STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 ACCEPTANCE OF SERVICE

I, Eric S. Merrifield, hereby accept service of the Summons and Complaint in the above-captioned case on behalf of Defendant, General Electric Company. This Acceptance of Service shall have the same force and effect as if personally served upon General Electric Company.

DATED this 11th day of April, 2014.

GENERAL ELECTRIC COMPANY

ERIC S. MERRIFIELD, WSBA #32949
Attorney for Defendant
General Electric Company
(518) 862-2708

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

CONFIRMATION RECEIPT

Case Number:	14-2-09134-6 SEA
Case Title:	WASHINGTON STATE OF ECOLOGY VS GENERAL ELECTRIC CO
Submitted By:	Andrew Fitz
Bar Number:	22169
User ID:	[redacted]
Submitted Date/Time:	4/17/2014 10:43:30 AM
Received Date/Time:	4/17/2014 10:43:30 AM
Total Cost:	$0.00

DOCUMENTS

Document Type:	OTHER (DO NOT FILE UNSIGNED ORDERS) RE ADDENDUM TO EX. B OF CONSENT DECREE
File Name:	AddendumToCDExB_Part1.pdf
Attachment(s):	AddendumToCDExB_Part2.pdf
	AddendumToCDExB_Part3.pdf
	AddendumToCDExB_Part4.pdf
Cost:	$0.00

Document Type:	RETURN OF SERVICE
File Name:	AcceptanceOfSrvc04-11-14.pdf
Cost:	$0.00

Printed On: 4/17/2014 10:43:56 AM

FILED
KING COUNTY, WASHINGTON

MAR 31 2014

SUPERIOR COURT CLERK

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 ORDER ENTERING CONSENT DECREE ~~[PROPOSED]~~

Having reviewed the Joint Motion for Entry of the Consent Decree, it is hereby ORDERED AND ADJUDGED that the Consent Decree in this matter is entered and that the Court shall retain jurisdiction over the Consent Decree to enforce its terms.

DATED this _____ day of 3/31 2014.

Judge/Commissioner
King County Superior Court

Presented by:

ROBERT W. FERGUSON Attorney General	General Electric Co.
ANDREW A. FITZ, WSBA #22169 Senior Counsel, Attorneys for Plaintiff State of Washington, Department of Ecology (360) 586-6752	Eric S. Merrifield, WSBA #32949 Attorney for Defendant General Electric Company (518) 862-2708

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

CONFIRMATION RECEIPT

Case Number:	14-2-09134-6 SEA
Case Title:	Dept of Ecology vs General Electric Co
Submitted By:	Andrew Fitz
Bar Number:	22169
User ID:	Fitzaa22169
Submitted Date/Time:	3/28/2014 4:58:06 PM
Received Date/Time:	3/31/2014 9:00:00 AM
Total Cost:	$240.00

DOCUMENTS

Document Type:	COMPLAINT
File Name:	Complaint.pdf
Cost:	$0.00

Document Type:	ORDER SETTING CASE SCHEDULE
File Name:	schedule.pdf
Cost:	$0.00

Document Type:	CASE INFORMATION COVER SHEET
File Name:	cics.pdf
Cost:	$0.00

Document Type:	SUMMONS
File Name:	Summons.pdf
Cost:	$0.00

Document Type:	MOTION OF PARTIES RE JOINT MOTION FOR ENTRY OF CD
File Name:	JtMotEnterCD.pdf
Cost:	$0.00

Document Type:	DECLARATION OF DEAN YASUDA RE MOTION FOR ENTRY OF CD
File Name:	JtMotEnterCD-YasudaDecl.pdf
Attachment(s):	JtMotEnterCD-YasudaDecl-AttA.pdf
	JtMotEnterCD-YasudaDecl-AttB.pdf
Cost:	$0.00

Document Type:	INVOICE VOUCHER
File Name:	KingCyVoucherRequest3-28-14.pdf
Cost:	$0.00

Printed On: 3/28/2014 5:00:22 PM

KC - EFiling - Print Friendly

Thank you. Your document(s) has been received by the Clerk.

Confirmation Receipt

Case Number:14-2-09134-6Case Designation:SEA
Case Title:Not available at this time

Filed By:Andrew Fitz Submitted Date/Time:3/28/2014 5:51:23 PM
Received Date/Time:3/31/2014 9:00:00 AM

[redacted]

Document TypeFile NameAttachment(s)Cost
OTHER (DO NOT FILE UNSIGNED ORDERS) RE CONSENT DECREEConsentDecree.pdf
ConsentDecreeExA(SiteDiagram).pdf
ConsentDecreeExB(CAP2014-03-13).pdf
ConsentDecreeExC(SOW).pdf
ConsentDecreeExD-1(EnviroCovenant).pdf
ConsentDecreeExD-2(EnviroCovenant).pdf
ConsentDecreeExE(PublicParticipationPlan).pdf
ConsentDecreeExF(Permits).pdf
ConsentDecreeExG(ContingentApprovedVIMEngDesignRpt).pdf
ConsentDecreeExH(GWMP)_Part1.pdf
ConsentDecreeExH(GWMP)_Part2.pdf
ConsentDecreeExH(GWMP)_Part3.pdf
ConsentDecreeExH(GWMP)_Part4.pdf
ConsentDecreeExI(OperationMonitorPlan)_Part1.pdf
ConsentDecreeExI(OperationMonitorPlan)_Part2.pdf
ConsentDecreeExI(OperationMonitorPlan)_Part3.pdf
0.00

[redacted]

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. ACCEPTANCE OF SERVICE

I, Eric S. Merrifield, hereby accept service of the Summons and Complaint in the above-captioned case on behalf of Defendant, General Electric Company. This Acceptance of Service shall have the same force and effect as if personally served upon General Electric Company.

DATED this ______ day of ______________, 2014.

GENERAL ELECTRIC COMPANY

____
ERIC S. MERRIFIELD, WSBA #32949
Attorney for Defendant
General Electric Company
(518) 862-2708

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 SUMMONS

TO: Eric S. Merrifield, attorney for Defendant, General Electric Company,

A lawsuit has been started against you in the above-entitled court by the State of Washington, Department of Ecology. Plaintiff's claim is stated in the written Complaint, a copy of which is served upon you with this Summons.

The parties have agreed to resolve this matter by entry of a Consent Decree, a copy of which is also attached. Accordingly, this Summons shall not require the filing of an Answer.

//

//

//

//

//

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

Further, all disputes arising under this cause shall be resolved under the terms of the Consent Decree.

DATED this 27th day of March 2014.

ROBERT W. FERGUSON
Attorney General

ANDREW A. FITZ, WSBA #22169
Senior Counsel
Attorneys for Plaintiff
State of Washington, Department of Ecology
(360) 586-6752

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 COMPLAINT

Plaintiff, State of Washington, Department of Ecology (Ecology) alleges as follows:

I. DESCRIPTION OF ACTION

1. This action is brought on behalf of the State of Washington, Department of Ecology (Ecology) to enter a settlement agreement known as a Consent Decree (Decree), which requires remedial action at a facility where there has been a release and/or threatened release of hazardous substances.

2. The Complaint and settlement are limited to the scope of the Decree. The facility, or Site, is referred to as General Electric Aviation Site located in Seattle, Washington.

II. JURISDICTION

3. This Court has jurisdiction over the subject matter and over the parties pursuant to the Model Toxics Control Act (MTCA), RCW 70.105D. Venue is proper in King County, the location of the Site.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

III. PARTIES

4. Plaintiff Ecology is an agency of the State of Washington responsible for overseeing remedial action at sites contaminated with hazardous substances under RCW 70.105D, the MTCA.

5. Defendant is General Electric Company (GE).

IV. FACTUAL ALLEGATIONS

6. The Site is generally located at 220 South Dawson Street, Seattle, Washington, and all locations where hazardous substances migrating from that property have come to be located.

7. Defendant has been named or has accepted status as a potentially liable person (PLP) for the Site under MTCA.

8. Defendant, General Electric Company, was the owner of property at 220 South Dawson Street, Seattle, Washington, and operated an aircraft parts manufacturing and repair business on that property, at the time of a release of hazardous substances.

9. Environmental investigations conducted at the Site indicate that releases and/or potential releases of hazardous substances including trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), vinyl chloride, and 1,1-dichloroethylene (1,1 DCE), have occurred in soil and groundwater at the Site above applicable standards as set forth in the MTCA Cleanup Regulation, WAC 173-340.

10. Ecology has determined that contamination at the Site presents a threat to human health or the environment, and that a final cleanup is necessary to remedy contamination. Ecology has also determined that cleanup of the Site will occur in the most expeditious manner if remedy selection for, and cleanup of, the Site moves forward now.

11. Ecology developed a draft Cleanup Action Plan (CAP) for the Site and negotiated a draft Consent Decree with Defendant for implementation of the CAP.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

12. The draft CAP was subject to public notice and comment between December 18, 2013, and January 16, 2014.

13. The final CAP was issued on March 13, 2014.

14. The Consent Decree was subject to public notice and comment between December 18, 2013, and January 16, 2014.

15. Ecology and Defendant have now entered into the final Consent Decree requiring cleanup of the Site. The final CAP is an integral and enforceable exhibit to the Decree.

V. CAUSES OF ACTION

16. Ecology realleges all preceding paragraphs.

17. Ecology alleges that Defendant is responsible for remedial action at the Site, pursuant to RCW 70.105D.

VI. PRAYER FOR RELIEF

18. Ecology requests that the Court approve and order entry of the proposed Consent Decree.

19. Ecology further requests that the Court retain jurisdiction to enforce the terms of the Consent Decree.

DATED this 27th day of March 2014.

ROBERT W. FERGUSON
Attorney General

ANDREW A. FITZ, WSBA #22169
Senior Counsel
Attorneys for Plaintiff
State of Washington, Department of Ecology
(360) 586-6752

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 JOINT MOTION FOR ENTRY OF CONSENT DECREE

COMES NOW Plaintiff, State of Washington, Department of Ecology, by and through its attorney, Andrew A. Fitz, Senior Counsel, and Defendant, General Electric Company, by and through its attorney, Eric S. Merrifield, and jointly move for entry of the Consent Decree in the matter captioned above. This motion is supported by the pleadings on file and the attached Declaration of Dean Yasuda. The Consent Decree has been signed by the parties to this action and has been the subject of public notice and comment as required by RCW 70.105D.040(4)(a).

DATED this 27th day of March 2014.

ROBERT W. FERGUSON Attorney General	General Electric Company
ANDREW A. FITZ, WSBA #22169 Senior Counsel Attorneys for Plaintiff State of Washington, Department of Ecology (360) 586-6752	Eric S. Merrifield, WSBA #32949 Attorney for Defendant General Electric Company (518) 862-2708

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON,
DEPARTMENT OF ECOLOGY,

Plaintiff,

v.

GENERAL ELECTRIC COMPANY,

Defendant.

NO. 14-2-09134-6

DECLARATION OF DEAN D. YASUDA

I, Dean D. Yasuda, declare as follows:

1. I am over 21 years of age and am competent to testify herein. The facts set forth in this declaration are from my personal knowledge.

2. I am employed by the Washington State, Department of Ecology as a Site Manager in the Hazardous Waste and Toxics Reduction Program. I am the designated Site Manager for, and am therefore knowledgeable about, matters relating to the former General Electric Company, GE Aviation Site (Site).

3. The Site is generally located at 220 South Dawson Street, Seattle, Washington.

4. Ecology has determined that releases and/or potential releases of hazardous substances including trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), vinyl chloride, and 1,1-dichloroethylene (1,1 DCE), in soil and groundwater

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

beneath and/or downgradient of the Property have occurred at the Site above applicable standards as set forth in the MTCA Cleanup Regulation, Chapter 173-340 WAC.

5. Ecology has determined that contamination at the Site presents a threat to human health or the environment.

6. Ecology has given notice to the General Electric Company of Ecology's determination that it is a potentially liable person (PLP) for the Site, as required by RCW 70.105D.020(26) and WAC 173-340-500.

7. The draft Cleanup Action Plan and proposed Consent Decree were available for public comment between December 18, 2013, and January 16, 2014. Ecology received two letters pertaining to the proposed documents during this comment period. These letters, together with Ecology's responses to the letters, are attached as Attachment A and Attachment B to this Declaration. Ecology has determined that no changes to the draft Cleanup Action Plan or the proposed Consent Decree are necessitated based upon the comments received. Ecology has determined that no additional public comment is required.

8. Ecology has determined that the actions to be taken pursuant to the Consent Decree are necessary to protect public health and the environment, and will lead to a more expeditious cleanup of hazardous substances at the Site in compliance with cleanup standards established under RCW 70.105D.030(2)(e) and Chapter 173-340 WAC.

I declare under penalty of perjury of the laws of the state of Washington that the foregoing is true and correct.

DATED this 13th day of March, 2014, in Bellevue, Washington.

Dean D. Yasuda

DEAN D. YASUDA

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
(360) 586-6770

ATTACHMENT A

Draper Associates' Comments & Ecology's Response

Draper Associates Limited Partnership
2100 W. Commodore Way
Seattle Washington 98199
206.282.5555

Via email to: dyas461@ecy.wa.gov.

December 23, 2013

Dean Yasuda
Wash. Dept. of Ecology
Hazardous Waste and Toxics Reduction Program
3190 160th Ave S.E.
Bellevue, Wa 98008

Re: Proposed Cleanup at the General Electric Co. Dawson St. Plant

Dear Mr. Yasuda.

Draper Associates owns property located at 5055 4th Ave. South which is located between 3rd Ave. S. and 4th Ave. S. on Dawson Street. (Our site is across the street to the east from the proposed remediation site.) We currently lease our property to Hertz Equipment Corporation.

The "Public Comment Notice" of December 2013, post marked December 17, 2013, indicates some of the contaminants have migrated as far as Utah Ave South. Under the cleanup action we respectfully request that stringent considerations be made to eliminate potential migration eastward onto our site and request conformation of the safeguards and testing showing no migration eastward has or will take place onto our site. Further, we would like assurance that none of the potentially harmful contaminated vapors could have propagated below the ground surface and moved onto our site.

