	Applicable to soil remediation actions and sites.
	2581	Applicable	For wastes contained or left in place following remedial action if potentially affecting water quality. Includes closure landfills and other areas where wastes have been discharged. Requires final cover be constructed IAW specific prescriptive standards	
	2582	Applicable	Requires surface impoundments to be closed by either removing all remaining contamination or closing the surface impoundment as a landfill.	Applicable to areas where wastes containing free liquids were discharged.
	2583	Applicable	Requires waste piles to be closed by removing all wastes and materials contaminated by wastes, or by constructing a cover IAW specific prescriptive standards.	Applicable to sites where waste piles exist.

Travis AFB NEWIOU
Potential Federal ARARs
Requirements under the US Code and Related Regulations

Source	Section	Type	Description	Remarks
Title 16 USC (Endangered Species Act)	1531(c)	Applicable	Requires action to conserve endangered species and critical habitats upon which endangered species depend. Includes consultation with the Dept of Interior.	Applicable to all sites and alternative actions where endangered species or habits on which endangered species depend is present.
	1536(a)	Applicable		
Title 50 CFR Part 402	All Sections	Applicable		
Title 16 USC (Fish and Wildlife Coordination Act)	662	Applicable	Regulates site actions that may effect fish or wildlife in lakes, stream, or other body of water by requiring coordination between the lead agency and the US Fish and Wildlife Service, Department. of the Interior, and applicable state agencies.	Applicable to actions which are located at or near, or which impact, Union Creek and pond. Also includes groundwater remediation actions which impact these sites.
Title 16 USC (Migratory Bird Treaty Act)	703	Applicable	Prohibits unlawful taking, possession, and sale of almost all species of native birds in the U.S.	Applicable to all sites where migratory birds or their habitats are located

Title 33 CFR Part 330	Appendix A, Subpart B	Relevant and Appropriate	Establishes requirements for federal permitting and establishes substantive requirements related to permitting.	The substantive provisions of this section (paras 7, 12, 13, 16, 18, 19, 27, and 33) are relevant and appropriate to all sites. The permitting requirements are not ARARs.
(Nationwide Permits)	Appendix A, Subpart B	Relevant and Appropriate	Establishes conditions and prerequisites for nationwide permitting system.	The substantive portion of this section are relevant and appropriate to all sites. The permitting requirements are not applicable at a CERCLA site.

Title 40 CFR Part 122	122.26	Applicable	Requirements to ensure stormwater discharges from remedial activities do not contribute to a violation of surface water quality standards.	Applicable to all alternative actions which have the potential to discharge to the stormwater system.
(Clean Water Act - EPA Administered Programs)	122.41(d)	Applicable	Requires all reasonable steps be taken to minimize or prevent discharges which have a reasonable likelihood of causing adverse impacts on surface water quality.	Applicable to all alternative actions.
	122.41(e)	Applicable	Requires proper operation and maintenance of treatment and control systems and equipment.	Applicable to all alternative actions. However, the permitting requirements of this section are not an ARAR.
	122.44(d)	Applicable	Requires that discharges to surface water must achieve federal and state water quality standards.	Applicable to all alternative actions which have the potential to discharge to surface water.

Title 40 CFR Part 144	All Sections	Applicable	Establishes that the injection of fluids into subsurface through wells cannot violate primary MCLs, must be maintained and monitored.	Applicable to actions where reinjection to potential drinking water source occurs. Requires injected fluids be at or below MCLs.
(Safe Drinking Water Act)				

40 USC (National Primary Drinking Water Standards)	300	Relevant and Appropriate	Establishes heath based standards for public water systems [maximum contaminant levels (MCLs)].	Relevant and appropriate to remediation of groundwater and surface water where such waters are a potential a drinking water source. Included are groundwaters classified as Class II aquifers.
Title 40 CFR Part 141	141.11	Relevant and Appropriate	Establishes the federal allowable maximum contaminant levels (MCLs) for arsenic in community water systems and nitrates in non-community water systems.	
	141.12	Relevant and Appropriate	Establishes federal maximum contaminant levels (MCLs) for trihalomethanes.	
	141.13	Relevant and Appropriate	Establishes federal turbidity requirements for both community and non-community water systems.	
	141.50	Relevant and Appropriate	Establishes maximum contaminant level goals (MCLGs) for various organic contaminants.	
	141.51	Relevant and Appropriate	Establishes MCLGs for inorganic contaminants	
	141.61	Relevant and Appropriate	Establishes MCLs for organic contaminants. Requires the best technology, treatment technique, or other means available for achieving compliance of MCLs contaminants.	
	141.62	Relevant and Appropriate	Establishes MCLs for inorganic contaminants. Requires the best technology, treatment technique, or other means available for achieving compliance of MCLs for identified contaminants, except flouride.	

40 CFR Part 230 (Clean Water Act - Disposal of Dredged or Fill Material)	230.10	Applicable	Prohibits discharge of dredged or fill material into waters or wetlands without a permit. Establishes limitations on such discharges.	Applicable to sites where wetlands and vernal pools are located. Permitting requirements are not a requirement at a CERCLA site and are not ARARs.
	230.71	Applicable	Places limitations/requirements on the disposal and treatment of the dredged or fill material discharged.	
	230.72	Applicable	Establishes requirements and methods for the control of the effects of dredged or fill material after discharge, through use of levees, caps, lined containment areas, timing and placement.	
	230.73	Applicable	Establishes requirements for minimizing discharge effects by use of specific dispersement methods.	
	230.74	Applicable	Requires use of available technology, adapted to the particular site, to minimize the adverse effects of dredge and fill discharges.	
	230.75	Applicable	Requires minimization of adverse effects on populations of plants and animals caused by the discharge of dredge or fill materials.	
	230.76	Applicable	Requires use of fill or dredge material discharge methods which minimize the adverse effects on human use potential.	

Title 40 CFR Part 258 (RCRA and Clean Water Act - Municipal Landfill Requirements)	258.10	Relevant and Appropriate	MSWLF units within 10,000 feet of a runway used by turbojet aircraft must be designed & operated so the unit does not pose a bird hazard to the aircraft.	Relevant and appropriate to all consolidation landfill sites or other landfill site where remediation activities will result in the uncovering of inactive landfills.
	258.21	Relevant and Appropriate	Requires MSWLFs to be covered with 6 inches of earthen material at the end of the day or more frequently if necessary.	
	258.22	Relevant and Appropriate	Requires that rodents, flies, mosquitoes, and animals capable of transmitting diseases to humans must be prevented or populations controlled at all times.	
	258.23	Relevant and Appropriate	Requires monitoring and control of, and sets concentration limits for methane at landfills sites.	
	258.25	Relevant and Appropriate	Requires natural or artificial barriers be used to prevent unauthorized vehicle traffic, illegal dumping, and public access to all MSWLFs.	
	258.26	Relevant and Appropriate	Requires run-on and run-off system to be designed to handle the potential flow from a 24-hour, 25-year storm.	
	258.51	Relevant and Appropriate	Requires installation of groundwater monitoring systems (GMS) that characterize the upper aquifer.	
	258.60	Relevant and Appropriate	Establishes final cover requirements for all MSWLF.	
	258.61	Relevant and Appropriate	Establishes federal post-closure care requirements for MSWLF.	

START
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ATTACHMENT A

Estimation of TCE and VOC Removal Rates With Time

Attached is a graph showing estimated TCE concentrations and removal rates as a function of time for the soil vapor extraction (SVE) systems at sites IC1 and IC7 at McClellan AFB. The curve shown was estimated based on the maximum concentration reported during testing at Site IC1, and the concentrations versus time data from Site S at McAFB. A primary assumption in this analysis is that TCE/VOC concentrations at IC1 and IC7 will decrease at the same rate as was measured at Site S. Sampling at IC1 and IC7 will be conducted to fully assess the accuracy of that assumption. The Site S data provides a basis for estimating the rate of change in TCE/VOC concentrations. Further details are presented below.

Basis

Normalized TCE concentration data from Site S are plotted on the figure. The data were normalized to Sites IC1 and IC7 by multiplying the actual Site S concentration data by the ratio of the maximum TCE concentration at Site IC1 (1,300 ppmv) to the maximum TCE concentration at Site S (1,650 ppmv). The actual Site S data, normalized data, and other data used for this evaluation are presented in the attached table. Site S data were estimated from a graph provided to URS by CH2M Hill.