We welcome any input that our tenant may have concerning the cleanup and potential issues that may arise.

The DOE Publication of notice can be found at: https://fortress.wa.gov/ecy/publications/publications/1304024.pdf
Respectfully

Charles Draper Jr.

Charles Draper Jr.

cc. John Hanson – Hertz Corp. Facilities Manager. JHanson@hertz.com

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

February 25, 2014

Mr. Charles Draper, Jr.
Draper Associates Limited Partnership
2100 W Commodore Way
Seattle, WA 98199

Re: Washington State Department of Ecology (Ecology) Response to Your Letter Regarding the Proposed Cleanup at the Former General Electric Facility, Dawson Street Plant. (WAD009278706)

Dear Mr. Draper:

Thank you for your comment letter regarding the Ecology proposed consent decree and cleanup action plan for the former General Electric (GE) Facility, located at 220 South Dawson Street, Seattle, Washington. Your comment letter was received on December 23, 2013 by electronic mail during the 30-day public comment period. Your comment specifically stated,

> *Under the cleanup action we respectfully request that stringent considerations be made to eliminate potential migration eastward onto our site and request conformation (sic) of the safeguards and testing showing no migration eastward has or will take place onto our site. Further, we would like assurance that none of the potentially harmful contaminated vapors could have propagated below the ground surface and moved onto our site.*

Ecology's consent decree and cleanup action plan are intended to cleanup soil, groundwater and indoor air to levels protective of human health and the environment, using the strictest cleanup levels that can be enforced under the current Washington State cleanup regulations (Chapter 173-340 WAC)

Ecology understands that the Draper Associates property is located at 5055 4th Ave South, Seattle, Washington, and located directly east of the former GE facility where cleanup is required. Based on soil and groundwater data collected to date, there is no indication that soil and groundwater contamination has migrated east of the former GE facility. Migration of contaminated groundwater from historic spills and releases of chemicals to the ground at the 220 South Dawson Street property are known to migrate west with the natural groundwater flow direction. GE will be required to maintain and monitor groundwater wells located on the east side (upgradient) of the 220 South Dawson Street property as part of the required cleanup. Ecology does not expect contaminated groundwater to migrate east (upgradient) during the cleanup process, but will require GE to monitor these upgradient wells as verification until cleanup is completed to Ecology's satisfaction.

Please call me at (425) 649-7264 if you have any questions regarding this letter, or have your attorney call Andy Fitz, AAG at (360) 586-6752 if you have questions on legal matters.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

DY:SA
By certified mail: 7012 3460 0000 3272 3796

cc: Dennis Johnson, Ecology HWTR
Andy Fitz, Ecology AAG
Marcia Bailey, EPA-X
Tom Antonoff, Jennifer Shea, GE
Tong Li, Ground Water Solutions
Jason Cochrun, McKinstry Co
Bill Chapman, K&L Gates
Bill Joyce, Salter, Joyce, Ziker- PLLC
Brien Flanagan, Schwabe, Williamson & Wyatt
James King, Hudson Bay Insulation
Jason Palmer, AECOM
Randy Maciel, Hudson Bay Insulation
Thomas Morin, Environmental Partners
Central Records: WAD009278706 HZW 6.2

ATTACHMENT B

Liberty Ridge's Comments & Ecology's Response

J Z P
JOYCE ZIKER
PARKINSON

William F. Joyce
Direct Dial: 206.957.5951
Email: wjoyce@jzplaw.com

Also Admitted in Oregon

January 15, 2014

Dean Yasuda
Washington Department of Ecology
Hazardous Waste and Toxics Reduction Program
3190 160th Avenue SE
Bellevue, WA 98008-5452

Re: **Proposed Cleanup at the General Electric Former Dawson Street Site**
Comments On Behalf of Liberty Ridge, LLC

Dear Mr. Yasuda:

This letter is submitted on behalf of Liberty Ridge, LLC ("Liberty Ridge") with respect to the proposed cleanup of the General Electric ("GE") Former Dawson Street Site in Seattle, Washington ("Site"). Liberty Ridge owns properties impacted by releases from GE's operations at the Site. Liberty Ridge has worked cooperatively with GE and the Department of Ecology ("Ecology") on the investigation of the extent of contamination and the evaluation of remediation options for the Site. Liberty Ridge has reviewed the proposed Consent Decree, Draft Cleanup Action Plan ("DCAP"), and other documents released for public comment by Ecology. Liberty Ridge requests Ecology's consideration of the following comments on the documents.

Liberty Ridge's technical consultant has previously expressed concerns to GE and Ecology about the effectiveness of the proposed use of potassium permanganate as the sub-surface treatment chemical to achieve cleanup levels in soil and groundwater. Liberty Ridge appreciates Ecology's inclusion of a contingent remedy for the Site. In the event it becomes apparent that cleanup levels will not be achieved in a reasonable timeframe, it is important that Ecology require GE to perform the contingent remedy described in section 7.0 of the DCAP.

As indicated in Figures 5-2 and 6-1 of the DCAP, the proposed remediation includes injections of potassium permanganate on Liberty Ridge's properties located at 5033 1st Avenue South ("5033 Property") and 5050 1st Avenue South ("5050 Property"). GE and Liberty Ridge previously negotiated an agreement that authorized access for groundwater monitoring at the 5050 Property, but that agreement has expired. Agreements authorizing access to conduct remediation activities will be necessary for the 5033 and 5050 Properties. Liberty Ridge will work with GE in good faith on access. However, any access agreement will need to include provisions that require GE to minimize disruptions to current operations on the properties, restore the property after remediation has been completed, and reimburse Liberty Mutual for its costs incurred at the Site.

Section XX of the proposed Consent Decree will require that Liberty Ridge sign and record restrictive covenants on its Properties. The form of the restrictive covenant is appended to the Consent Decree as Exhibit D-2. In order to prevent exposure to contaminants in groundwater released during GE's operations, the restrictive covenant prohibits or significantly restricts certain uses of the Properties. Liberty Ridge has previously provided initial comments to GE on the form of the restrictive covenant. Liberty Ridge is prepared to negotiate with GE on the final language of the restrictive covenants in conjunction with the access agreements referenced above.

Under Section XIX of the proposed Consent Decree, GE receives contribution protection for matters addressed under the Consent Decree. Contribution protection means that GE is shielded from claims for the "matters addressed" in the settlement. "Matters addressed" are defined in this section as remedial actions under the Consent Decree, Ecology's costs, and costs incurred by "any other person with respect to the Site."

Liberty Ridge believes the language of this section should not operate to bar claims for costs already incurred by parties, including Liberty Ridge, impacted by releases of contaminants from GE's operations. Liberty Ridge requests that Ecology modify this provision so that it is clear and unambiguous that past costs incurred by Liberty Ridge and other parties prior to entry of the Consent Decree are not extinguished by the contribution protection granted to GE.

Liberty Ridge greatly appreciates Ecology's work at this Site. Please contact me if you have any questions about Liberty Ridge's comments.

Sincerely,

JOYCE ZIKER PARKINSON, PLLC

William F. Joyce

cc: Jimmy Blais
Jennifer Shea
Andy Fitz

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

February 25, 2014

Mr. William Joyce
Joyce, Ziker, Parkinson, PLLC
1601 Fifth Avenue, Suite 2040
Seattle, WA 98101

Re: Washington State Department of Ecology (Ecology) Response to Your Letter Regarding the Proposed Cleanup at the Former General Electric Facility, Dawson Street Plant (WAD009278706)

Dear Mr. Joyce:

Thank you for your comment letter regarding the Ecology proposed consent decree and cleanup action plan for the former General Electric (GE) Facility, located at 220 South Dawson Street, Seattle, Washington. Your comment letter was received on January 16, 2014 by electronic mail during the 30-day public comment period. Your comments (italicized) and Ecology's responses (non-italicized) are stated below:

Liberty Ridge's technical consultant has previously expressed concerns to GE and Ecology about the effectiveness of the proposed use of potassium permanganate as the sub-surface treatment chemical to achieve cleanup levels in soil and groundwater. Liberty Ridge appreciates Ecology's inclusion of a contingent remedy for the Site. In the event it becomes apparent that cleanup levels will not be achieved in a reasonable timeframe, it is important that Ecology require GE to perform the contingent remedy described in section 7.0 of the DCAP.

Ecology will be carefully monitoring the results of the in-situ chemical oxidation (ISCO) treatment injections on and off the 220 South Dawson Street property. Based on the results of the ISCO performance monitoring data, Ecology will require ISCO system optimization and possibly additional permanganate injections in order to achieve the required cleanup levels in a reasonable timeframe. If Ecology determines that the ISCO treatments will not result in meeting the required cleanup levels in a reasonable timeframe, GE will be required to proceed with performing the contingent remedy described in Section 7.0 of the cleanup action plan.

GE and Liberty Ridge previously negotiated an agreement that authorized access for groundwater monitoring at the 5050 Property, but that agreement has expired. Agreements authorizing access to conduct remediation activities will be necessary for the 5033 and 5050 Properties. Liberty Ridge will work with GE in good faith on access. However, any access agreement will need to include provisions that require GE to minimize disruptions to current operations on the properties, restore the property after remediation has been completed, and reimburse Liberty Mutual [sic] for its costs incurred at the Site.

Comment noted. Under the proposed Consent Decree, GE is obligated to "make all reasonable efforts to secure access rights for those properties within the Site not owned or controlled by GE where remedial activities or investigations will be performed pursuant to [the] Decree..." *See* Proposed Consent Decree, Section IX.

In order to prevent exposure to contaminants in groundwater released during GE's operations, the restrictive covenant prohibits or significantly restricts certain uses of the Properties. Liberty Ridge has previously provided initial comments to GE on the form of the restrictive covenant. Liberty Ridge is prepared to negotiate with GE on the final language of the restrictive covenants in conjunction with the access agreements referenced above.

Comment noted. Under the proposed Consent Decree, GE must make "good faith efforts" to cause restrictive covenants to be recorded on downgradient plume properties. These properties include the Liberty Ridge property. If GE is unable to secure such covenants, it is obliged to provide notice to Ecology and describe its good faith efforts toward securing the covenants. *See* Proposed Consent Decree, Section XX. With respect to the final language of any restrictive covenants, Ecology notes that GE is to record covenants that are "substantially in the form" of Exhibits D-1 and D-2. *See Id.* These exhibits include substantive provisions that Ecology has already determined are appropriate for this Site.

Liberty Ridge believes the language of this section should not operate to bar claims for costs already incurred by parties, including Liberty Ridge, impacted by releases of contaminants from GE's operations. Liberty Ridge requests that Ecology modify this provision so that it is clear and unambiguous that past costs incurred by Liberty Ridge and other parties prior to entry of the Consent Decree are not extinguished by the contribution protection granted to GE.

Ecology does not read the language of Section XIX (Contribution Protection) to bar claims for recovering remedial costs already incurred by other parties. Ecology had this issue in mind when negotiating the language of Section XIX and did not intend to produce such an effect. Ecology believes that based upon the language of RCW 70.105D.080 and case law construing similar statutory provisions under CERCLA (which can be looked to for persuasive authority), there is a distinction between contribution actions and actions to recover remedial costs already incurred. *See* RCW 70.105D.080 ("[A] person may bring a private right of action, *including a claim for contribution*...against any other person liable under RCW 70.105D.040 for the recovery of remedial action costs.") (emphasis added); *Atlantic Research Corp. v. United States*, 551 U.S. 128 (2007) (CERCLA Sections 107(a) and 113(f)(1) provide different [although sometimes overlapping] causes of actions; Section 107(a) is a cost recovery action, whereas a suit brought under Section 113(f)(1) is a contribution action); *PacificCorp Envtl. Remediation Co. v. Wash. State Dept. of Transp.*, 162 Wash. App. 627, 662 fn.114 (2011) (because MTCA was modeled after CERCLA, Washington courts will find case law interpreting CERCLA persuasive); *see also*, *Burlington Northern v. Time Oil*, 738 F.Supp. 1330 (W.D. Wash 1990) (distinguishing effect of a CERCLA consent decree's contribution protection section on contribution claims versus claims for remedial costs already incurred). Based on this distinction, Ecology does not believe the consent decree language requires modification.

Please call me at (425) 649-7264 if you have any questions regarding this letter, or call Andy Fitz, AAG at (360) 586-6752 if you have questions on legal matters.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

DY:SA
By certified mail: 7012 3460 0000 3272 4038

cc: Dennis Johnson, Ecology HWTR
Andy Fitz, Ecology AAG
Marcia Bailey, EPA-X
Tong Li, Ground Water Solutions
Jason Cochrun, McKinstry Co
Bill Chapman, K&L Gates
Brien Flanagan, Schwabe, Williamson & Wyatt
James King, Hudson Bay Insulation
Jason Palmer, AECOM
Randy Maciel, Hudson Bay Insulation
Thomas Morin, Environmental Partners
Central Records: WAD009278706 HZW 6.2

Bob Ferguson
ATTORNEY GENERAL OF WASHINGTON
Ecology Division
2425 Bristol Court SW 2nd Floor • Olympia WA 98502
PO Box 40117 • Olympia WA 98504-0117 • (360) 586-6770

April 9, 2014

Eric S. Merrifield
General Electric Company
319 Great Oaks Blvd.
Albany, NY 12203

RE: ***Dep't of Ecology v. General Electric Company***
King County Superior Court No. 14-2-09134-6

Dear Mr. Merrifield:

Enclosed is a conformed copy of the Order Entering Consent Decree in the above-captioned case. Also enclosed are conformed copies of the Joint Motion for Entry of Consent Decree, Declaration of Dean Yasuda, and Consent Decree with exhibits filed on March 31, 2014.

In addition, you will find enclosed for official service copies of the Summons and Complaint in this matter and an Acceptance of Service for your signature. Please sign the Acceptance of Service and return it to me in the envelope provided. I will then file it with the court.