The data beginning from the highest concentration at Site S were used to create a best-fit exponential curve. The highest concentration was 1,650 ppmv (normalized to 1,300 ppmv on the figure) at a time of 650 hrs after startup (3.9 weeks). From time zero (t=0) until the start of the exponential curve, the concentration at IC1/IC7 is assumed to be constant at the high concentration, and the curve is therefore flat.

The best-fit curve is drawn on the figure and extended to approximately 60 weeks time. The curve has the form:

$$C = Ae^{-Bt}$$

where,
C = TCE concentration (ppmv)
A = constant (ppmv) (represents y-axis intercept)
B = rate constant (hr^{-1})
t = time (hr)

This equation is linearized by taking the natural log of both sides, as follows:

$$Ln(C) = Ln(A) - (Bt)$$

Using the normalized data from Site S, plotting Ln(C) vs t, and performing linear regression analysis, the constants become:

A = 1,719 ppmv (or 27.6 lb/hr)
B = 0.00045 hr^{-1}

The linear regression coefficient $r^2 = 0.86309$.

On the Y-axis on the right of the graph, data are represented in terms of the TCE removal rate (lb/hr), assuming an extraction rate of 800 scfm and the TCE concentrations shown by the left-hand Y-axis. 800 scfm is the design flow rate for the SVE systems at sites IC1 and IC7.

Cumulative Mass Removal Calculations

The area under the curve is integrated to determine the total mass of TCE removed. The area under the initial flat section of the curve is calculated as a rectangle. The area under the exponential portion of the curve is calculated as follows:

$$\text{Area (lbs)} = A/B \times [e^{-Bt(0)} - e^{-Bt(1)}]$$

where, $t(0)$ = time at start of curve (650 hr)
$t(1)$ = time at end point (8,736 hr (1 year)).

The total for the first 52 weeks is 59,841 pounds, including 13,830 pounds in the initial 650 hours, and 46,010 pounds under the exponential curve (up until 52 weeks total time). For the entire second year, from t = 8,086 hrs until t = 16,822 hrs, the mass removed would equal 1,217 lbs, or approximately 2 percent of the total mass from the first year.

PCE

The highest PCE concentrations detected during soil gas permeability testing was 1,400 ppmv. By assuming that PCE would follow the same decay pattern as TCE, the mass of PCE extracted over the first year would be 81,316 pounds.

Total VOC Emission Rates

As stated in the Engineering Evaluation/Cost Analysis (EE/CA) documents for sites IC1 and IC7, TCE and PCE contribute the majority of contaminant mass. Therefore, using the analysis and results described above, the total VOC mass extracted from the vadose zone during the first year would be approximately 160,551 pounds. Based on greater than 98 percent emissions control, the total VOC mass emitted would be less than 3,300 pounds for the first year. As noted above, in subsequent years the emission rate would be only a fraction of the emissions during the first year (e.g., only 2% of 1st year emissions during year 2).

In the EE/CAs, the mass of VOCs at site IC1 is estimated at only 3,211 pounds. Therefore, extraction estimates of 160,551 pounds in the first year, as described above, may be a conservatively high estimate. The assumption that TCE and PCE concentrations would decay at the Site S rate could result in too conservative (high) an outcome of the estimate. Furthermore, the emission control systems at Sites IC1 and IC7 will likely perform better than 98% control. Finally, the emission estimates include mass associated with 13 VOCs that were not detected during soil gas sampling. Half the detection limit for each of these 13 VOCs (See Table 9 of Exhibit A) were included in the estimates of mass extracted. Therefore, the extraction and emission estimates provided herein should be considered conservative, and could potentially be significant overestimates.

YEAR 2 EMITTED

$$Q_{EM1} = (Q_{EX1})(1 - D.R.E.)$$

$$= (59{,}837 \text{ lbs})(0.02)$$

$$Q_{EM1} = \underline{1197 \text{ lbs}}$$

YEAR 2 EXTRACTED

$$Q_{EX2} = \frac{(21.266 \text{ lb/hr})}{(0.00045 \text{ hr}^{-1})}\left(e^{-(0.00045)(8086)} - e^{-(0.00045 \text{ hr}^{-1})(16{,}822 \text{ hr})}\right)$$

$$= 47{,}257 \quad (0.0262 - 0.000515.)$$

$$Q_{EX2} = \underline{1214 \text{ lbs}}$$ (Table 9 indicates 1217 lbs due to truncation).

YEAR 2 EMITTED

$$Q_{EM2} = (Q_{EX2})(1 - D.R.E.)$$

$$= (1214 \text{ lbs})(0.02)$$

$$Q_{EM2} = \underline{24.3 \text{ lb}}$$

URS	PROJECT		JOB NO.
	SUBJECT		DATE
URS CONSULTANTS A PROFESSIONAL SERVICES ORGANIZATION	BY	CHECKED	SHEET NO.

EMISSION REDUCTION CREDIT ALLOCATION

TOTAL ESTIMATED VOC EMISSIONS ANNUALLY (FROM TABLE 9)
= 3,211 lbs

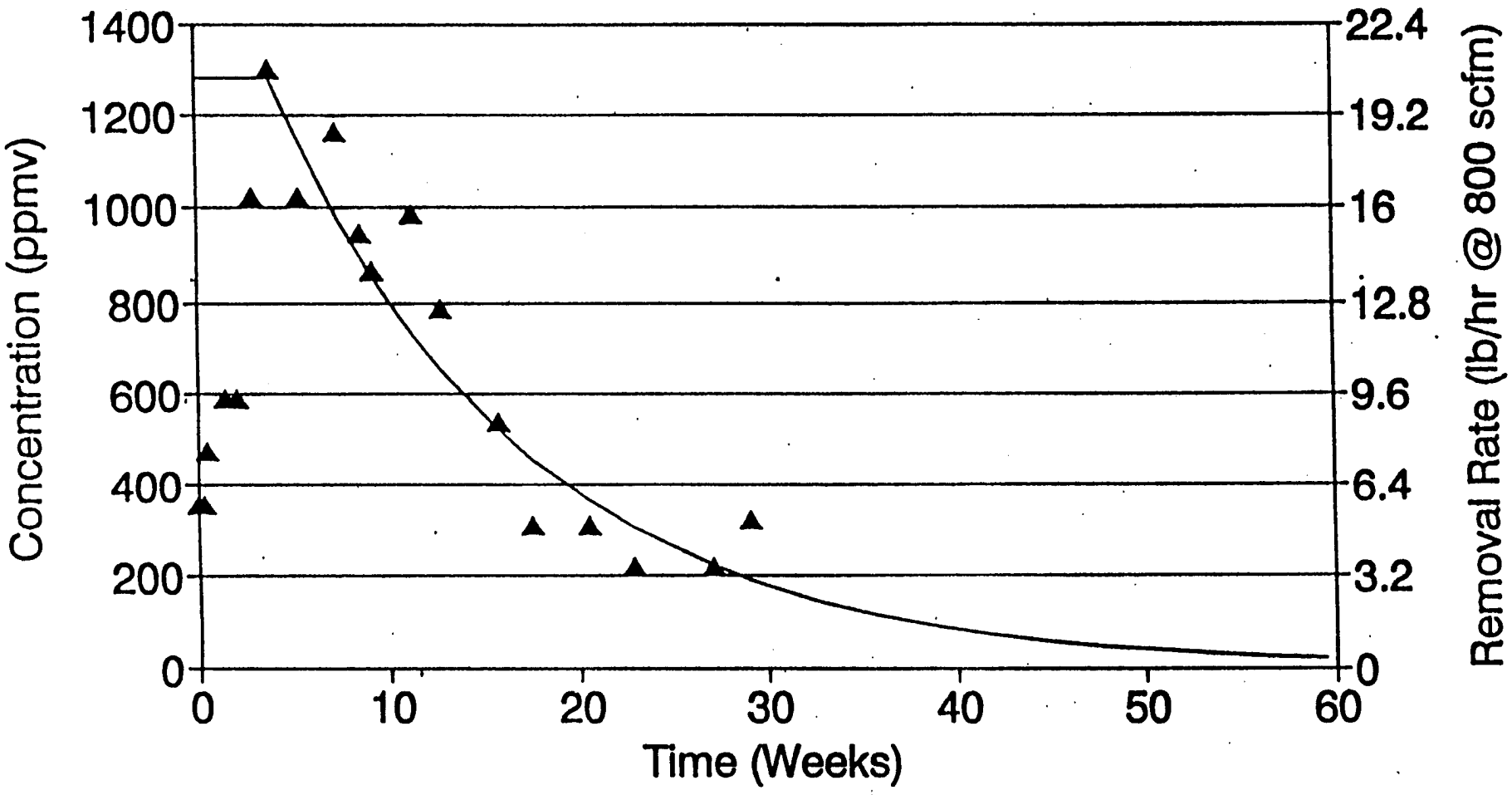
ERCs REQUIRED QUARTERLY

= 803 lbs/QUARTER
OR
= 0.40 TONS/QUARTER

URS	PROJECT	JOB NO.
	SUBJECT	DATE
URS CONSULTANTS A PROFESSIONAL SERVICES ORGANIZATION	BY CHECKED	SHEET NO.

ESTIMATED TCE CONCENTRATIONS

McClellan AFB, Site IC1 and IC7



▲ Site S (Normalized) —— Estimate @ IC1/IC7

SAMPLE CALCULATION FOR TCE

GOVERNING EQUATION FOR MASS EXTRACTED

$$Q = (A/B)\left(e^{-Bt(1)} - e^{-Bt(e)}\right) + A\left(t(e) - t(0)\right)$$

WHERE Q = MASS REMOVED (lbs)

A = INITIAL REMOVAL RATE (lbs/HR)

B = DECAY CONSTANT ($0.00045\ HR^{-1}$)

$t(0)$ = START-UP TIME (0 HR)

$t(e)$ = START OF EXPONENTIAL DECAY (~650 HR)

$t(1)$ = AFTER 1 YEAR OPERATION (8086 HR)

$t(2)$ = AFTER 2 YEARS OPERATION (16822 HR)

ESTIMATE INITIAL REMOVAL RATE FOR TCE FROM INITIAL CONCENTRATION

$$A = \frac{PV}{RT}(MW)$$

A = INITIAL REMOVAL RATE (lbs/HR)

P = INITIAL CONCENTRATION (PPMV × 10^{-6} ATM)

V = VOLUME (800 ft^3/MIN)

R = GAS CONSTANT ($0.7302\ \frac{ATM\ ft^3}{lbmol\ °R}$)

T = TEMPERATURE (460 °R + 68 °F = 528 °R)

MW = MOLECULAR WEIGHT (131.4 lb/lbmol FOR TCE)

SO

$$A = \frac{(11{,}300\ PPMV \times 10^{-6}\ ATM)(800\ ft^3/MIN)(60\ MIN/HR)(131.4\ lb/lb}{(0.7302\ \frac{ATM\ ft^3}{lbmol\ °R})(528\ °R)}$$

$$A = \underline{21.266\ lb/HR}$$

YEAR 1 EXTRACTED

$$Q_{EX1} = \frac{(21.266\ lb/HR)}{(0.00045\ HR^{-1})}\left(e^{-(0.00045\ HR^{-1})(0\ HR)} - e^{-(0.00045\ HR^{-1})[8086\ +}\right) + (21.266\ lbs/HR)(650$$

$$= 47{,}257(0.9737) + 13823\ lb$$

$$Q_{EX1} = \underline{59{,}837\ lbs}$$

TABLE 9 SHOWS 59,641 WHICH IS DUE TO ROUNDING ERROR IN TWO SIGNIFICANT DIGITS IN THE SPREADSHEET CALCULATIONS.

URS CONSULTANTS — A PROFESSIONAL SERVICES ORGANIZATION	PROJECT		JOB NO.
	SUBJECT		DATE
	BY	CHECKED	SHEET NO.

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

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AR CATEGORY ___ ___ . ___ ___

Originals Maintained at McClellan AFB EM

APPENDIX J

PCO COST INFORMATION

2.0 PROPOSED BUDGET

ITEM	MATRIX PERSONNEL REQUIRED	TOTAL HOURS	HOURLY RATE	SUBTOTAL	TOTAL
A. Pre-engineering of system with consultation of URS staff	1 Engineer 1 Technician 1 Manager of Fabrication	60 45 40	$65.00 $35.00 $45.00	$3,900 $1,570 $1,800	$7,275
B. Final design and production drawings/specifications of system	1 Engineer 1 Technician 1 Manager of Fabrication	40 20 30	$65.00 $35.00 $45.00	$2,600 $700 $1,350	$4,650
C. Testing/break-in of system at Matrix	1 Engineer 1 Technician 1 Manager of Fabrication	40 80 20	$65.00 $35.00 $45.00	$2,600 $2,800 $900	$6,300
D. Shipment of system to McClellan	—	--	—	—	$4,500
E. Setup of system for use at McClellan	1 Engineer 1 Technician 1 Project Manager	40 40 40	$65.00 $35.00 $75.00	$2,600 $1,400 $3,000	$7,000
F. Rental fee for 2 units at McClellan	10 weeks (includes setup/take down & shipping time): 10 weeks x 2 units x $2000/week/unit	--	—	—	$40,000
G. Two weeks of ongoing testing at McClellan	1 Engineer 1 Technician 1 Project Manager	100 100 100	$65.00 $35.00 $75.00	$6,500 $3,500 $7,500	$17,500
H. Living expenses for staff for two weeks	21 days/person @ $150/day	--	—	—	$9,450
I. Air travel to/from McClellan for staff	4 round trip flights @ $850/flight	--	—	—	$3,400
J. Gases/enhancing agents	—	--	—	—	$5,500
K. Ozone generator rental	3 month (minimum charge) @ $200/month	--	—	—	$6,000
L. Demobilization	1 Technician	40	$35.00	$1,400	$1,400
M. Shipment of system back to Matrix	—	--	—	—	$4,500
N. Engineering assistance/Report review	1 Engineer	25	$65.00	$1,625	$1,625
				TOTAL	$119,100

CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO. SC-95-F-0443

FORM APPROVED OMB NO. 9000-0013

NOTE: This form is used in contract actions if submission of cost or pricing data is required. (See FAR 15.804-6(b))

2. NAME AND ADDRESS OF OFFEROR (Include ZIP Code)
Matrix Photocatalytic Inc.
22 Pegler Street
London, Ontario
Canada N5Z 2B5

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT
Robert B. Henderson
President

3B. TELEPHONE NO. (519)660-8669

4. TYPE OF CONTRACT ACTION (Check)

- [X] A. NEW CONTRACT
- [ ] B. CHANGE ORDER
- [ ] C. PRICE REVISION/ REDETERMINATION
- [ ] D. LETTER CONTRACT
- [ ] E. UNPRICED ORDER
- [ ] F. OTHER (Specify)

5. TYPE OF CONTRACT (Check)
[X] FFP [ ] CPFF [ ] CPIF [ ] CPAF
[ ] FPI [ ] OTHER (Specify)

6. PROPOSED COST (A+B=C)

A. COST	B. PROFIT/FEE	C. TOTAL
$89,207	$29,893	$119,100

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE
McClellan AFB
October 1, 1995 to November 30, 1995

8. List and reference the identification, quantity and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. (Continue on reverse, and then on plain paper, if necessary. Use same headings.)

A. LINE ITEM NO.	B. IDENTIFICATION	C. QUANTITY	D. TOTAL PRICE	E. REF.
1	Planning/Management	375 hr	18,225	A,B,C
2	Mobilization/Demobilization	40 hr	10,400	D,L,M
3	Start-up/2 weeks & field service		88,850	E-K
4	Engineering Assistance/Report Rev	25 hr	1,625	N
5	Field Service in excess of 2 week	80 hr	2,800	

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING (If available)

A. CONTRACT ADMINISTRATION OFFICE
N/A

B. AUDIT OFFICE
N/A

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? (If "Yes," identify)
Worksite, SVE well, utilities scrubber
[X] YES [ ] NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? (If "Yes," complete Item 11B)
[X] YES [ ] NO

11B. TYPE OF FINANCING (If one)
[ ] ADVANCE PAYMENTS [X] PROGRESS PAYMENTS
[ ] GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? (If "Yes," identify item(s), customer(s) and contract number(s))
[ ] YES [X] NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31 COST PRINCIPLES? (If "No," explain)
[X] YES [ ] NO

14. COST ACCOUNTING STANDARDS BOARD (CASB) DATA (Public Law 91-379 as amended and FAR PART 30)

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? (If "No," explain in proposal)
[ ] YES [X] NO Canadian Company

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT (CASB DS-1 or 2)? (If "Yes," specify in proposal the office to which submitted and if determined to be adequate)
[ ] YES [X] NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NON-COMPLIANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)
[ ] YES [X] NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)
[ ] YES [X] NO

This proposal is submitted in response to the RFP, contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date and conforms with the instructions in FAR 15.804-6(b) (2), Table 15-2. By submitting this proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

15. NAME AND TITLE (Type)
Robert B. Henderson
President

16. NAME OF FIRM
Matrix Photocatalytic Inc.

17. SIGNATURE
RB Henderson

18. DATE OF SUBMISSION
August 3, 1995

NSN 7540-01-142-9845 1411-102 STANDARD FORM 1411 (REV. 7-87) Prescribed by GSA FAR (48 CFR) 53.215-2(c)

RAGE INC.
A SUBSIDIARY OF GLOBAL ENVIRONMENTAL CORP.