Thank you for your assistance in this matter.

Sincerely,

Danielle E. French

DANIELLE E. FRENCH
Legal Assistant to
ANDREW A. FITZ
Senior Counsel
(360) 586-8171

def
Enclosures
cc w/o enc.: Jennifer Shea
cc w/enc: Dean Yasuda

FILED
KING COUNTY, WASHINGTON
MAR 31 2014
SUPERIOR COURT CLERK

STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. GENERAL ELECTRIC COMPANY, Defendant.	NO. 14-2-09134-6 CONSENT DECREE

TABLE OF CONTENTS

I. INTRODUCTION 1
II. JURISDICTION 2
III. PARTIES BOUND 3
IV. DEFINITIONS 3
V. FINDINGS OF FACTS 4
VI. WORK TO BE PERFORMED 7
VII. DESIGNATED PROJECT COORDINATORS 8
VIII. PERFORMANCE 9
IX. ACCESS 10
X. SAMPLING, DATA SUBMITTAL, AND AVAILABILITY 10
XI. PROGRESS REPORTS 11
XII. RETENTION OF RECORDS 12
XIII. TRANSFER OF INTEREST IN PROPERTY 13
XIV. RESOLUTION OF DISPUTES 13
XV. AMENDMENT OF DECREE 15
XVI. EXTENSION OF SCHEDULE 16
XVII. ENDANGERMENT 17
XVIII. COVENANT NOT TO SUE 18
XIX. CONTRIBUTION PROTECTION 20
XX. LAND USE RESTRICTIONS 20

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XXI. FINANCIAL ASSURANCE 20
XXII. INDEMNIFICATION 25
XXIII. COMPLIANCE WITH APPLICABLE LAWS 25
XXIV. REMEDIAL ACTION COSTS 26
XXV. IMPLEMENTATION OF REMEDIAL ACTION 27
XXVI. PERIODIC REVIEW 28
XXVII. PUBLIC PARTICIPATION 28
XXVIII. DURATION OF DECREE 30
XXIX. CLAIMS AGAINST THE STATE 30
XXX. EFFECTIVE DATE 30
XXXI. WITHDRAWAL OF CONSENT 31

EXHIBIT A Site Diagram
EXHIBIT B Cleanup Action Plan
EXHIBIT C Scope of Work & Schedule
EXHIBIT D-1 Restrictive Covenant
EXHIBIT D-2 Restrictive Covenant
EXHIBIT E Public Participation Plan
EXHIBIT F Required Permits and Substantive Requirements of Procedurally Exempt Permits or Approvals
EXHIBIT G: Final Engineering Design Report – Vapor Intrusion Mitigation System, Sections 6.0 through 6.1 as approved by Ecology letters dated December 4, 2007 and March 7, 2011
EXHIBIT H: Groundwater Sampling and Analysis Plan, Revision 1, dated January 2008 and Quality Assurance Project Plan, dated January 2008
EXHIBIT I: Operation and Monitoring Plan, dated March 2010

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

I. INTRODUCTION

A. The mutual objective of the State of Washington, Department of Ecology (Ecology) and the General Electric Company (GE or Defendant) under this Decree is to provide for remedial action at a facility where there has been a release or threatened release of hazardous substances. As more fully described in the Cleanup Action Plan (Exhibit B), this Decree requires GE to perform actions that include, but are not limited to, the following activities: install, optimize as required, operate, and monitor the effectiveness of a multiphased in-situ treatment, hydraulic control system and vapor intrusion mitigation system, in order to meet soil, groundwater, and indoor air cleanup levels; provide for protection, performance, and confirmation monitoring of the cleanup action taken at the Site; implement institutional controls as necessary; and provide for financial assurance sufficient to complete the cleanup actions.

Ecology has determined that these actions are necessary to protect human health and the environment.

B. The Complaint in this action is being filed simultaneously with this Decree. An Answer has not been filed, and there has not been a trial on any issue of fact or law in this case. However, the Parties wish to resolve the issues raised by Ecology's Complaint. In addition, the Parties agree that settlement of these matters without litigation is reasonable and in the public interest, and that entry of this Decree is the most appropriate means of resolving these matters. The requirements of this Decree will concurrently satisfy GE's obligations for corrective action, as set forth in WAC 173-303-64620 (including financial assurance for corrective action).

C. By signing this Decree, the Parties agree to its entry and agree to be bound by its terms.

D. By entering into this Decree, the Parties do not intend to discharge non-settling parties from any liability they may have with respect to matters alleged in the Complaint. The

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

Parties retain the right to seek reimbursement, in whole or in part, from any liable persons for sums expended under this Decree.

E. This Decree shall not be construed as proof of liability or responsibility for any releases of hazardous substances or cost for remedial action nor an admission of any facts and GE reserves the right to contest any facts or liability determination made herein; provided, however, that GE shall not challenge the authority of the Attorney General and Ecology to enforce this Decree.

F. The Court is fully advised of the reasons for entry of this Decree, and good cause having been shown:

Now, therefore, it is HEREBY ORDERED, ADJUDGED, AND DECREED as follows:

II. JURISDICTION

A. This Court has jurisdiction over the subject matter and over the Parties pursuant to the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

B. Authority is conferred upon the Washington State Attorney General by RCW 70.105D.040(4)(a) to agree to a settlement with any potentially liable person (PLP) if, after public notice and any required hearing, Ecology finds the proposed settlement would lead to a more expeditious cleanup of hazardous substances. RCW 70.105D.040(4)(b) requires that such a settlement be entered as a consent decree issued by a court of competent jurisdiction.

C. Ecology has determined that a release or threatened release of hazardous substances has occurred at the Site that is the subject of this Decree.

D. Ecology has given notice to GE of Ecology's determination that GE is a PLP for the Site, as required by RCW 70.105D.020(21) and WAC 173-340-500.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

E. The actions to be taken pursuant to this Decree are necessary to protect public health and the environment.

F. This Decree has been subject to public notice and comment.

G. Ecology finds that this Decree will lead to a more expeditious cleanup of hazardous substances at the Site in compliance with the cleanup standards established under RCW 70.105D.030(2)(e) and Chapter 173-340 WAC.

H. GE has agreed to undertake the actions specified in this Decree and consents to the entry of this Decree under MTCA.

III. PARTIES BOUND

This Decree shall apply to and be binding upon the Parties to this Decree, their successors and assigns. The undersigned representative of each party hereby certifies that he or she is fully authorized to enter into this Decree and to execute and legally bind such party to comply with this Decree. GE agrees to undertake all actions required by the terms and conditions of this Decree. No change in ownership or corporate status shall alter GE's responsibility under this Decree. GE shall provide a copy of this Decree to all contractors and subcontractors retained to perform work required by this Decree, and shall ensure that all work undertaken by such contractors and subcontractors complies with this Decree.

IV. DEFINITIONS

Unless otherwise specified herein, all definitions in RCW 70.105D.020 and WAC 173-340-200 shall control the meanings of the terms in this Decree.

A. Site: The Site is referred to as the former GE Aviation Site. The Site is generally located at 220 South Dawson Street, Seattle, Washington, and all locations where hazardous substances migrating from that property have come to be located. The Site is generally described in the Site Diagram (Exhibit A). The Site constitutes a Facility under RCW 70.105D.020(5).

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

B. Parties: Refers to the State of Washington, Department of Ecology (Ecology) and General Electric Company.

C. Defendant: Refers to General Electric Company.

D. Consent Decree or Decree: Refers to this Consent Decree and each of the exhibits to this Decree. All exhibits are integral and enforceable parts of this Consent Decree. The terms "Consent Decree" or "Decree" shall include all exhibits to this Consent Decree.

E. Days: Shall mean calendar days. The date of the event from which a time period begins to run shall not be included in computing the time period. The last day of a period so computed shall be included in the period unless it is a Saturday, Sunday, or legal holiday recognized by the State of Washington, in which case the period extends to the end of the next calendar day which is not a Saturday, Sunday, or legal holiday recognized by the State of Washington.

V. FINDINGS OF FACTS

Ecology makes the following findings of fact without any express or implied admissions of such facts by GE.

A. In 1949, GE purchased property at 220 South Dawson Street in Seattle, Washington (the "Property"). From 1959 to 1994, GE manufactured and repaired aircraft parts at the Property. In 1994, Defendant ceased manufacturing and repair operations at the Property. GE used the Property as warehouse and office space until December 1996, at which time GE vacated the Property and transferred ownership. Since then, various companies have used the building on the Property as a warehouse. Keymac, LLC currently owns the Property.

B. Groundwater in the vicinity of the Property is generally encountered between seven and ten feet below ground surface. Groundwater flows west to southwest.

C. During operation of its aircraft parts manufacturing and repair business, GE used petroleum products and chlorinated solvents, including trichloroethylene (TCE), 1,1,1-

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

trichloroethane (TCA), and perchloroethylene (PCE) at the Property (COCs). Releases of these COCs have occurred to the soils and groundwater at the former GE facility located at 220 South Dawson Street, Seattle, Washington.

D. Prior to signing Agreed Order DE02HWTRNR-4686 in 2002, GE voluntarily undertook independent remedial actions at the Site. Between December 1995 and August 1996, GE excavated more than 3,000 tons of soil from the Site and sent it off-site for treatment in a high-temperature cement kiln. During this time, GE removed from the Property all soils with concentrations of total petroleum hydrocarbons and chlorinated volatile organic compounds (CVOCs) that exceeded MTCA cleanup levels based on residential exposure scenarios that were in effect at that time, with the exception of soils below the water table and three small areas where soil excavation was not feasible due to proximity to existing structures.

E. In August 1996, as an independent action, GE began operating a shallow groundwater extraction system on the Property. The system has extracted to date in excess of 100 million gallons of shallow groundwater at the Site. GE also conducted periodic groundwater sampling and provided reports on these activities to Ecology on a regular basis.

F. Based on data from investigations conducted at the Site by GE under the 2002 order, Ecology has determined that groundwater downgradient of the Property is known to be contaminated from releases of hazardous substances at the Property. GE's investigations have detected TCE, PCE, 1,1,1-TCA, vinyl chloride, cis-1,2 dichloroethylene, trans-1,2 dichloroetheylene, 1,1-dichloroethylene, arsenic, and 1,4 dioxane in groundwater beneath and/or downgradient of the Property. Many of these COCs exceeded the MTCA Method B groundwater cleanup levels.

G. The Site is located in an industrial portion of the Duwamish River Valley. Land uses are predominantly light industrial (e.g. manufacturing and warehousing) with some

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

commercial businesses, occasional residences, and vacant lots. The Property is zoned Industrial General 2 Unlimted/85 and the adjacent properties and properties between the site and the Duwamish Waterway are also zoned for industrial purposes. Two residences are located immediately south of the site: one appears to be vacant and both are located between industrial facilities.

H. The previous Agreed Order, DE 02HWTRNR-4686 required GE to conduct groundwater interim actions and remedial investigations, and to investigate vapor intrusion within buildings above the contaminated groundwater.

I. Pursuant to Agreed Order DE 02HWTRNR-4686, GE installed a new recovery well, a new shallow monitoring well, an intermediate monitoring well, and several downgradient monitoring wells from 2002-2005; GE collected quarterly groundwater samples and provided the results to Ecology; and GE conducted an investigation of downgradient groundwater using geoprobes in 2002 and collected data for evaluating natural attenuation parameters in February 2004. Sampling was conducted in August 2003 and February 2004 to assess the potential for site groundwater to geochemically alter metal concentrations in groundwater. Analysis of groundwater for 1,4 dioxane was also required by Ecology and conducted by GE in 2004 and 2005.

J. GE performed several rounds of modeling to evaluate the indoor air pathway for the former GE building as well as for the downgradient Liberty Ridge and former Interior Environments buildings. GE sampled indoor and sub-slab air at the former GE building and indoor air at the former Interior Environments building.

K. Based on several vapor intrusion assessment reports prepared on behalf of GE for Ecology, dated February 6, 2006, October 12, 2006, and January 9, 2007, indoor air concentrations of TCE were measured above the MTCA Method C air cleanup level in several occupied businesses within the 220 South Dawson Street building. The MTCA Method C air

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

cleanup level as applied by Ecology in these circumstances is a protective level set based on the assumption that a person working in the building is exposed to TCE vapor twenty-four (24) hours per day, seven (7) days per week, for thirty (30) years. The eight other volatile compounds measured as part of the above-listed studies did not exceed the MTCA Method C air cleanup levels. Indoor air TCE concentrations in some areas of the building also exceeded Ecology's remediation level set for the interim action based on a forty (40) hour per week worker scenario. Under Agreed Order No. DE 4258, GE installed a vapor intrusion mitigation (VIM) system as an interim action to reduce a threat to human health and to reduce TCE concentrations to levels below the MTCA Method C air cleanup level.

L. GE conducted a remedial investigation under Agreed Order No. DE 02HWTRNR-4686. GE also prepared a feasibility study under Agreed Order No. DE 5477. Based on the Focused Feasibility Study Report (FFS Report), as modified and approved by Ecology in a letter dated December 24, 2009, Ecology has selected Modified Remedial Alternative 2, as described in the CAP (Exhibit B) as a final cleanup action for the Site.

VI. WORK TO BE PERFORMED

This Decree contains a program designed to protect human health and the environment from the known release, or threatened release, of hazardous substances or contaminants at, on, or from the Site.

A. GE shall perform a final cleanup action for the Site by implementing the Modified Alternative 2 remedy set forth in the CAP (Exhibit B) in accordance with the Scope of Work and Schedule (Exhibit C); and agrees also, if it is so determined by Ecology, that GE shall perform the contingent remedy as described in the CAP. Completion of the work herein shall supplant and satisfy all previous Agreed Orders between GE and Ecology, including but not limited to Agreed Orders No. DE02HWTRNR-4686, No. DE 5477, and No. DE 4258. Certain work items from these superseded Agreed Orders are described by Exhibits G, H, and

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

I, and are incorporated into Exhibit C to this Decree (Scope of Work and Schedule). GE shall continue to perform these items as ongoing work until the Engineering Design Report (EDR) is approved and implemented.