March 20, 1997

Matrix Photo Catalytic
22 Degler Street
London, Ontario
Canada N5Z 2B5

Attention: Doug Garside

Reference: HCl Removal System
Our Ref. #P97105

Dear Mr. Garside:

As per our telephone conversation, we are pleased to quote on a gas absorption scrubber for the following operating conditions:

Application	Photo Catalytic Process
Gas Volume	250 ACFM
Hcl Content	2000 - 100 PPM

RECOMMENDED EQUIPMENT

Item 1 One (1) Rage Gas absorption scrubber size 100 constructed of Fiberglass as per the attached drawing. The unit will be equipped with a packed section, demister and recycle tank mounted on a steel skid. The unit will also be equipped with the following:

1. Recycle pump
2. Caustic tank approximately 25 gallons
3. pH controller
4. Automatic valve for caustic injection
5. Float control valve

The unit will be shipped in components and erected on site by others.

The total FOB Fabrication Shop price is . . . $9,876.00

Delivery could be made in 8-10 weeks after drawing approval.

Terms of payment are as follows:

50% with purchase order
50% upon receipt of equipment

P.O. Box 1300 • Bedminster Industrial Park
Unit 1, Apple Tree Lane • Plumsteadville, PA 18949
215-766-7700 • Fax (215) 766-0205

OPERATING CONDITIONS

Recycle Liquid Required	10 GPM @ 15 PSIG
Recycle Liquid pH	8-10
Caustic Required	0.5 per day
Bleed Off Required	0.5 GPM
Make Up Liquid Required	0.5 - 1 GPM
Scrubber Pressure Drop	4" Wg.

The unit will remove 99.9% of Hcl providing the proper liquid rate and pH is maintained.

We trust the above information is adequate for your review. Should you have any further questions, please feel free to contact me.

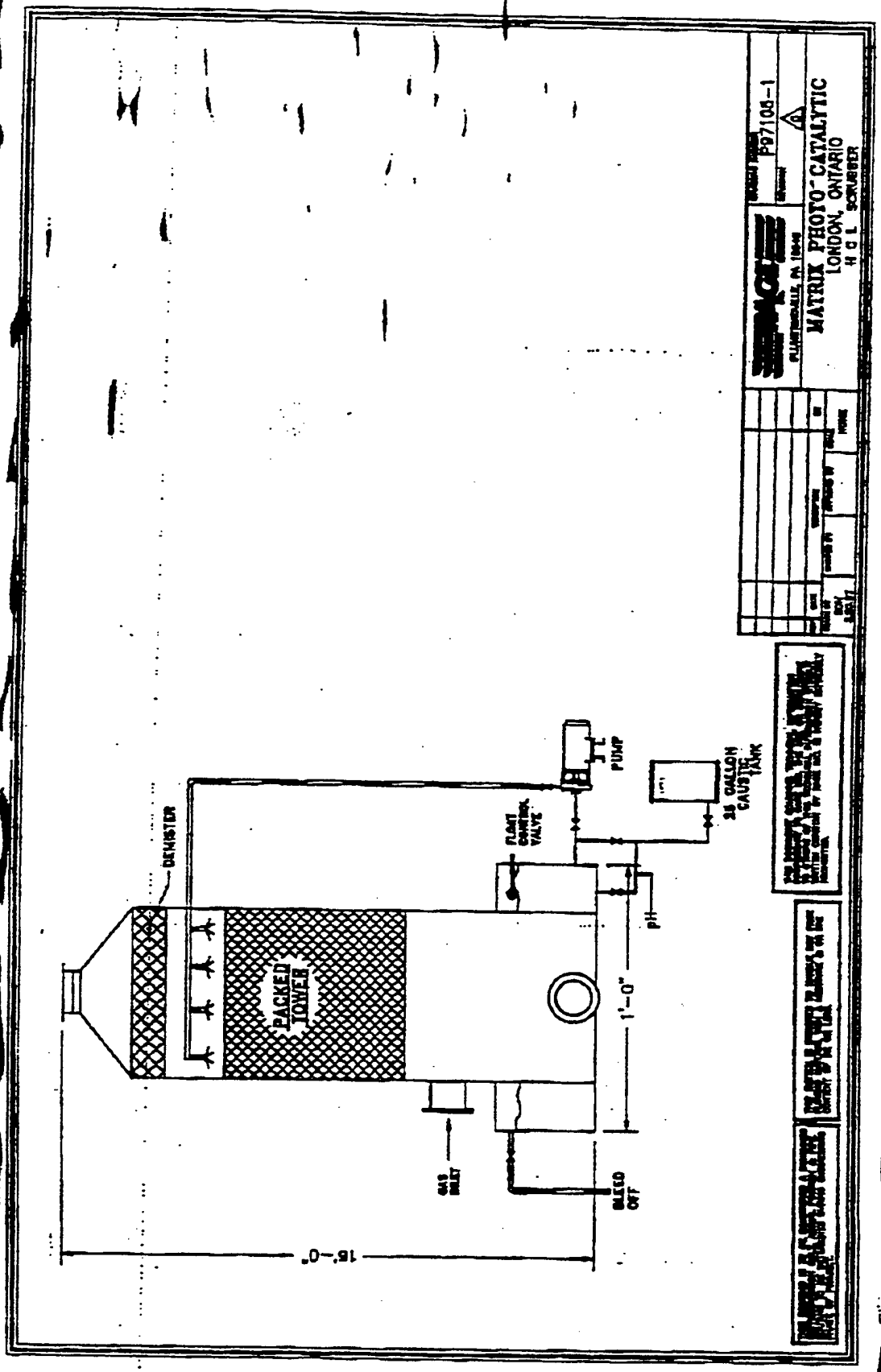
Very truly yours,

BAGE INC.

William V. Rice

WVR:pg

Encl.


P97105-1
MATRIX PHOTO-CATALYTIC
LONDON, ONTARIO
H C L SCRUBBER
DEMISTER
PACKED TOWER
FLOAT CONTROL VALVE
PUMP
25 GALLON CAUSTIC TANK
pH
1'-0"
GAS INLET
BLEED OFF
16'-0"

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

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Originals Maintained at McClellan AFB EM

APPENDIX K

GAC COST INFORMATION

U.S. Filter/Westates
6611 San Leandro Street
Oakland, CA 94621
Tel. (800) 659-1718
Fax (510) 639-7762

OFFICE COPY **OFFICE COPY**

CUSTOMER: Marcus Taylor
URS Greiner

Vapor Isotherm report created on 07/17/97 at 11:10 by Ryan.

VAPOR PHASE ISOTHERM DESIGN PARAMETERS

System Temperature	100.00000 °F
Air Flow Rate	250.00000 SCFM
System Pressure	14.70000 psi
Relative Humidity	50.0000 %

VAPOR PHASE DESIGN

Component Name	Concentration	Q [Wt %]	#GAC/day at Saturation
ETHENE,TRICHLORO- (TCE)	100.0000 ppmv	20.3475	56.8420

Total Carbon Usage Estimated at Breakthrough
99.4736 #GAC/day

(Total has been multiplied by a factor of 1.75)

* Modelling indicates a GAC requirement for 56 lbs/day: you may want to consider using 68 lbs/day as a design basis.