B. GE agrees not to perform any remedial actions outside the scope of Section VI.A above specifically, or generally, of this Decree unless the Parties agree to modify the Scope of Work and Schedule (Exhibit C) and Ecology modifies the Cleanup Action Plan (Exhibit B) to cover these actions. All work conducted by GE under this Decree shall be done in accordance with Chapter 173-340 WAC unless otherwise provided herein.

C. Ecology shall issue written notice of completion that the requirements of this Decree have been satisfactorily completed when the work as described in the CAP has been performed.

VII. DESIGNATED PROJECT COORDINATORS

The project coordinator for Ecology is:

Dean Yasuda
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452
(425) 649-7264
Email: dyas461@ecy.wa.gov

The project coordinator for Defendant is:

Tom Antonoff
U.S. Remedial Project Manager - Legacy Site CoE
GE
319 Great Oaks Blvd
Albany, NY 12203
Phone: (518) 862-2720
Email: tom.antonoff@ge.com

Each project coordinator shall be responsible for overseeing the implementation of this Decree. Ecology's project coordinator will be Ecology's designated representative for the Site. To the maximum extent possible, communications between Ecology and GE and all

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Decree shall be directed through the project coordinators. The project coordinators may designate, in writing, working level staff contacts for all or portions of the implementation of the work to be performed required by this Decree.

Any party may change its respective project coordinator. Written notification shall be given to the other party at least ten (10) calendar days prior to the change.

VIII. PERFORMANCE

All geologic and hydrogeologic work performed pursuant to this Decree shall be under the supervision and direction of a geologist licensed in the State of Washington or under the direct supervision of an engineer registered in the State of Washington, except as otherwise provided for by Chapters 18.220 and 18.43 RCW (in this section, "direct" shall not mean personal presence at the Site).

All engineering work performed pursuant to this Decree shall be under the direct supervision of a professional engineer registered in the State of Washington, except as otherwise provided for by RCW 18.43.130.

All construction work performed pursuant to this Decree shall be under the direct supervision of a professional engineer or a qualified technician under the direct supervision of a professional engineer. The professional engineer must be registered in the State of Washington, except as otherwise provided for by RCW 18.43.130.

Any documents submitted containing geologic, hydrologic, or engineering work shall be under the seal of an appropriately licensed professional as required by Chapter 18.220 RCW or RCW 18.43.130.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

GE shall notify Ecology in writing of the identity of any engineer(s) and geologist(s), contractor(s) and subcontractor(s), and others to be used in carrying out the terms of this Decree, in advance of their involvement at the Site.

IX. ACCESS

Ecology or any Ecology authorized representative shall have full authority to enter and freely move about all property at the Site that GE either owns, controls, or has access rights to at all reasonable times for the purposes of, *inter alia*: inspecting records, operation logs, and contracts related to the work being performed pursuant to this Decree; reviewing GE's progress in carrying out the terms of this Decree; conducting such tests or collecting such samples as Ecology may deem necessary; using a camera, sound recording, or other documentary type equipment to record work done pursuant to this Decree; and verifying the data submitted to Ecology by GE. Ecology or any Ecology authorized representative shall provide reasonable notice as provided under WAC 173-340-800 to GE and the property owner or tenant whenever it seeks direct physical access to GE's remedial equipment when GE or GE's representatives are not present, unless an emergency has been determined and prevents such notice. GE shall make all reasonable efforts to secure access rights for those properties within the Site not owned or controlled by GE where remedial activities or investigations will be performed pursuant to this Decree; provided subject to the language above, that Ecology may make unannounced visits with the permission of the owners or tenants of the Site. All Parties who access the Site pursuant to this section shall comply with any applicable Health and Safety Plan(s). Ecology employees and their representatives shall not be required to sign any liability release or waiver as a condition of Site property access.

X. SAMPLING, DATA SUBMITTAL, AND AVAILABILITY

With respect to the implementation of this Decree, GE shall make the results of all sampling, laboratory reports, and/or test results generated by it or on its behalf available to

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

Ecology. Pursuant to WAC 173-340-840(5), all sampling data shall be submitted to Ecology in both printed and electronic formats in accordance with Section XI (Progress Reports), Ecology's Toxics Cleanup Program Policy 840 (Data Submittal Requirements), and/or any subsequent procedures specified by Ecology for data submittal.

If requested by Ecology, GE shall allow Ecology and/or its authorized representative to take split or duplicate samples of any samples collected by GE pursuant to the implementation of this Decree. GE shall notify Ecology seven (7) days in advance of any sample collection or work activity at the Site. Ecology shall, upon request, allow GE and/or its authorized representative to take split or duplicate samples of any samples collected by Ecology pursuant to the implementation of this Decree, provided that doing so does not interfere with Ecology's sampling. Without limitation on Ecology's rights under Section IX (Access), Ecology shall notify GE prior to any sample collection activity unless an emergency prevents such notice.

In accordance with WAC 173-340-830(2)(a), all hazardous substance analyses shall be conducted by a laboratory accredited under Chapter 173-50 WAC for the specific analyses to be conducted, unless otherwise approved by Ecology.

XI. PROGRESS REPORTS

A. GE shall submit to Ecology written Progress Reports that describe the actions taken during the previous month(s) to implement the requirements of this Decree. The Progress Reports shall include the following:

1. A list of on-site activities that have taken place since the last reporting period;

2. Detailed description of any deviations from required tasks not otherwise documented in project plans or amendment requests;

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

3. Description of all deviations from the Scope of Work and Schedule (Exhibit C) and Cleanup Action Plan (Exhibit B) during the current month and any planned deviations in the upcoming month;

4. For any deviations in schedule, a plan for recovering lost time and maintaining compliance with the schedule;

5. All raw data (including laboratory analyses) received by GE during the past month and an identification of the source of the sample; and

6. A list of deliverables for the upcoming month if different from the schedule.

B. Progress reports shall be submitted to Ecology in accordance with the following schedule:

1. Quarterly during preparation of the Engineering and Design Report, until such report is approved.

2. Monthly, during the construction of any phase of the optimized hydraulic control & in-situ chemical oxidation system or contingent remedy.

3. Quarterly, after Ecology approval of all portions of the constructed optimized hydraulic control & in-situ chemical oxidation system.

C. All Progress Reports shall be submitted by the fifteenth (15^{th}) day of the month in which they are due after the effective date of this Decree. Unless otherwise specified, Progress Reports and any other documents submitted pursuant to this Decree shall be sent by the GE project coordinator by certified mail, return receipt requested, to Ecology's project coordinator.

XII. RETENTION OF RECORDS

During the pendency of this Decree, and for ten (10) years from the date this Decree is no longer in effect as provided in Section XXVIII (Duration of Decree), GE shall preserve all records, reports, documents, and underlying data in its possession relevant to the

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

implementation of this Decree and shall insert a similar record retention requirement into all contracts with project contractors and subcontractors. Upon request of Ecology, GE shall make all records available to Ecology and allow access for review within a reasonable time.

Nothing in this Decree is intended by GE to waive any right it may have under applicable law to limit disclosure of documents protected by the attorney work-product and/or attorney/client privilege. If GE withholds any requested records based on an assertion of privilege, it shall provide Ecology with a privilege log specifying the records withheld and the applicable privilege. No actual data collected on Site pursuant to this Decree shall be considered privileged.

XIII. TRANSFER OF INTEREST IN PROPERTY

The following conditions apply to the extent GE holds or in the future comes to hold any interest in all or any portion of the Site.

No voluntary conveyance or relinquishment of title, easement, leasehold, or other interest in any portion of the Site shall be consummated by GE without provision for continued operation and maintenance of any containment system, treatment system, and/or monitoring system installed or implemented pursuant to this Decree.

Prior to GE's transfer of any interest in all or any portion of the Site, and during the effective period of this Decree, GE shall provide a copy of this Decree to any prospective purchaser, lessee, transferee, assignee, or other successor in said interest; and, at least thirty (30) days prior to any transfer, GE shall notify Ecology of said transfer. Upon transfer of any interest, GE shall restrict uses and activities to those consistent with this Consent Decree and notify all transferees of the restrictions on the use of the property.

XIV. RESOLUTION OF DISPUTES

A. In the event a dispute arises as to an approval, disapproval, proposed change, or other decision or action by Ecology's project coordinator, or an itemized billing statement

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

under Section XXIV (Remedial Action Costs), the Parties shall utilize the dispute resolution procedure set forth below.

1. Upon receipt of Ecology's project coordinator's written decision, or the itemized billing statement, GE has fourteen (14) days within which to notify Ecology's project coordinator in writing of its objection to the decision or itemized statement.

2. The Parties' project coordinators shall then confer in an effort to resolve the dispute. If the project coordinators cannot resolve the dispute within fourteen (14) days of Ecology's receipt of GE's written notice of objection, unless a longer period is mutually agreed to by the Parties, Ecology's project coordinator shall issue a written decision.

3. GE may then request regional management review of the decision. This request shall be submitted in writing to the Hazardous Waste & Toxics Reduction Program's Northwest Region Section Manager within seven (7) days of receipt of Ecology's project coordinator's written decision.

4. Ecology's Hazardous Waste & Toxics Reduction Program's Northwest Region Section Manager shall conduct a review of the dispute and shall endeavor to issue a written decision regarding the dispute within thirty (30) days of GE's request for review.

5. If GE finds Ecology's Hazardous Waste & Toxics Reduction Program's Northwest Region Section Manager's decision unacceptable, GE may then request final management review of the decision. This request shall be submitted in writing to the Ecology Hazardous Waste & Toxics Reduction Program Manager within seven (7) days of receipt of the Hazardous Waste & Toxics Reduction Program's Northwest Region Section Manager's decision.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

6. Ecology's Hazardous Waste & Toxics Reduction Program Manager shall conduct a review of the dispute and shall endeavor to issue a written decision regarding the dispute within thirty (30) days of GE's request for review of the Hazardous Waste & Toxics Reduction Program's Northwest Region Section Manager's decision. The decision of the Hazardous Waste & Toxics Reduction Program Manager shall be Ecology's final decision on the disputed matter.

B. If Ecology's final written decision is unacceptable to GE, GE has the right to submit the dispute to the Court for resolution. The Parties agree that one judge should retain jurisdiction over this case and shall, as necessary, resolve any dispute arising under this Decree. In the event GE presents an issue to the Court for review, the Court shall review the action or decision of Ecology on the basis of whether such action or decision was arbitrary and capricious, or any other standard applicable under RCW 70.105D.060.

C. The Parties agree to only utilize the dispute resolution process in good faith and agree to expedite, to the extent possible, the dispute resolution process whenever it is used. Where either party utilizes the dispute resolution process in bad faith or for purposes of delay, the other party may seek sanctions.

D. Implementation of these dispute resolution procedures shall not provide a basis for delay of any activities required in this Decree, unless Ecology agrees in writing to a schedule extension or the Court so orders.

XV. AMENDMENT OF DECREE

The project coordinators may agree to minor changes to the work to be performed without formally amending this Decree. Minor changes will be documented in writing by Ecology, within seven (7) to fourteen (14) days of verbal commitment, including a decision by Ecology to direct GE to implement the contingent remedial action.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

Substantial changes to the work to be performed shall require formal amendment of this Decree. This Decree may only be formally amended by a written stipulation among the Parties that is entered by the Court, or by order of the Court. Such amendment shall become effective upon entry by the Court. Agreement to amend the Decree shall not be unreasonably withheld by any party.

GE shall submit a written request for amendment to Ecology for approval. Ecology shall indicate its approval or disapproval in writing and in a timely manner after the written request for amendment is received. If the amendment to the Decree is a substantial change, Ecology will provide public notice and opportunity for comment. Reasons for the disapproval of a proposed amendment to the Decree shall be stated in writing. If Ecology does not agree to a proposed amendment, the disagreement may be addressed through the dispute resolution procedures described in Section XIV (Resolution of Disputes).

XVI. EXTENSION OF SCHEDULE

A. An extension of schedule shall be granted only when a request for an extension is submitted in a timely fashion, generally at least fourteen (14) days prior to expiration of the deadline for which the extension is requested, and good cause exists for granting the extension. All extensions shall be requested in writing. The request shall specify:

1. The deadline that is sought to be extended;
2. The length of the extension sought;
3. The reason(s) for the extension; and
4. Any related deadline or schedule that would be affected if the extension were granted.

B. The burden shall be on GE to demonstrate to the satisfaction of Ecology that the request for such extension has been submitted in a timely fashion and that good cause exists for granting the extension. Good cause may include, but may not be limited to:

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

1. Circumstances beyond the reasonable control and despite the due diligence of GE including delays caused by unrelated third parties or Ecology, such as (but not limited to) delays by Ecology in reviewing, approving, or modifying documents submitted by GE;

2. Acts of God, including fire, flood, blizzard, extreme temperatures, storm, or other unavoidable casualty; or

3. Endangerment as described in Section XVII (Endangerment).

However, neither increased costs of performance of the terms of this Decree nor changed economic circumstances shall be considered circumstances beyond the reasonable control of GE.

C. Ecology shall act upon any written request for extension in a timely fashion. Ecology shall give GE written notification of any extensions granted pursuant to this Decree. A requested extension shall not be effective until approved by Ecology or, if required, by the Court. Ecology shall not unreasonably deny a request for extension of time. Unless the extension is a substantial change, it shall not be necessary to amend this Decree pursuant to Section XV (Amendment of Decree) when a schedule extension is granted.

D. An extension shall only be granted for such period of time as Ecology determines is reasonable under the circumstances. Ecology may grant schedule extensions exceeding ninety (90) days only as a result of:

1. Delays in the issuance of a necessary permit which was applied for in a timely manner;

2. Other circumstances deemed exceptional or extraordinary by Ecology; or

3. Endangerment as described in Section XVII (Endangerment).

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XVII. ENDANGERMENT

In the event Ecology determines that any activity being performed at the Site is creating or has the potential to create a danger to human health or the environment, Ecology may direct GE to cease such activities for such period of time as it deems necessary to abate the danger. GE shall immediately comply with such direction.

In the event GE determines that any activity being performed at the Site is creating or has the potential to create a danger to human health or the environment, GE may cease such activities. GE shall notify Ecology's project coordinator as soon as possible, but no later than twenty-four (24) hours after making such determination or ceasing such activities. Upon Ecology's direction, GE shall provide Ecology with documentation of the basis for the determination or cessation of such activities. If Ecology disagrees with GE's cessation of activities, it may direct GE to resume such activities.

If Ecology concurs with or orders a work stoppage pursuant to this section, GE's obligations with respect to the ceased activities shall be suspended until Ecology determines the danger is abated, and the time for performance of such activities, as well as the time for any other work dependent upon such activities, shall be extended, in accordance with Section XVI (Extension of Schedule), for such period of time as Ecology determines is reasonable under the circumstances.

Nothing in this Decree shall limit the authority of Ecology, its employees, agents, or contractors to take or require appropriate action in the event of an emergency.

XVIII. COVENANT NOT TO SUE

A. Covenant Not to Sue: In consideration of Defendant's compliance with the terms and conditions of this Decree, Ecology covenants not to institute legal or administrative actions against Defendant regarding the release or threatened release of hazardous substances covered by this Decree.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

This Decree covers only the Site specifically identified in this Consent Decree and those hazardous substances that Ecology knows are located at the Site as of the date of entry of this Decree. This Decree does not cover any other hazardous substance or area. Ecology retains all of its authority relative to any substance or area not covered by this Decree.

This Covenant Not to Sue shall have no applicability whatsoever to:

1. Criminal liability;

2. Liability for damages to natural resources; and

3. Any Ecology action, including cost recovery, against PLPs not a party to this Decree.

If factors not known at the time of entry of the settlement agreement are discovered and present a previously unknown threat to human health or the environment, the Court shall amend this Covenant Not to Sue.

B. Reopeners: Ecology specifically reserves the right to institute legal or administrative action against Defendant to require it to perform additional remedial actions at the Site and to pursue appropriate cost recovery, pursuant to RCW 70.105D.050 under the following circumstances:

1. Upon Defendant's failure to meet the requirements of this Decree, including, but not limited to, failure of the remedial action to meet the cleanup standards identified in the CAP (Exhibit B);

2. Upon Ecology's determination that remedial action beyond the terms of this Decree is necessary to abate an imminent and substantial endangerment to human health or the environment;

3. Upon the availability of new information regarding factors previously unknown to Ecology, including the nature or quantity of hazardous substances at the

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

Site, and Ecology's determination, in light of this information, that further remedial action is necessary at the Site to protect human health or the environment; or

4. Upon Ecology's determination that additional remedial actions beyond those described in the CAP (which include the contingent remedy described in Section 7 of the CAP) are necessary to achieve cleanup standards within the reasonable restoration time frame set forth in the CAP. For the purposes of this reopener, "the reasonable restoration timeframe set forth in the CAP" anticipates the possibility, as described in Section 7 of the CAP, that a contingent remedy may need to be implemented in the event Modified Alternative 2, with optimized or not-optimized hydraulic control, does not achieve the Site cleanup levels. "The reasonable restoration timeframe set forth in the CAP" further includes any timeframes that may be revised as necessary per WAC 173-340-360(4). An Ecology determination that it is necessary to implement the contingent remedy procedures set forth in Section 7 of the CAP will not trigger this reopener.

C. Except in the case of an emergency, prior to instituting legal or administrative action against Defendant pursuant to this section, Ecology shall provide Defendant with fifteen (15) calendar days notice of such action.

XIX. CONTRIBUTION PROTECTION

With regard to claims for contribution against GE, the Parties agree that GE is entitled to protection against claims for contribution for matters addressed in this Decree as provided by RCW 70.105D.040(4)(d). The "matters addressed" in this Consent Decree are all remedial actions taken or to be taken and all remedial costs (including Ecology's oversight costs) incurred or to be incurred by Ecology or any other person with respect to the Site.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XX. LAND USE RESTRICTIONS

GE shall make good faith efforts to cause restrictive covenants substantially in the form of Exhibit D-1 (for 220 South Dawson Street property and any other properties that may have both soil and groundwater contamination) and Exhibit D-2 (for downgradient groundwater plume properties) to be recorded with the office of the King County Auditor by the current owners of properties within the Site within one year of the finalization of the Engineering Design Report (EDR). The restrictive covenants shall restrict future uses of the Site as specified in the CAP, Section 6.1, item 18. GE shall provide Ecology with a copy of the recorded restrictive covenants within thirty (30) days of the recording date. If GE is unable to secure such covenants, GE shall provide notice to Ecology of its inability to secure such covenants within ten (10) days of the completion of the remedial action, together with a description of its good faith efforts to secure such covenants.

XXI. FINANCIAL ASSURANCE

A. Financial assurance for remedial action is required by WAC 173-340-440(11) and WAC 173-303-64620(1) and (2). Ecology's Financial Assurance Officer shall determine when GE's actions and submissions meet the requirements of these provisions.

B. GE must submit the original executed or otherwise finalized financial assurance instruments or documents to Ecology's Financial Assurance Officer; facsimiles or photocopies are not acceptable to meet this requirement. In addition, GE must also submit copies of financial assurance instruments or documents to Ecology's project coordinator.

C. Unless otherwise specified, the definitions and requirements for allowable financial assurance mechanisms set forth in the current financial assurance rules covering closure and post-closure (40 C.F.R. § 264.141, 40 C.F.R. § 264.142, 40 C.F.R. § 264.143, 40 C.F.R. § 264.145, 40 C.F.R. § 264.148, 40 C.F.R. § 264.151, and WAC 173-303-620) will be the definitions and requirements for allowable financial assurance for remedial actions under this Decree. It is the intention of the Parties that these definitions and requirements will

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

apply to this remedial action, and the words "remedial action" are hereby substituted for the words "closure," "post closure," "post-closure," or "postclosure" in the above listed regulations as needed to produce this result.

D. Ecology's Financial Assurance Officer will use the following resources as guidance (in no particular order of importance):

1. The Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Financial Assurance for Corrective Action Proposed Rule, 51 Fed. Reg. 37853 (Oct. 24, 1986);

2. The financial assurance provisions of Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities Advance Notice of Proposed Rulemaking, 61 Fed. Reg. 19432 (May 1, 1996);

3. The Interim Guidance on Financial Responsibility for Facilities Subject to RCRA Corrective Action (U.S. EPA, Sept. 30, 2003); and/or

4. Any other guidance applicable to financial assurance and corrective or remedial action that may be available at the time.

The financial assurance provisions of the Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities, 55 Fed. Reg. 30798 (July 27, 1990), may be used as secondary guidance at the discretion of Ecology. Unless otherwise specified herein, where the language of this Decree conflicts with these rules, proposed rules, notices, and guidance documents, the language of this Decree shall prevail.

E. Within thirty (30) days from the effective date of this Decree, GE shall submit to Ecology for review and approval a written cost estimate to cover the activities listed in the Scope of Work and Schedule (Exhibit C). If Ecology rejects GE's cost estimate as submitted, Ecology shall provide to GE a revised cost estimate amount that will be the approved cost estimate. Ecology will, if requested by GE in writing, provide a written explanation of the

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

variance between GE's proposed cost estimate and Ecology's approved cost estimate. Within thirty (30) days after Ecology's final approval of GE's cost estimate amount or GE's receipt of Ecology's approved cost estimate amount, GE shall establish and maintain continuous coverage of financial assurance in the amount of the approved cost estimate and submit the applicable financial assurance documentation per paragraph B of this section. If Ecology does not accept, reject, or revise GE's cost estimate within sixty (60) days after submittal, GE's cost estimate will be deemed approved for purposes of this paragraph. Ecology reserves the right to review and revise GE's cost estimate after the 60-day review period. If Ecology revises the GE's cost estimate after the 60-day review period, GE will have thirty (30) days after the revision to provide an updated financial assurance instrument.

F. If GE is required to submit an additional work plan(s) under this Decree, or to conduct activities related to remedial action not previously part of the original cost estimate, the process outlined in paragraph E above shall apply in the submission process of an additional work plan(s).

G. If GE believes that the estimated cost of work to complete activities under this Decree has diminished below the amount covered by existing financial assurance provided under this Decree, GE may submit a written proposal to Ecology to reduce the amount of the financial assurance provided under this section so that the amount of the financial assurance is equal to the estimated cost of the remaining work to be performed. The written proposal shall specify, at a minimum, the cost the remaining work to be performed and the basis upon which such cost was calculated. If Ecology decides to accept such a proposal, Ecology shall notify GE of its decision in writing. After receiving Ecology's written decision, GE may reduce the amount of financial assurance only in accordance with and to the extent permitted by such written decision. Within thirty (30) days after receipt of Ecology's written decision, GE shall submit the applicable financial assurance documentation per paragraph B of this section. No

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

change to the form or terms of any financial assurance provided under this section, other than a reduction in amount, is authorized under this paragraph.

H. All cost estimates must be based on the costs to the owner or operator of hiring a third party to complete the work. A third party is neither a parent nor a subsidiary of GE. On a case-by-case basis, Ecology may also determine that a company which shares a common higher-tier corporate parent or subsidiary might not qualify as a third party. A cost estimate may not incorporate any salvage value that may be realized with the sale of wastes, facility structures or equipment, land, or other assets associated with the facility. GE may also not incorporate a zero cost for wastes that might have economic value.

I. GE shall annually adjust all cost estimates for inflation. Adjustments for inflation shall be calculated in accordance with the procedure outlined in 40 C.F.R. § 264.143(b).

J. Acceptable financial assurance mechanisms are trust funds, surety bonds, letters of credit, insurance, the financial test, and the corporate guarantee. Ecology may allow other financial assurance mechanisms if they are consistent with the laws of Washington and if GE demonstrates to the satisfaction of Ecology that those mechanisms provide adequate financial assurance.

K. If GE is using the financial test or corporate guarantee to meet its financial assurance obligation, the annual inflationary adjustment shall occur within ninety (90) days after the close of GE's fiscal year. If GE is using any mechanism other than the financial test or corporate guarantee, this adjustment shall occur each year within thirty (30) days after the anniversary of the effective date of this Decree.

L. If GE seeks to establish financial assurance by using a surety bond for payment or a letter of credit, GE shall at the same time establish and thereafter maintain a standby trust fund acceptable to Ecology into which funds from the other financial assurance instrument can

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

be deposited, if the financial assurance provider is directed to do so by Ecology, pursuant to the terms of this Decree.

M. GE shall notify Ecology's project coordinator and Financial Assurance Officer by certified mail of the commencement of a voluntary or involuntary bankruptcy proceeding, naming GE as debtor, within ten (10) days after commencement of the proceeding. A guarantor of a corporate guarantee must make such a notification if it is named as debtor as required under the terms of the corporate guarantee.

N. Once GE has established financial assurance with an acceptable mechanism as described above, GE will be deemed to be without the required financial assurance:

1. In the event of bankruptcy of the trustee or issuing institution; or

2. If the authority of the trustee institution to act as trustee has been suspended or revoked; or

3. If the authority of the institution issuing the surety bond, letter or credit, or insurance policy has been suspended or revoked.

In the event of bankruptcy of the trustee or a suspension or revocation of the authority of the trustee institution to act as a trustee, GE must establish a replacement financial assurance mechanism by any means specified in WAC 173-303-620 or other financial instrument as approved by Ecology within sixty (60) days after such an event.

O. Ecology's Financial Assurance Officer is:

Kimberly Goetz
Department of Ecology
Hazardous Waste and Toxics Reduction Program
P.O. Box 47600
Olympia, WA 98504-7600
Telephone: (360) 407-6754
Fax: (360) 407-6715
E-mail: kimberly.goetz@ecy.wa.gov

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XXII. INDEMNIFICATION

Defendant agrees to indemnify and save and hold the State of Washington, its employees, and agents harmless from any and all claims or causes of action for death or injuries to persons or for loss or damage to property to the extent arising from or on account of acts or omissions of Defendant, its officers, employees, agents, or contractors in entering into and implementing this Decree. However, Defendant shall not indemnify the State of Washington nor save nor hold its employees and agents harmless from any claims or causes of action to the extent arising out of the negligent acts or omissions of the State of Washington, or the employees or agents of the State, in entering into or implementing this Decree.

XXIII. COMPLIANCE WITH APPLICABLE LAWS

A. All actions carried out by GE pursuant to this Decree shall be done in accordance with all applicable federal, state, and local requirements, including requirements to obtain necessary permits, except as provided in RCW 70.105D.090. The permits or other federal, state, or local requirements that Ecology has determined are applicable and that are known at the time of entry of this Decree have been identified in Exhibit F.

B. Pursuant to RCW 70.105D.090(1), GE is exempt from the procedural requirements of Chapters 70.94, 70.95, 70.105, 77.55, 90.48 RCW as it relates to state Waste Discharge Permits, and Chapter 90.58 RCW and of any laws requiring or authorizing local government permits or approvals. However, GE shall comply with the substantive requirements of such permits or approvals. The exempt permits or approvals and the applicable substantive requirements of those permits or approvals, as they are known at the time of entry of this Decree, have been identified in Exhibit F.

GE has a continuing obligation to determine whether additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under this Decree. In the event either Ecology or GE determines that additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

this Decree, it shall promptly notify the other party of this determination. Ecology and GE shall jointly determine whether Ecology or GE shall be responsible to contact the appropriate state and/or local agencies. If Ecology so requires, GE shall promptly consult with the appropriate state and/or local agencies and provide Ecology with written documentation from those agencies of the substantive requirements those agencies believe are applicable to the remedial action. Ecology shall make the final determination on the additional substantive requirements that must be met by GE and on how GE must meet those requirements. Ecology shall inform GE in writing of these requirements. Once established by Ecology, the additional requirements shall be enforceable requirements of this Decree. GE shall not begin or continue the remedial action potentially subject to the additional requirements until Ecology makes its final determination.