* Equipment: Recommend two to three VSC-2000's in series. Based on model estimate breakthrough is $\frac{1800}{68} = 26$ days.

Costs - VSC-2000 - $4,900/unit

Service Costs - $2,500/unit per changeout service; within 200 miles of Oakland, CA.

* indicates that Relative Humidity was calculated
– indicates that Relative Humidity was approximated

The above carbon usage estimates are based on both experimental data as well as predictive models. Actual carbon usage rates observed at various stages of breakthrough depend on many factors, and may therefore differ from the above estimates. Please contact Westates Carbon Products for further assisitance.

U.S. Filter/Westates
6611 San Leandro Street
Oakland, CA 94621
Tel. (800) 659-1718
Fax (510) 639-7762

OFFICE COPY **OFFICE COPY**

CUSTOMER: Marcus Taylor
URS Greiner

Vapor Isotherm report created on 07/17/97 at 11:10 by Ryan.

VAPOR PHASE ISOTHERM DESIGN PARAMETERS

System Temperature	100.00000 °F
Air Flow Rate	250.00000 SCFM
System Pressure	14.70000 psi
Relative Humidity	50.0000 %

VAPOR PHASE DESIGN

Component Name	Concentration	Q [Wt %]	#GAC/day at Saturation
ETHENE,TRICHLORO- (TCE)	500.0000 ppmv	29.9336	193.1930

Total Carbon Usage Estimated at Breakthrough
~~338.0878~~ #GAC/day

(Total has been multiplied by a factor of 1.75)

* Modelling indicates a GAC requirement of ~ 193 lbs/day; you may want to consider using 230 lbs/day on a design basis.

* Equipment - Recommend two VSC-8000's in series. (8000# GAC each)
Estimated breakthrough is $\frac{8000}{230} = 35$ days.
Costs - VSC-8000 - $25,000/unit
Changeout Service Cost - $9,500/unit; within 200 miles of Oakland, CA.

* Indicates that Relative Humidity was calculated
– indicates that Relative Humidity was approximated

The above carbon usage estimates are based on both experimental data as well as predictive models. Actual carbon usage rates observed at various stages of breakthrough depend on many factors, and may therefore differ from the above estimates. Please contact Westates Carbon Products for further assistance.

U.S. Filter/Westates
6611 San Leandro Street
Oakland, CA 94621
Tel. (800) 659-1718
Fax (510) 639-7762

OFFICE COPY **OFFICE COPY**

CUSTOMER: Marcus Taylor
URS Greiner

Vapor Isotherm report created on 07/17/97 at 11:10 by Ryan.

VAPOR PHASE ISOTHERM DESIGN PARAMETERS

System Temperature	100.00000 °F
Air Flow Rate	250.00000 SCFM
System Pressure	14.70000 psi
Relative Humidity	50.0000 %

VAPOR PHASE DESIGN

Component Name	Concentration	Q (Wt %)	#GAC/day at Saturation
ETHENE,TRICHLORO- (TCE)	2000.0000 ppmv	38.6074	599.1548

Total Carbon Usage Estimated at Breakthrough
~~1048.5208~~ #GAC/day

(Total has been multiplied by a factor of 1.75)

* Modelling indicates a GAC requirement of 600 lbs/day; you may want to consider using 720 lbs/day as a design basis.

* Equipment recommend two RB20 carbon vessels in series each contains approximately 20,000 lbs carbon.

- Estimate breakthrough based on model in 28 days. (20000/720)

Costs - RB20 carbon vessel $55,000 each

Changeout Service Costs - $19,000/event; within 200 miles from Oakland, CA.

* Indicates that Relative Humidity was calculated
– indicates that Relative Humidity was approximated

The above carbon usage estimates are based on both experimental data as well as predictive models. Actual carbon usage rates observed at various stages of breakthrough depend on many factors, and may therefore differ from the above estimates. Please contact Westates Carbon Products for further assistance.

Monthly Project Costs
McClellan AFB, Site IC 1

Time Period	Jun-97
Hours Operated	299
Mass Removed (VOCs by Volatilization/ Extraction) (lb)	32

Item Description	Unit	Unit Cost	Quantity	Extended Cost
Operations/ Maintenance				
Contractor Labor (URSG)				
Operation	LS	$2,500	1	$2,500
Preventative Maintenance	LS	$1,000	1	$1,000
Repairs	LS	$2,000	1	$2,000
Utilities [1]				
Electric	kwh	$0.061	1,953	$119
Water Discharged for Treatment	1000 gallons	$2.23	0	$0
O&M and Replacement Supplies [2]	LS	$600	1	$600
Total Operations/ Maintenance Cost				**$6,219**
Monitoring				
Contractor Labor (URSG)	LS	$4,000	1	$4,000
Analytical				
Mobile Laboratory	LS	$1,292	1	$1,292
TO-14 Analyses	LS	$225	1	$225
Residuals	LS	$1,772	1	$1,772
Stack Testing	LS	$0	1	$0
Total Monitoring Cost				**$7,289**
Data Reduction/ Reporting				
Contractor Labor (URSG)				
Data Analysis	LS	$1,814	1	$1,814
Report Preparation	LS	$1,169	1	$1,169
IRPIMS	LS	$1,156	1	$1,156
Direct Costs	LS	$300	1	$300
Total Data Reduction/ Reporting Cost				**$4,439**

Notes:
1. Utility costs are paid by McAFB. Unit costs are typical estimates
2. O&M supplies include parts, oils, etc.

Monthly Project Costs
McClellan AFB, Site IC 7

Time Period	Jun-97
Hours Operated	647
Mass Removed (VOCs by Volatilization/ Extraction) (lb)	93

Item Description	Unit	Unit Cost	Quantity	Extended Cost
Operations/ Maintenance				
Contractor Labor (URSG)				
Operation	LS	$3,000	1	$3,000
Preventative Maintenance	LS	$1,000	1	$1,000
Repairs	LS	$500	1	$500
Utilities [1]				
Electric	kwh	$0.061	6,533	$399
Water Discharged for Treatment	1000 gallons	$2.23	0	$0
O&M and Replacement Supplies [2]	LS	$500	1	$500
Total Operations/ Maintenance Cost				**$5,399**
Monitoring				
Contractor Labor (URSG)	LS	$2,500	1	$2,500
Analytical				
Mobile Laboratory	LS	$1,107	1	$1,107
TO-14 Analyses	LS	$0	1	$0
Residuals	LS	$1,772	1	$1,772
Stack Testing	LS	$0	1	$0
Total Monitoring Cost				**$5,379**
Data Reduction/ Reporting				
Contractor Labor (URSG)				
Data Analysis	LS	$1,805	1	$1,805
Report Preparation	LS	$1,729	1	$1,729
IRPIMS	LS	$1,500	1	$1,500
Direct Costs	LS	$500	1	$500
Total Data Reduction/ Reporting Cost				**$5,534**

Notes:
1. Utility costs are paid by McAFB. Unit costs are typical estimates
2. O&M supplies include parts, oils, etc.

START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

ANON ENON ACON ECON

AR CATEGORY ___ ___ . ___ ___

Originals Maintained at McClellan AFB EM

APPENDIX L

CATALYTIC OXIDATION COST INFORMATION

Table 3A
OU D Monthly Operations Cost Worksheet

PROJECT COSTS FOR	January 1996	(Month 24)
Total hours in month	744	
Hours of operation	671.5	
Hours non-operation	72.5	
Operational frequency	90%	

DESCRIPTION	UNIT	UNIT COST ($)	QUANTITY	COST
OPERATIONS/MAINTENANCE				
Contractor labor	L.S.			$ 17,256.00
Other Direct Costs	L.S.			$ 1,106.00
Contractor Equipment	L.S.			$ 10,448.00
Utilities				
Electric	kWh	0.06100	55,800	$ 3,403.80
Natural Gas	Therms	0.23300	6,590	$ 1,535.47
Water	Gallons	0.000537	248,000	$ 133.18
Telephone	L.S.			$ 640.00
O & M Supplies				
Caustic (15%)	Gallons	0.35	2,070	$ 724.50
Caustic (10%)	Gallons	0.23	580	$ 133.40
Catalyst	Lbs	4.50	250	$ 1,125.00
Acid	Gallons	2.00	20	$ 40.00
Spare Parts/Other	L.S.			$ 1,208.00
Facility Rental	L.S.			$ 450.00
TOTAL OPERATIONS COSTS				$ 38,203.35
MONITORING				
Contractor Labor				$ 2,418.00
Other Direct Costs	L.S.			$ 226.00
Analytical				
Mobile Lab	Week		0	$ -
TO-12 Analyses	Each	50.00	2	$ 100.00
TO-14 Analyses	Each	250.00	2	$ 500.00
8010/8020 Analysis	Each	150.00	44	$ 6,600.00
Other Analyses	L.S.			$ 190.00
Stack Testing	L.S.			-
TOTAL MONITORING COSTS				$ 10,034.00
DATA REDUCTION/REPORTING				
Contractor Labor	L.S.			$ 1,138.00
Other Direct Costs	L.S.			$ 90.00
TOTAL REPORTING COSTS				$ 1,228.00
TOTAL MONTHLY COSTS				$ 49,465.35
Contaminants Removed (lbs)				5150
Monthly Cost/lb (approx.)				$ 9.60

Note: refer to Monthly Cost Breakdown Summary and Table 4 for cost discussion.