C. Pursuant to RCW 70.105D.090(2), in the event Ecology determines that the exemption from complying with the procedural requirements of the laws referenced in RCW 70.105D.090(1) would result in the loss of approval from a federal agency that is necessary for the State to administer any federal law, the exemption shall not apply and GE shall comply with both the procedural and substantive requirements of the laws referenced in RCW 70.105D.090(1), including any requirements to obtain permits.

XXIV. REMEDIAL ACTION COSTS

GE shall pay to Ecology costs incurred by Ecology pursuant to this Decree and consistent with WAC 173-340-550(2). These costs shall include work performed by Ecology or its contractors for, or on, the Site under Chapter 70.105D RCW, including remedial actions and Decree preparation, negotiation, oversight, and administration. These costs shall include work performed both prior to and subsequent to the entry of this Decree. Ecology's costs shall include costs of direct activities and support costs of direct activities as defined in WAC 173-340-550(2). GE shall pay $58,314.56 to Ecology for settlement of remedial action

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

costs related to this Site as of June 30, 2011. Payment shall be submitted within thirty (30) days of the effective date of this Decree, and any claim for the balance shall be released. Ecology shall not attempt to collect costs for any additional time incurred prior to June 30, 2011. For all costs incurred subsequent to June 30, 2011, GE shall pay the required amount within thirty (30) days of receiving from Ecology an itemized statement of costs that includes a summary of costs incurred, an identification of involved staff, and the amount of time spent by involved staff members on the project. A general statement of work performed will be provided upon request. Itemized statements shall be prepared quarterly. Pursuant to WAC 173-340-550(4), failure to pay Ecology's costs within ninety (90) days of receipt of the itemized statement of costs will result in interest charges at the rate of twelve percent (12%) per annum, compounded monthly.

In addition to other available relief, pursuant to RCW 70.105D.055, Ecology has authority to recover unreimbursed remedial action costs by filing a lien against real property subject to the remedial actions.

XXV. IMPLEMENTATION OF REMEDIAL ACTION

If Ecology determines that GE has failed without good cause to implement the remedial action, in whole or in part, Ecology may, after thirty (30) days written notice to GE, perform any or all portions of the remedial action that remain incomplete. If Ecology performs all or portions of the remedial action because of GE's failure to comply with its obligations under this Decree, GE shall reimburse Ecology for the costs of doing such work in accordance with Section XXIV (Remedial Action Costs), provided that GE is not obligated under this section to reimburse Ecology for costs incurred for work inconsistent with or beyond the scope of this Decree. GE and Ecology agree to first meet and confer before Ecology exercises its option under this section.

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

Except where necessary to abate an emergency situation, GE shall not perform any remedial actions at the Site outside those remedial actions required by this Decree, unless Ecology concurs, in writing, with such additional remedial actions pursuant to Section XV (Amendment of Decree).

XXVI. PERIODIC REVIEW

As remedial action, including groundwater monitoring, continues at the Site, the Parties agree to review the progress of remedial action at the Site, and to review the data accumulated as a result of monitoring the Site as often as is necessary and appropriate under the circumstances. At least every five (5) years after the initiation of cleanup action at the Site the Parties shall meet to discuss the status of the Site and the need, if any, for further remedial action at the Site. At least ninety (90) days prior to each periodic review, GE shall submit a report to Ecology that documents whether human health and the environment are being protected based on the factors set forth in WAC 173-340-420(4). Ecology reserves the right to require further remedial action at the Site under appropriate circumstances.

XXVII. PUBLIC PARTICIPATION

A Public Participation Plan (Exhibit E) is required for this Site. Ecology shall review any existing Public Participation Plan to determine its continued appropriateness and whether it requires amendment, or if no plan exists, Ecology shall develop a Public Participation Plan alone or in conjunction with GE.

Ecology shall maintain the responsibility for public participation at the Site. However, GE shall cooperate with Ecology, and shall:

A. If agreed to by Ecology, develop appropriate mailing list, prepare drafts of public notices and fact sheets at important stages of the remedial action, such as the submission of work plans, remedial investigation/feasibility study reports, cleanup action plans, and engineering design reports. As appropriate, Ecology will edit, finalize, and

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

distribute such fact sheets and prepare and distribute public notices of Ecology's presentations and meetings.

B. Notify Ecology's project coordinator prior to the preparation of all press releases and fact sheets, and before major meetings with the interested public and local governments, except as set forth below. Likewise, Ecology shall notify GE prior to the issuance of all press releases and fact sheets, and before major meetings with the interested public and local governments, except as set forth below. For all press releases, fact sheets, meetings, and other outreach efforts by GE that do not receive prior Ecology approval, GE shall clearly indicate to its audience that the press release, fact sheet, meeting, or other outreach effort was not sponsored or endorsed by Ecology. This section does not apply to communications by GE that are required or conducted pursuant to law(s) or regulations other than MTCA or the MTCA Cleanup Regulation, Chapter 173-340 WAC, or communications by GE with investors or insurance carriers.

C. When requested by Ecology, participate in public presentations on the progress of the remedial action at the Site. Participation may be through attendance at public meetings to assist in answering questions, or as a presenter.

D. When requested by Ecology, arrange and/or continue information repositories at the following locations:

1. New Holly Library
7058 32nd Avenue S.
Seattle, WA 98118

2. Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

At a minimum, copies of all public notices, fact sheets, and documents relating to public comment periods shall be promptly placed in these repositories. A copy of all documents related to this Site shall be maintained at these repositories.

XXVIII. DURATION OF DECREE

The remedial program required pursuant to this Decree shall be maintained and continued until GE has received written notification from Ecology that the requirements of this Decree have been satisfactorily completed. This Decree shall remain in effect until dismissed by the Court. When dismissed, Section XVIII (Covenant Not to Sue) and Section XIX (Contribution Protection) shall survive, in addition to any other sections that explicitly extend beyond the duration of the decree. Periodic review is not a basis for continuation of this Decree.

XXIX. CLAIMS AGAINST THE STATE

GE hereby agrees that it will not seek to recover any costs accrued in implementing the remedial action required by this Decree from the State of Washington or any of its agencies; and further, that GE will make no claim against the State Toxics Control Account or any local Toxics Control Account for any costs incurred in implementing this Decree. Except as provided above, however, GE expressly reserves its right to seek to recover any costs incurred in implementing this Decree from any other PLP. This section does not limit or address funding that may be provided under Chapter 173-322 WAC.

XXX. EFFECTIVE DATE

This Decree is effective upon the date it is entered by the Court.

\\\

\\\

\\\

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XXXI. WITHDRAWAL OF CONSENT

If the Court withholds or withdraws its consent to this Decree, it shall be null and void at the option of any party and the accompanying Complaint shall be dismissed without costs and without prejudice. In such an event, no party shall be bound by the requirements of this Decree.

STATE OF WASHINGTON DEPARTMENT OF ECOLOGY	ROBERT M. MCKENNA Attorney General
________________________ Katherine B. Seiler Program Manager Hazardous Waste & Toxics Reduction Program (360) 407-6702	________________________ Andrew A. Fitz, WSBA #22169 Senior Counsel (360) 586-6752
Date: ________________	Date: ________________
GENERAL ELECTRIC CO.	K&L GATES LLP Attorneys for Defendant
________________________ Ann R. Klee Vice President Environmental Health and Safety	William H. Chapman ________________________ William H. Chapman, WSBA #14294 Partner (206) 623-7580
Dated: ________________	Date: ________________

ENTERED this _____ day of _______________ 20____.

____
JUDGE
King County Superior Court

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

XXXI. WITHDRAWAL OF CONSENT

If the Court withholds or withdraws its consent to this Decree, it shall be null and void at the option of any party and the accompanying Complaint shall be dismissed without costs and without prejudice. In such an event, no party shall be bound by the requirements of this Decree.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Katherine B Seiler

Katherine B. Seiler
Program Manager
Hazardous Waste & Toxics Reduction Program
(360) 407-6702

Date: 3/26/14

ROBERT M. MCKENNA
Attorney General

Andrew A. Fitz, WSBA #22169
Senior Counsel
(360) 586-6752

Date: 3/27/14

GENERAL ELECTRIC CO.

____
Ann R. Klee
Vice President
Environmental Health and Safety

Dated: ______________

K&L GATES LLP
Attorneys for Defendant

____
William H. Chapman, WSBA #14294
Partner
(206) 623-7580

Date: ______________

ENTERED this ____ day of 3/3/14 20____.

____
JUDGE
King County Superior Court

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 586-6760

EXHIBIT A

Site Diagram

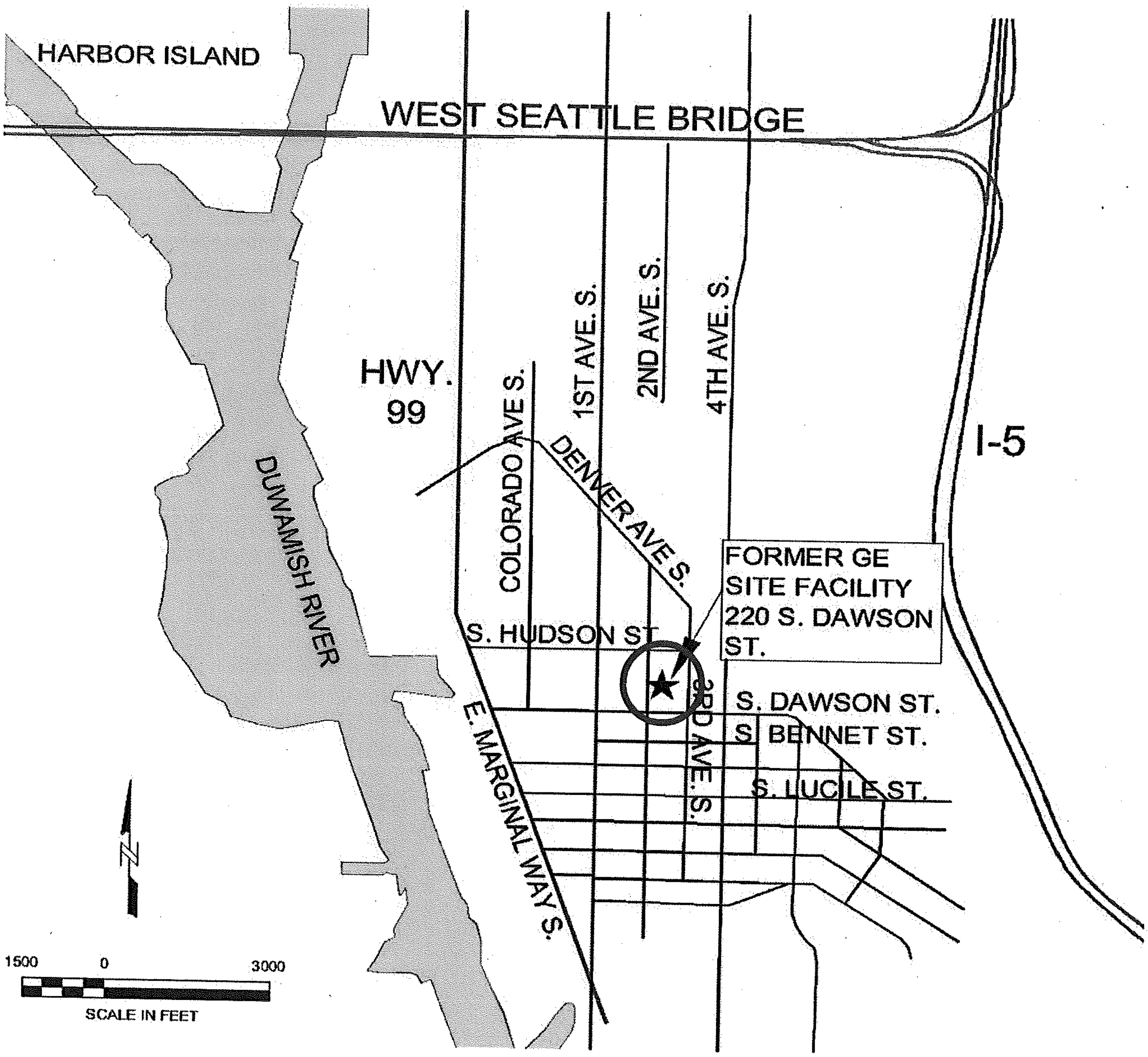


Exhibit A

SITE DIAGRAM

EXHIBIT B

<u>Cleanup Action Plan</u>

Cleanup Action Plan
GE South Dawson Street
Seattle, Washington

Washington State Department of Ecology

March 13, 2014

Contents

1.0 Introduction 1-1
1.1 Purpose of the Cleanup Action Plan 1-1
1.2 Purpose and Organization 1-3

2.0 Site Description and Background 2-1
2.1 Site Location and Use History 2-1
2.2 Surrounding Land Use 2-1

3.0 Remedial Investigation Summary 3-1
3.1 Investigative and Remedial History 3-1
3.1.1 Investigative History 3-1
3.1.2 Interim Actions 3-2
3.2 Geology 3-3
3.3 Hydrogeology 3-3
3.3.1 Groundwater Elevations and Gradients 3-4
3.3.2 Groundwater Recharge and Discharge 3-4
3.3.3 Aquifer Hydraulic Characteristics 3-4
3.4 Nature and Extent of Contaminated Media 3-5
3.4.1 Soil 3-6
3.4.2 Groundwater 3-7
3.4.3 Vapor 3-10
3.5 Exposure Assessment 3-11

4.0 Cleanup Standards and Immediate Action Levels 4-1
4.1 Groundwater Cleanup Levels and Points of Compliance 4-1
4.1.1 CVOCs, semi-volatiles and metals 4-1
4.1.2 TPH 4-3
4.2 Soil Cleanup Levels and Point of Compliance 4-3
4.2.1 CVOC 4-3
4.2.2 TPH 4-4
4.3 Indoor Air Cleanup Levels, Immediate Action Levels, and Points of Compliance 4-5
4.3.1 Cleanup Levels and Point of Compliance 4-5
4.3.2 Indoor Air Immediate Action Level 4-5
4.4 Applicable State and Federal Laws 4-6

5.0 Cleanup Alternatives 5-1
5.1 Alternative 1 – Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging and Subslab Depressurization System 5-1
5.1.1 Optimized Hydraulic Control 5-2
5.1.2 Soil Vapor Extraction/Air Sparging 5-2
5.1.3 Subslab Depressurization System 5-3
5.1.4 Institutional Controls 5-3
5.2 Alternative 2 – Optimized Hydraulic Control, *In situ* Chemical Oxidation, Subslab Depressurization System, Institutional Controls 5-3
5.2.1 Optimized Hydraulic Control 5-4
5.2.2 *In Situ* Chemical Oxidation 5-4
5.2.3 Subslab Depressurization System 5-5
5.2.4 Institutional controls 5-5
5.3 Modified Alternative 2 – Optimized Hydraulic Control, In-Situ Chemical Oxidation, Sub-Slab Depressurization System, and Institutional Controls 5-5
5.4 Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation and Subslab Depressurization System 5-6
5.4.1 Optimized Hydraulic Control 5-6
5.4.2 Enhanced Anaerobic Bioremediation 5-6
5.4.3 Subslab Depressurization System 5-8
5.4.4 Institutional Controls 5-8
5.5 Alternative 4 – Soil Vapor Extraction/ Air Sparging 5-8
5.5.1 SVE/AS System 5-8
5.5.2 Institutional Controls 5-8
5.6 Alternative 5 – *In Situ* Chemical Oxidation, Subslab Depressurization System and Institutional Controls 5-8
5.6.1 *In Situ* Chemical Oxidation 5-9
5.6.2 Subslab Depressurization System 5-9
5.6.3 Institutional Controls 5-9
5.7 Alternative 6 – Enhanced Anaerobic Bioremediation, Subslab Depressurization System and Institutional Controls 5-9
5.7.1 Enhanced Anaerobic Bioremediation 5-10
5.7.2 Subslab Depressurization System 5-10
5.7.3 Institutional Controls 5-10
5.8 Summary of Rationale for Selected Cleanup Action 5-10
5.8.1 Threshold Requirements-Initial Assessment of Alternatives 5-11
5.8.2 Additional Criteria 5-13
5.9 Selecting the Preferred Alternative 5-15

6.0 Ecology Final Site Cleanup Action –Modified Alternative 2 6-1

7.0 Contingent Remedy 7-1

8.0 References 8-1

List of Tables

Table 3-1 Summary of Vapor Intrusion Study - Subslab Samples Collected in the December 2005 Sampling Event – 220 South Dawson Street Building....3-9
Table 3-2 Summary of Vapor Intrusion Indoor Air and Ambient Air Sample Results for the 220 South Dawson Street Building.... 3-9
Table 4-1 Summary of Applicable Cleanup Levels and Points of Compliance for the Site 4-5
Table 4-2 Applicable State and Federal Laws 4-7

List of Figures

Figure 1 -1 Vicinity Map
Figure 1 -2 Approximate Site Location Map
Figure 3-1 Previous Investigations Location Map
Figure 3-2 2008 Cross Section Location Map
Figure 3-3a February 2008 Plan View Groundwater Concentration Contour - Trichloroethene
Figure 3-3b February 2008 Cross Section – Trichloroethene
Figure 3-4a February 2008 Plan View Groundwater Concentration Contour – cis-1,2-Dichloroethene
Figure 3-4b February 2008 Cross Section – cis-1,2-Dichloroethene
Figure 3-5 February 2008 Cross Section – 1,1-Dichloroethene
Figure 3-6 February 2008 Cross Section – 1,1,1-Trichloroethane
Figure 3-7 February 2008 Cross Section – Vinyl Chloride
Figure 3-8 February 2008 Cross Section – Tetrachloroethene
Figure 5-1 Alternative 1
Figure 5-2 Alternative 2
Figure 5-3 Subslab Depressurization System – Former GE Building
Figure 5-4 Alternative 3
Figure 5-5 Alternative 4
Figure 5-6 Alternative 5
Figure 5-7 Alternative 6
Figure 6-1 Selected Site Cleanup Action and the Approximate Site Boundaries

List of Acronyms

1, 1, 1,-TCA (TCA)	1, 1, 1-trichloroethane
AS	air sparging
bgs	below ground surface
CAP	Cleanup Action Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	contaminant (or "constituent") of concern
CPS	construction plans and specifications
CVOCs	Chlorinated Volatile Organic Compounds
CULs	cleanup levels
CWA	Federal Water Pollution Control Act – Clean Water Act
DCE	1, 1-dichloroethene
EAB	enhanced anaerobic bioremediation
Ecology	Washington State Department of Ecology
EDR	engineering design report
EISB	enhanced in situ bioremediation
EPA	U.S. Environmental Protection Agency
EPI	Environmental Partners, Inc.
EPC	exposure point concentration
FFS	focused feasibility study
GAC	granular active carbon
GE	General Electric
GPM	gallons per minute
IAL	immediate action level
IPIMAL	inhalation pathway interim measure action level
ISCO	in situ chemical oxidation
ISVE	in situ vapor extraction
$KMnO_4$	potassium permanganate
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meters

MCL	Maximum Contaminant Levels (Clean Water Act)
MSL	mean sea level
MTCA	State of Washington Model Toxics Control Act (Chapter 70.015D RCW)
NA	not applicable
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act (42 U.S.C. § 6901 et. seq.). In Washington State, Ecology has been authorized to enforce RCRA requirements through the Washington State Hazardous Waste Management Act (Chapter 70.105 RCW) and associated regulations.
RCW	Revised Code of Washington
ROI	radius of influence
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
VC	vinyl chloride
VCP	Voluntary Cleanup Program
VIM	vapor intrusion mitigation
VOCs	volatile organic compounds
WAC	Washington Administrative Code

1.0 Introduction

As required by the Washington Administrative Code (WAC) 173-340-380, the Washington State Department of Ecology (Ecology) is issuing this Cleanup Action Plan (CAP) for a cleanup action to be conducted by General Electric (GE) at the General Electric Aviation Div. Facility (hereinafter Facility or Site). The terms "site" and "facility" as used throughout this document are synonymous, and refer to the terms as they are defined under the Model Toxics Control Act (MTCA), Chapter 70.105D.020(5) and MTCA's implementing regulations, WAC 173-340-200. As currently understood by Ecology, this Site includes the 220 South Dawson Street Property, and those locations where contamination from the 220 South Dawson Street Property have come to be located. This includes properties directly north of the 220 South Dawson Street Property, and properties impacted downgradient. The approximate site boundaries are shown in figure 1-2.

1.1 Purpose of the Cleanup Action Plan

This CAP presents the cleanup action for the former GE Facility. The CAP provides a summary of the rationale to select the cleanup action, the cleanup standards to be achieved, the planned approach to achieve cleanup, the expected restoration timeframe, and a cost estimate of the cleanup action. This CAP also provides a brief summary of the results of GE's remedial investigation/feasibility (RI/FS) study work and the considered remedial alternatives.

A comment period was established to allow the public an opportunity to review the draft CAP and submit comments to Ecology. Once the comment period closed Ecology consideredall comments received before finalizing the CAP. In addressing the comments Ecology did not need to revise the CAP document and noadditional public comment on the CAP was required.

The CAP is intended to meet Corrective Action requirements under the Resource Conservation and Recovery Act (RCRA), Hazardous Waste Management Act, Chapter 70.105 RCW, and Dangerous Waste Regulations, WAC 173-303-646 (collectively hereinafter Corrective Action Requirements), as well as the requirements of MTCA and its implementing regulations (Chapter 173-340 WAC). The Department of Ecology, Hazardous Waste and Toxics Reduction (HWTR) Program is overseeing compliance with these requirements for this Facility.

The combination of actions summarized below has been developed to constitute the most permanent, practicable cleanup action for the Site. Ecology has made the preliminary determination that this cleanup action meets the threshold requirements of WAC 173-340-360 to:

- Protect human health and the environment,
- Comply with cleanup standards,
- Comply with applicable state and federal laws, and
- Provide for compliance monitoring.

This combination of actions also meets the requirements of WAC 173-340-360 to:

- Use permanent solutions to the maximum extent practicable.
- Provide for a reasonable restoration timeframe.
- Consider public concerns.

In brief, the principal features of the cleanup action at the Site are the implementation of permanganate in-situ chemical oxidation (ISCO) treatments at the Site and concurrent optimized hydraulic control at 2nd Avenue South as shown in Figure 6-1 and discussed in more detail in Section 6. A monitoring program will be implemented to confirm the effectiveness of the ISCO treatment and optimized hydraulic control.

There will be on-going operation and maintenance of the 220 S. Dawson Street vapor intrusion mitigation system until indoor air cleanup standards are achieved. Institutional controls, including financial assurances, will also be in place to help ensure the long-term operation and maintenance of the final remedial system.

1.1.1 Human Health and Environmental Concerns: Contamination at the Site poses a threat to human health and the environment, which is thus the subject of this CAP. The main human health and ecological concerns are briefly described below. There are also additional chemicals of concern not described here that are included in the cleanup level tables (see Table 4-1), which include arsenic, petroleum as diesel and heavy oil, and 1,4 dioxane.

- Chlorinated solvent contaminated soil presents a potential dermal, ingestion and inhalation exposure to construction workers, utility workers, and employees that work below grade in the chlorinated solvent release areas of the 220 S. Dawson Street property.

  Likewise chlorinated solvent contaminated groundwater presents a potential dermal, ingestion and inhalation exposure to construction workers, utility workers, and employees that work below grade.

- Chlorinated solvent contamination in groundwater poses a potential ingestion, dermal, and inhalation exposure if groundwater is extracted for above ground use, though at this time the groundwater is not being used for potable purposes.

- Chlorinated solvent contaminated groundwater has the potential to migrate to the Duwamish River resulting in the consumption of impacted fish as well as ecological receptor exposure.

- Chlorinated solvent contaminated groundwater site wide and chlorinated solvent contaminated soils at the 220 S. Dawson Street building have the potential to produce indoor air contamination above cleanup levels in buildings located above or near the contaminated soil or groundwater without proper operation of an adequate optimized groundwater hydraulic control system, operation of the 220 S. Dawson Street building vapor intrusion mitigation system, and institutional controls to prevent building work that could exacerbate the vapor intrusion pathway. Chlorinated solvent contaminated groundwater also has the potential to create indoor air contamination above cleanup levels in new or existing buildings near or directly above the contaminated groundwater if the underlying groundwater contamination increases.

1.2 Purpose and Organization

The purpose of this CAP is to describe Ecology's cleanup action for the Site, consistent with WAC 173-340-380 of MTCA and with Corrective Action Requirements. The CAP provides the following information:

- Brief site description and background (Section 2)
- Brief summary of remedial investigation and current environmental conditions (Section 3)
- Cleanup requirements applicable to the Site, including cleanup levels, point of compliance and other federal, state, and local requirements (Section 4)
- Brief summary description of the remedial alternatives evaluated in the Focused Feasibility Study (FFS) and Ecology rationale for selection of the cleanup alternative (Section 5)
- A description of the selected cleanup action (Section 6)
- Financial Assurance and Cost Estimate Requirements (Section 6)
- Description of the schedule for implementation of the cleanup action (Section 7)
- List of the references cited in this report (Section 8).

This CAP will be incorporated in a judicially-approved Consent Decree. As part of the design phase of the cleanup, a draft Engineering Design Report (EDR), Construction Plans and Specification Report, and other deliverables will be prepared for Ecology review and approval. The draft EDR will contain design details on the Ecology cleanup action, as well as Compliance Monitoring Plans. Following Ecology approval of the EDR, the cleanup action will be implemented.

2.0 Site Description and Background

2.1 Site Location and Use History

The Site is located within the Northwest Quarter of Section 20, Range 4 East, Township 24 North, of the U.S. Geological Survey, Seattle South, Washington, 7.5-minute quadrangle (Figure 1 -1). The Site is defined by the extent of contamination caused by the release of hazardous substances at the Site. The Site is generally described in the site location map, Figure 1-2. The ground surface is approximately 15 feet above mean sea level (MSL) and generally slopes to the west at a gradient of 1 to 3 feet per mile. There is no apparent topographic relief across the Site.

The 220 South Dawson Street Property is occupied by a building that was originally constructed in 1949. The building is surrounded by asphalt pavement. GE occupied the premises in 1949 and began the manufacture and repair of equipment used in aircraft in 1959.

The General Electric Aviation-Dawson (GEA/D) manufacturing facility is an interim status dangerous waste storage facility and operated its dangerous waste container storage unit from the time its Part A application was filed in August 1980 until 1989. However, from 1989 through early 1994 dangerous wastes were only accumulated for less than 90 days in the container storage area. The dangerous waste storage area was used to store various solvents, petroleum products and acids including TCE, 1,1,1-TCE, and PCE. These solvents, along with their breakdown products and impurities (cis-1,2 dichloroethylene, trans-1,2 dichloroethylene, 1,1-dichloroethylene, vinyl chloride, 1,4-dioxane) and arsenic are the primary contaminants for the cleanup.

The RCRA closure procedures for the dangerous waste storage area were three-fold: (1) remove any contaminated asphalt in the storage area, (2) remove any contaminated soils which exceed the clean closure performance standard defined in the May 1994 closure plan submittal and (3) perform confirmatory soil sampling to ensure that the clean closure performance standards were met.

Manufacturing operations ceased in 1994, and GE continued to use the property for office and warehouse space until it sold the property to new owners in 1996. Since 1996, the building has been used for various warehousing operations by the new owners and/or their tenants.

GE completed closure of its dangerous waste storage unit in 1995. However, in addition to the closure requirements described above, MTCA and Corrective Action Requirements also mandate that GE conduct an investigation and cleanup of the Site. That cleanup is the subject of this CAP, which will satisfy both MTCA and HWMA Corrective Action Requirements.