Table 3B
OU D Monthly Operations Cost Worksheet

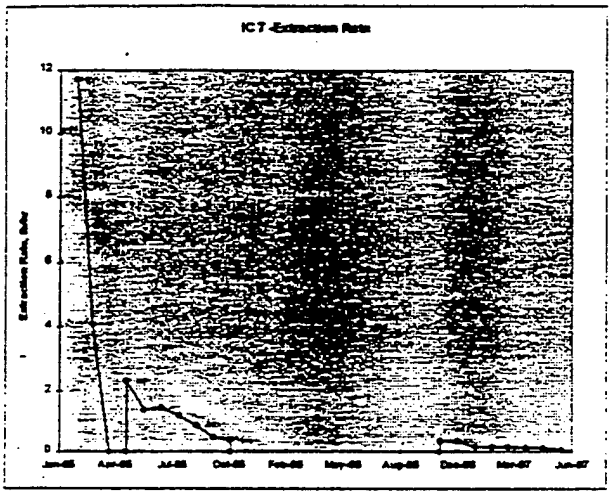
PROJECT COSTS FOR	February 1996	(Month 25)
Total hours in month	696	
Hours of operation	483	
Hours non-operation	213	
Operational frequency	69%	

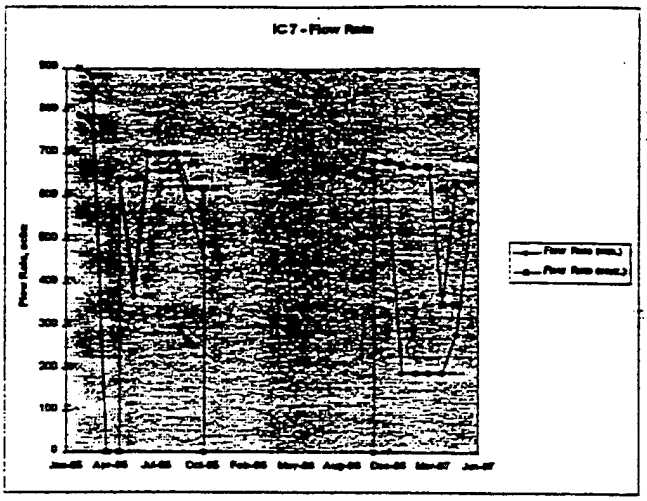
DESCRIPTION	UNIT	UNIT COST ($)	QUANTITY	COST
OPERATIONS/MAINTENANCE				
Contractor labor	L.S.			$ 17,233.00
Other Direct Costs	L.S.			$ 478.00
Contractor Equipment	L.S.			$ 11,897.00
Utilities				
Electric	kWh	0.06100	38,160	$ 2,327.76
Natural Gas	Therms	0.23300	8,050	$ 1,875.65
Water	Gallons	0.000537	449,125	$ 241.18
Telephone	L.S.			$ 400.00
O & M Supplies				
Caustic (10%)	Gallons	0.23	2,880	$ 662.40
Catalyst	Lbs	4.50	0	$ -
Acid	Gallons	2.00	30	$ 60.00
Spare Parts/Other	L.S.			$ 1,200.00
Facility Rental	L.S.			$ 450.00
TOTAL OPERATIONS COSTS				$ 36,824.99
MONITORING				
Contractor Labor				$ 601.00
Other Direct Costs	L.S.			$ 478.00
Analytical				
Mobile Lab	Week		0	$ -
TO-12 Analyses	Each	50.00	2	$ 100.00
TO-14 Analyses	Each	250.00	3	$ 750.00
8010/8020 Analysis	Each	150.00	11	$ 1,650.00
Other Analyses	L.S.	190.00	1	$ 190.00
Stack Testing	L.S.		0	$ -
TOTAL MONITORING COSTS				$ 3,769.00
DATA REDUCTION/REPORTING				
Contractor Labor	L.S.			$ 966.00
Other Direct Costs	L.S.			$ 128.00
TOTAL REPORTING COSTS				$ 1,094.00
TOTAL MONTHLY COSTS				$ 41,687.99
Contaminants Removed (lbs)				3224
Monthly Cost/lb (approx.)				$ 12.93

Note: refer to Monthly Cost Breakdown Summary and Table 4 for cost discussion.

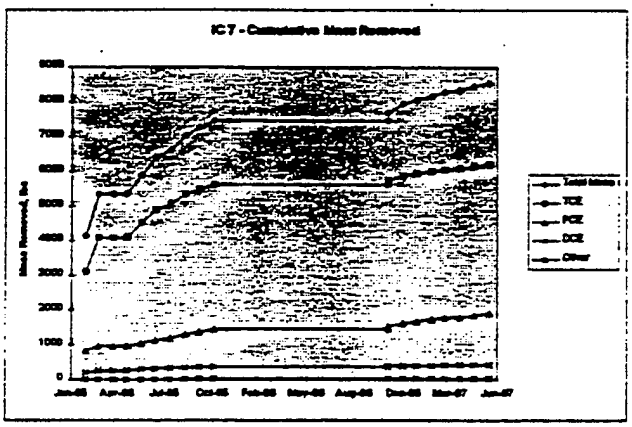
Contaminated Soil Gas Treatment

Key Measured Parameters





Contaminant Removal Effectiveness



Testing of Treated Product

- CatOx destruction and removal efficiency of 95 percent.
- GAC removal efficiency of 96 percent.
- Scrubber acid gas removal efficiency of greater than 99 percent.
- NOx emission rate of 0.079 pounds/hour
- SOx emission rate of <0.008 pounds/hour
- CO emission rate of 0.33 pounds/hour
- Particulate matter emission rate of 0.034 pounds/hour
- Dioxin/furan emission rate of 3.06×10^{-8} pounds/hour

Cost

Capital Costs

SVE with Catalytic Oxidation/Acid Scrubber

Labor	$ 38,300
Subcontractors	315,000
Equipment*	468,800
Total	$822,100

* Includes 1,000 scfm catalytic oxidizer and acid scrubber emission control system

SVE with Granular Activated Carbon

Subcontractors *	$67,400

* Includes all equipment

Operating Costs

Catalytic Oxidation (2/95 through 12/95)

Electricity	$9,400
Natural gas	8,600
Water	2,200
Caustic	1,600
O&M supplies	10,600
Labor	113,700
Monitoring	59,700
Analytical	193,600
Total Operating Cost	$399,400
Total VOC Removed - CatOx	7,460 pounds

Cost Sensitivities

Operating costs may vary as follows:

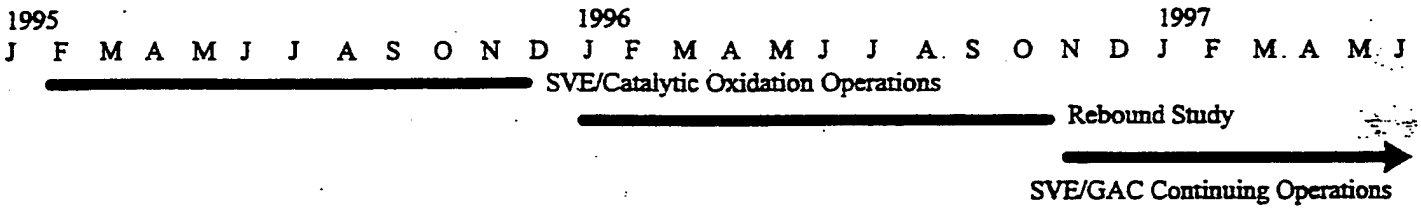
- Cost of natural gas and electricity
- Disposal cost of residual wastes
- Contaminant treatment requirements for air discharge
- Analytical/monitoring and reporting requirements

Granular Activated Carbon (11/96 through 6/97)	
Electricity	$ 3,100
O&M supplies	7,100
Labor	41,300
Monitoring	26,700
Analytical	42,900
Total Operating Cost	$121,100
Total VOC Removed - GAC	1,077 pounds

REGULATORY/INSTITUTIONAL ISSUES

- SVE was the cleanup technology selected for VOC hot spot removal. While the SVE technology deals with the removal of the contaminants from the soil, it does not address treating the contaminants prior to discharge to the atmosphere. Catalytic oxidation and vapor phase granular activated carbon (GAC) were utilized to destroy/remove the recovered contaminants from the air stream.
- Treatment was necessary to meet regulatory air discharge requirements.
- SVE is performed in-situ, which is less costly and obtrusive than conventional methods such as excavation. It also reduces the risk of exposure to contaminants for workers.

SCHEDULE



LESSONS LEARNED

Key Operating Parameters

- Soil vapor extraction is an effective remedial technology for sites contaminated with halogenated organics with contamination up to 100 feet below ground surface and permeability greater than 6.9×10^{-12} centimeters squared.
- SVE can be effectively used in conjunction with other remedial technologies to provide remediation of vadose zone, capillary fringe, and groundwater in concert.
- Catalytic oxidation is a cost-effective emission control approach for VOC concentrations in excess of 100 ppmv; however, cost effectiveness is reduced at concentrations below 50 ppmv at which point transition to granular activated carbon should be made.
- Catalytic oxidation has potential for generation of dioxins/furans. However, all results indicate emission levels are well below guidelines.
- Hardness of makeup water along with salts formed by the neutralization of acid gases contributes to scaling of scrubber packing and injection nozzles. Periodic acid flushing (pH 5.5 to 6) of the packing may be required to remove scale build-up.
- Optimal granular activated carbon adsorption capacity is achieved at vapor stream temperatures below 120 degrees Fahrenheit and relative humidities below 50 percent.

Cost

Capital Costs

SVE WITH:

Catalytic Oxidation/Acid Scrubber

Labor	$ 35,700
Subcontractors	460,000
Equipment*	532,400
Total	$1,028,100

* Includes 1,000 scfm catalytic oxidizer and scrubber emission control system

Granular Activated Carbon

Subcontractors *	$47,000

* Includes all equipment.

Cost Sensitivities

Operating costs may vary as follows:

- Cost of natural gas and electricity
- Disposal cost of residual wastes
- Contaminant treatment requirements for air discharge
- Analytical/monitoring and reporting requirements

Operating Costs

Catalytic Oxidation (3/95 through 11/95)

Electricity	$7,000
Natural gas	9,000
Water	2,000
Caustic	1,200
O&M supplies	12,700
Labor	72,000
Monitoring	55,000
Analytical	218,000
Total Operating Cost	$376,900

Total VOCs removed by CatOx - 4,105 pounds

Granular Activated Carbon (9/96 through 6/97)

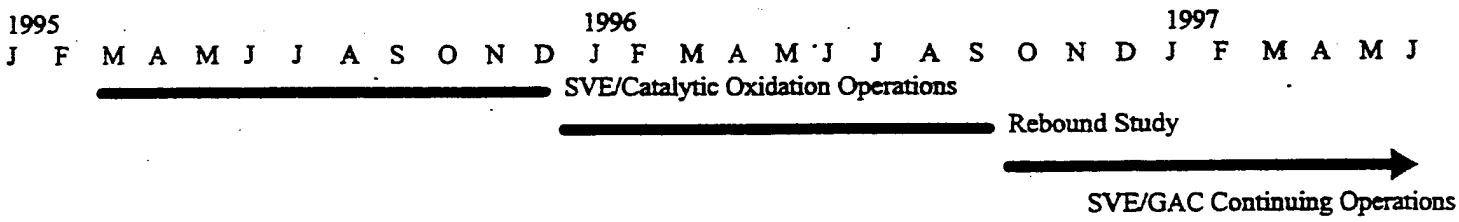
Electricity	$23,400
O&M supplies	10,200
Labor	46,800
Monitoring	50,500
Analytical	59,600
Total Operating Cost	$170,500

Total VOCs removed by GAC - 1,306 pounds

REGULATORY/INSTITUTIONAL ISSUES

- SVE was the cleanup technology selected for VOC hot spot removal. While the SVE technology deals with the removal of the contaminants from the soil, it does not address treating the contaminants prior to discharge to the atmosphere. Catalytic oxidation and vapor phase granular activated carbon (GAC) were utilized to destroy/remove the recovered contaminants from the air stream.
- Treatment was necessary to meet regulatory air discharge requirements.
- SVE is performed in-situ, which is less costly and obtrusive than conventional methods such as excavation. It also reduces the risk of exposure to contaminants for workers.

SCHEDULE



START
NEW DOCUMENT

TRACKING #: _____

SECURITY CLASS (circle):

ANON ENON ACON ECON

AR CATEGORY ___ ___ . ___ ___

Originals Maintained at McClellan AFB EM

APPENDIX M

DEMONSTRATION COST INFORMATION

Table 1
Demonstration Costs the for PCO Unit

Vendor Cost		URSG Demonstration Cost	
PCO Unit (Installed)	$136,756	Management and Planning	$9,500
Catalyst replacement[1]	$4,800	Preparation of Work Implementation Plan	$30,000
		Equipment Installation and Testing	60,000
		Analytical	$12,500
		Reporting	40,000
Total	**$141,556**	**Total**	**$152,000**

1 Catalyst replacementwas performed before moving the PCO Unit from IC 29 to OU C1

STATEMENT OF WORK
FOR
PHOTOCATALYTIC OXIDATION PERFORMANCE DEMONSTRATION
19 Dec 95

1.0 GENERAL REQUIREMENTS

1.1 The Contractor shall provide a complete and functional photocatalytic oxidation (PCO) system, including a suitably sized blower, for the destruction of airborne contaminants in the off-gas from a soil vapor extraction (SVE) system during a technology demonstration project to be conducted at McClellan Air Force Base (McAFB) by URS Consultants, Inc. (Engineer). The Contractor shall also provide technical assistance and consultation to the Engineer during the planning, startup, testing and reporting phase of the project. The Engineer will provide required site facilities and construction services, operations labor, utilities, testing and analytical services, and reporting services for the demonstration.

1.2 The PCO system shall be used to treat a split stream from the SVE system at McAFB Site OU C1. The anticipated contaminants and the maximum contaminant concentrations in the vapor phase at Site OU C1 are listed in Table 1. It is expected actual contaminant concentrations during the testing phase will be lower than listed in Table 1 (by 30 to 70 percent). It will be feasible to dilute the influent to the PCO system if there is an upper concentration limit to the PCO process, or if it is desired to test under differing influent concentrations.

2.0 SUBMITTALS

2.1 The Contractor shall submit detailed drawings for the PCO equipment as necessary to allow the Engineer to plan for and complete the installation and operation of the PCO equipment. Contractor shall provide at a minimum:

- Equipment plan and elevation drawings showing all interconnections to other equipment or utilities;
- Electrical one-line and control wiring drawing;
- Process and Instrumentation Diagram;
- Equipment weights;
- Operations and Maintenance Manual, covering:
- Routine startup procedures
- Routine operating procedures and normal operating ranges
- Troubleshooting procedures
- Maintenance procedures

3.0 PCO EQUIPMENT

3.1 The PCO equipment shall have a minimum capacity of 50 scfm under conditions sufficient to try and achieve 98 percent destruction and removal efficiency (DRE) of the total VOCs in the influent. The system shall be capable of a minimum 10:1 turn down to allow testing at different operating flow rates (residence times).

3.2 The contractor shall provide a blower compatible with the provided PCO equipment. The pressure of the split stream routed to the blower will be 6 to 12 inches of mercury vacuum; actual pressure entering the blower can be controlled by a throttling valve at the blower inlet. If the PCO effluent is to be routed through the existing scrubber, the pressure at the PCO outlet will be provided after the contractor provides blower capacity and PCO operation information.

3.3 The system shall be capable of unattended operation (except for startup, monitoring and routine maintenance) in an uncovered outdoor environment, with ambient temperatures ranging from 40°F to 110°F. The process influent temperature will be from 100°F to 160°F, as determined at the discharge from the influent blower provided by the contractor.

3.4 The Contractor shall provide all spare and replacement parts required for the operation of its PCO system for the duration of the test.

3.5 The PCO instrumentation shall include, at a minimum, temperature and pressure indicators at the influent and effluent, flow indicator at the influent, and all necessary controls for safe unattended operation.

3.6 The PCO system control panel shall accept a signal from the SVE system control panel to shut down the PCO system in the event the SVE system is not operating.

3.7 The burden of identifying analytes that may be of concern to the technology (but not shown in Table 1) is with the vendor. The vendor shall also identify in the proposal the concerns for each of the associated analytes.

4.0 INSTALLATION

4.1 Contractor shall be responsible for delivering the PCO equipment to the McAFB site and unloading the equipment at the site. Contractor shall also be responsible for picking up the equipment after the test and transporting it from the site.

4.2 Engineer will install the PCO equipment at the site as follows; in accordance with Contractor's installation instructions. Engineer will provide:

- interconnections to the SVE system (PCO influent and effluent); effluent will be directed through the existing wet scrubber in the SVE system at Site OU C1;
- electrical power to the PCO system's control panel or motor control center;
- Electrical interconnection from the SVE panel to the PCO panel;

4.3 Contractor shall inspect the installation and notify the Engineer of any observed deficiencies in installation.

5.0 TECHNICAL SERVICES AND REPORTING

5.1 The Contractor shall be available at reasonable times to consult with the Engineer over the telephone regarding equipment installation, operation and maintenance of the system, evaluation and interpretation of

monitoring data, operating parameters and set points for testing, and other technical issues for the demonstration.

5.2 A qualified technical representative of the Contractor who is knowledgeable of the design and operating characteristics of the PCO system shall be present on site or available to meet with the Engineer in Sacramento during working hours for a minimum of two weeks during startup and initial testing and operation of the PCO.

5.3 All data and other results from the demonstration project will be available to the Contractor for its own use and interpretation, unless such data are protected by a third-party confidentiality agreement.

5.4 The Contractor shall provide an estimate of the capital costs of the scaled-up system upon completion of the demonstration.

6.0 DEMONSTRATION SCHEDULE

6.1 The treatability testing is scheduled to begin October 1, 1995 and continue for a period of eight weeks and ending November 30, 1995 (assuming a maximum at 20% downtime). This schedule is subject to modification as plans for the demonstration go through client and regulatory review, and as initial data from the demonstration become available.

6.2 The first two weeks of the demonstration will include testing under different operating conditions. Parameters that may be varied include flow rate (residence time), VOC concentrations, UV light intensity, or other parameters. The Contractor will work with the Engineer to optimize the performance of the system.

Table 1

DESIGN MAXIMUM INFLUENT CONCENTRATIONS

Compound	Design Maximum Influent Concentration (ppmv)
Vinyl Chloride	11
1,1-Dichloroethene	6
Methylene Chloride	61
1,1-Dichloroethane	4
cis-1,2-Dichloroethene	260
Chloroform	5
1,1,1-Trichloroethane	8
Benzene	20
1,2-Dichloroethane	120
Trichloroethene	3,000
Toluene	38
Ethyl Benzene	11
m,p-Xylene	37
o-Xylene	13
Styrene	19
1,3,5-Trimethylbenzene	5
1,2,4-Trimethylbenzene	19
1,4-Dichlorobenzene	1
1,2-Dichlorobenzene	5
n-Octane	50
Acetone	140
Cyclohexane	100
Tetrachloroethene (PCE)	100
Total Freons	<5
Total Non-methane Hydrocarbons (includes above compounds)	6,000

September 7, 1995

Mr. Robert Henderson
Matrix Photocatalytic, Inc.
22 Pegler Street
London, Ontario, Canada N5Z 2B5

95-0443
62400.40.20

Subject: **Contract No. SC-95-F-0443**
McClellan AFB SVE Removal Action
Photocatalytic Oxidation Performance Demonstration
Notification of Award/Notice To Proceed

Dear Mr. Henderson:

Congratulations! Your firm has been awarded the enclosed contract in the sum of $119,100. Please consider this your official Notice To Proceed, however, please be advised that our prime contract is incrementally funded and we are still awaiting final approval from the Government for the remainder of the treatability testing activities. Consequently, you are only authorized to incur costs associated with meeting the contract deliverable dates specified in Section F.3 of the contract for submittal of equipment drawings, component specifications, and equipment utility requirements. URS will provide written direction concerning equipment delivery after we receive the final approval from the Government. Please advise us if, at any point, the contract schedule is in jeopardy of being delayed.

Sincerely,

URS CONSULTANTS, INC. - CALIFORNIA

Robert C. Leighton
Program Administrator

Enclosure

cc: SM - Sarabjit Singh
PE - Gary Loeman
PE - Marcus Taylor
Procurement & Chron Files

a. The purpose of this modification is to restructure the contract to reflect changed operating conditions at the demonstration site. The scope of work and pricing structure are changed and a new line item has been established to set up a possible future demonstration of the photocatalytic oxidation unit at another site.

b. Modify PART I - SCHEDULE as follows:

(1) In SECTION B, clause B.2, delete items numbers 1 through 5 and replace them with the following:

Item No.	Description	Price
1	Planning and Management	$18,225
2	First demonstration at McClellan AFB, CA.	
	a. Shipment of trailer to McClellan AFB	$ 4,500
	b. Setup of system	5,600
	c. Two weeks of testing	5,250
	d. Living expenses for staff during testing	4,500
	e. Air travel to/from	2,550
	f. Ozone generator charge	1,500
	TOTAL for item 1	$23,900
3	Second demonstration at McClellan AFB, CA.	
	Phase I - Ship and test	
	a. Two weeks testing	$10,000
	b. Air travel to/from	1,700
	c. Living expenses for staff during testing	4,200
	d. Ozone generator charge	1,500
	e. Blower containment case	600
	Subtotal	$18,000
	Phase II - Return of equipment	
	f. Return shipment of trailer	4,500
	g. Air travel to/from (1 person)	850
	h. Living expenses for technician (2 days)	218
	g. Technician time (2 days)	560
	TOTAL for item 2	$ 6,128
4	Third demonstration at McClellan AFB, CA in Government fiscal year 1996. This demonstration is at the discretion of McClellan AFB personnel but may not occur due to funding or other considerations.	
	a. Shipment of trailer to McClellan AFB	$ 4,500
	b. Setup of system	5,600
	c. Eight weeks of testing	6,175
	d. Living expenses for staff during testing	12,200
	e. Air travel to/from	1,700
	f. Ozone generator charge	6,000
	g. Return shipment of trailer	4,500
	h. Air travel to/from (1 person)	850
	i. Living expenses for technician (2 days)	218
	j. Technician time (2 days)	560
	TOTAL for item 1	$42,303
5	Field Services at $35.00/per hour for an estimated 80 hours.	
	TOTAL (Excluding Line Item No. 5)	$108,556
6	Performance incentive	$ 10,544

TOTAL PRICE $119,100

(2) In SECTION F, clause F.2, delete paragraph "c)" in its entirety.

(3) In SECTION H, add the following new clause:

H.22 PERFORMANCE INCENTIVE

(a) URS desires to prove the feasibility of using the photocatalytic oxidation technology to increase the destruction and removal efficiency (DRE) of the soil vapor extraction systems installed by URS at McClellan AFB, CA. In pursuit of that goal, URS will provide the Contractor performance incentive pay up to the maximum of $10,544 for attaining DRE performance according to the following ground rules.

(1) The vapor stream will be sampled by URS and analyzed by a URS-contracted laboratory.

(2) The SW 8021 analytical results will be used to calculate a DRE percentage.

(3) The average of the DREs obtained during the operational period will be cumulated into a single average DRE for the six week operational period.

(4) No performance incentive will be paid for cumulative DRE below 75%.

(5) Performance incentive pay will be calculated on a straight line basis from 75% to 95%.

(3) From PART III - LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS, delete the Attachment A Statement of work and replace it with the new Attachment A Scope of Work.