2.2 Surrounding Land Use

The Site, which lies within the Duwamish industrial corridor, is zoned General Industrial 2 (IG2) and is within the Urban designation of the Shoreline District Overlay (U/85) (City of Seattle 2008 zoning maps: (http://www.seattle.gov/dpd/Research/Zoning_Maps/default.asp). Land uses in the Duwamish industrial corridor are predominantly light industrial (e.g., manufacturing and warehousing) with some commercial businesses, occasional residences, and vacant lots. The adjacent properties and properties between the Site and Slip 1 of the Lower Duwamish Waterway (Slip 1 is approximately 1,600 feet from the 220 South Dawson Street building, Figure 1-1) are currently used or zoned for industrial purposes, which in the City of Seattle allows for some commercial use. Immediately south of the Site (cross-gradient), two residences are located between industrial operations. At the time of this plan, one of the residences appeared to be abandoned.

Directly to the north of the 220 South Dawson Street property is the McKinstry building. Immediately west (and downgradient) are the Iridio building at 5050 1st Avenue South and a lot with a recently demolished building at 5033 1st Avenue South. These properties are known to be above the chlorinated solvent groundwater plume resulting from spills and leaks at the 220 South Dawson Street property.

The Duwamish Valley is an area known to be the subject of multiple historic releases. As of June 2006, there were 76 MTCA and/or Corrective Action sites, 8 Voluntary Cleanup Program (VCP) sites, 15 leaking underground storage tank sites (UST), 18 sites with registered USTs, and 1 active Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site in the vicinity of the Site. Most of these sites have contaminated groundwater. In addition, the King County Department of Health reports that numerous landfills were historically located in the Duwamish industrial corridor, including at least one within 1,500 feet of the 220 South Dawson Street property. The locations and boundaries of some of the landfills in the Duwamish area, as well as the years of operation and the types of wastes accepted, are not known.

3.0 Remedial Investigation Summary

The FFS as revised and approved by Ecology provides a comprehensive discussion of the nature and extent of contamination at the Site that support Ecology's selection of the final remedy (AECOM 2008; Ecology 2008/2009a/2009b). This section provides a brief summary of the nature and extent of contamination at the Site supporting Ecology's selection of the final remedy

For discussion-only purposes in this CAP, the Site is described as the on-property area and the off-property area. The on-property area includes the 220 S Dawson Street property, which contains the former GE building. The off-property area includes all other areas of the Site besides the 220 South Dawson Street property. The approximate Site boundaries are shown on Figure 1-2).

3.1 Investigative and Remedial History

3.1.1 Investigative History

Releases occurred to the subsurface soils and groundwater from past GE operational practices at the former GE 220 S. Dawson Street facility or released from the aquifer as a result of changes in geochemical conditions resulting from those releases.

Chlorinated volatile organic compounds (CVOCs) are in soil, shallow groundwater, and soil gas/vapors at the former GE building on the 220 South Dawson Street property. The CVOCs found at the Site include PCE, TCE, 1,1,1-TCA, 1,1-dichloroethene (DCE), cis-1,2 dichloroethene, trans-1,2-dichloroethene, vinyl chloride (VC). Elevated arsenic and 1,4 dioxane are also in groundwater.

Quarterly groundwater monitoring has been performed since 1997. The groundwater monitoring events include collecting samples from monitoring wells located upgradient, crossgradient, and downgradient of contaminated groundwater areas.

In 2001, Environmental Partners, Inc. (EPI), conducted investigations at the adjacent property (Liberty Ridge, formerly Western Cartage located at 5050 1st Avenue South) which is downgradient of the 220 South Dawson Street property to characterize soil and groundwater contamination (EPI 2001). EPI designed their investigation to focus on the most probable contaminant source areas beneath the Liberty Ridge building and no on-property TCE sources were identified. Results of the EPI investigation generally confirmed the groundwater quality data collected during the GE quarterly groundwater monitoring events showing low levels of CVOCs in groundwater consistent with contaminant migration from sources at the 220 South Dawson Street property. The EPI investigation results did not reveal any contaminant sources other than those sources associated with GE's historic activities at the 220 South Dawson Street property. GE began sampling several of the EPI wells as part of its quarterly monitoring program in February 2004.

An initial evaluation of the indoor air, at the former GE building located at 220 South Dawson Street, was conducted in 2004 using models to predict the expected indoor air volatile concentrations based on known volatile contaminant concentrations in the underlying groundwater. Ecology did not agree with modeling parameters and analysis, and thus did not approve the model results. Pursuant to the 2002 Agreed Order, in December 2005, GE collected subslab vapor, indoor and ambient air samples to evaluate the conditions within the GE building. Three additional rounds of indoor and ambient air sampling were conducted in 2006 and 2007. Pursuant to the results of the indoor air sample data and a subsequent 2007 Agreed Order between Ecology and GE, GE installed a subslab depressurization system in June 2007 and confirmation indoor and ambient air sampling was conducted in November 2007 (AECOM 2008). Monthly and annual checks on the vapor intrusion mitigation (VIM) system have been required up until the time of this Cleanup Action Plan.

In 2006 an evaluation of the indoor air and potential exposure conditions performed at the former Interior Environments buildings located at 5033 1st Avenue South, downgradient of the former GE building indicated no unacceptable excess cancer exposure risk above 1EE-05, the basis Ecology used to determine if an interim action (such as the installation of a vapor intrusion mitigation system) would be necessary. (RETEC 2006). Ecology notes that this evaluation was not intended to determine compliance with the groundwater and indoor air cleanup levels where an individual excess cancer risk of 1EE-06 per constituent and total excess cancer risk of 1EE-05 is required.

3.1.2 Interim Actions

In 1995 and 1996 an independent interim action for soil was conducted in the on-property area (220 South Dawson Street), which included CVOC contaminated soil removal. GE excavated over 3,000 tons of soil from the areas shown on Figure 3-1. Most of the soils above the water table with concentrations above 1995 MTCA residential /unrestricted criteria protection of groundwater were removed. Excavation and removal of CVOC contaminated soils exceeding the 1995 cleanup levels and below the water table was not planned nor performed. Small volumes of contaminated soils exceeding the 1995 cleanup levels in the unsaturated zone remain in inaccessible areas beneath the building's structural footings, near a transformer and beneath a utility pole (Area 1, Area 7, and Area 9, as shown on Figure 3-1 (Dames & Moore 1996). The current MTCA unrestricted chlorinated solvent constituent soil and groundwater cleanup levels in this CAP are lower than the cleanup values in 1995. Therefore, there are currently more on-property contaminated soils requiring remediation under this CAP than estimated in 1996. Additionally, unknown volumes of contaminated soil remain below the water table in the saturated zone. An independent interim action groundwater recovery system (which includes groundwater extraction and discharge) was designed and constructed in 1996 and began operating in August 1996. Groundwater was recovered from two wells (RW-1 and RW-2, shown on Figure 3-1) on the downgradient side of the 220 South Dawson Street property with the objective of containing and recovering contaminated groundwater beneath the property. This work was not reviewed or approved by Ecology; however, Ecology does believe it has significantly reduced off-property (beyond 2nd Avenue South) migration of the chlorinated solvent groundwater plume.

In 2002 Ecology and GE entered into an Agreed Order to complete the contaminated groundwater investigation, investigate indoor air contamination via the vapor intrusion pathway, and continue operation of the current groundwater extraction system with the addition of a source area pumping well, RW-3. In August 2003 the groundwater recovery system was modified as required in the 2002 MTCA Agreed Order (Ecology 2002). A new recovery well (RW-3) was added and pumping locations and pumping rates were modified. The objective of this modified groundwater recovery system was to better contain and recover contaminated groundwater, focusing on the source area in the northern portion of the property. RW-2 and RW-

3 groundwater recovery wells are designed to operate at a combined rate of 16 gallons per minute (gpm) with discharge to King County sewer. GE is required to implement recovery well operating and maintenance procedures to maintain RW-2 and RW-3 pumping rates as close to their design rates, 6.0 gpm and 10.0 gpm, respectively. GE continues to operate the RW-2/RW-3 groundwater extraction system.

Based on the results of indoor air sampling showing unacceptably elevated TCE indoor concentrations (excess cancer risk above 1EE-05) in the 220 South Dawson Street building, Ecology and GE entered into an Agreed Order in 2007 requiring GE to operate and maintain a VIM system at the 220 S. Dawson Street building

3.2 Geology

The Site lies in a depositional basin referred to as the Duwamish Trough. The basin holds up to approximately 200 feet of sediments deposited by the Duwamish River (deltaic, estuarine, and alluvial) and volcanic lahar deposits. The Duwamish Trough is bounded and floored by bedrock consisting of sedimentary rock and limited volcanic intrusive rocks. The recent alluvium filling the trough includes sands and silts deposited by the Duwamish River and its tributaries. In the vicinity of the Site, the mudflows have not been encountered, and the lower alluvial deposits consist typically of fine sands and silts with shells. This alluvial sequence grades upward from estuarine to a more river-dominated depositional sequence, with complexly interbedded sand, silt, and gravel (Fabritz, Massman and Booth 1998). In the late 1800s and early 1900s, during development of Seattle, the tide flat and flood plain were reclaimed for development through channelization of the Duwamish River and placement of fill. In many cases, the contact between fill and native soils is difficult to discern as the fill used is similar to the native soil.

Site investigation work has extended to a maximum depth of 65 feet below ground surface (feet bgs), approximately one-quarter to one-third of the total depth of the alluvial valley deposits. This upper 65 feet of the approximately 200-foot valley deposits is interpreted to be equivalent to the river-dominated sequence of interbedded sand, silt and gravel (Fabritz, Massman and Booth 1998). However, in the vicinity of the Site, the stratigraphic sequence consists predominantly of sand and silty sand. Gravel has not been encountered and silt beds within the native alluvium are limited and generally not continuous. Site boring logs show relatively uniform silty sand and sand with thin discontinuous silt layers extending to a depth of 57 feet bgs. Deeper borings suggest that the interval between the 30- to 50-foot depths contains some thin discontinuous silt layer.

3.3 Hydrogeology

According to the *Duwamish Basin Groundwater Pathways Conceptual Model Report*, regionally the Duwamish River Valley is considered "a single, large aquifer system" due to the "singular nature of its geologic origin and its location within a valley bounded both laterally and vertically by walls comprised of bedrock, silts, and dense glacially overridden strata" (Duwamish Study, 1998). Investigations associated with the GE Site have focused on the uppermost 65 feet of this approximately 200-foot thick aquifer. Terms used in this report such as "shallow" and "deep" groundwater refer only to the portion of the aquifer studied and are not meant to imply that it is the "deep" portion of the whole aquifer in the greater Duwamish Valley.

For the purposes of the Site RI/FS, three aquifer zones (intervals) were defined in the upper 65 feet of the regional aquifer. The shallow zone of the aquifer is defined as the top of the water table down to approximately 20 feet bgs. The term "intermediate zone" is defined as the aquifer zone from 20 to approximately 40 feet bgs. The term "deep zone" of the aquifer is defined as the aquifer zone below 40 to approximately 65 feet bgs.

3.3.1 Groundwater Elevations and Gradients

Groundwater occurs under unconfined conditions in the aquifer zones beneath the affected properties. Groundwater is generally encountered between 7 and 11 feet bgs. Water levels varied seasonally by between 1.0 and 1.5 feet, with highest water levels measured in February and lower levels measured in August.

Overall groundwater flow is from the east to the west and slightly southwest. Flow directions in the vicinity of pumping wells RW-2 and RW-3 vary, as these are influenced by the ongoing groundwater recovery. The overall flow direction is consistent with the measured groundwater flow direction prior to the installation of the recovery system. Horizontal hydraulic gradients generally range from 0.0003 to 0.002 feet/feet in the shallow aquifer zone.

Vertical hydraulic gradients between shallow and intermediate as well as between intermediate to deep aquifer zone are small, generally range from +0.01 to -0.005 ft/ft. The water level elevation differences between different aquifer zones are generally less than 0.05 feet. A slightly downward hydraulic gradient is generally observed during the raining season, probably due to infiltration recharge occurred at unpaved ground surfaces.

3.3.2 Groundwater Recharge and Discharge

The Duwamish Study (1998) estimates that infiltration recharge on the eastern side of the Duwamish Valley is generally less than 10 inches per year. The Site (in particular near 220 S. Dawson Street) is currently capped with asphalt and concrete, however, historically the extent of this coverage was not as complete.

Groundwater recharge to the Site is primarily lateral flow from the eastern side of the Duwamish Valley. Limited infiltration recharge may also occur through bare ground surfaces or leaky storm water lines. Groundwater discharge occurs as lateral flow to the west toward the Duwamish waterway. No surface water ponds or wetlands exist at the vicinity the Site.

3.3.3 Aquifer Hydraulic Characteristics

Two pumping tests were conducted in May 1996 and August 2003 to characterize aquifer hydraulic properties. Aquifer hydraulic properties estimated from the pumping test data indicate that the shallow aquifer zone is relatively homogeneous and fairly conductive. Transmissivity values estimated by GE (RETEC 2007) range from 2,700 to 7,400 feet^2/day. Additional pumping test data analysis conducted by Ecology (2008a) estimated transmissivity values at the Site ranging from 2,800 to 14,000 feet^2/day. Assuming the shallow aquifer zone thickness of 15 feet, hydraulic conductivity will range from 185 to 930 feet/day.

3.4 Nature and Extent of Contaminated Media

The primary contaminants of concerns (COCs) for soil, groundwater and vapor, as defined in the 2008 Agreed Order, include: TCE, 1,1,1-TCA, PCE, cis-1,2- dichloroethene (cis-1,2 DCE), trans-1,2-dichloro-ethylene, 1,1-dichloroethene, VC, arsenic, petroleum hydrocarbons as diesel and heavy oil, and 1,4-dioxane. Arsenic and 1,4-dioxane are not volatile substances and are not considered potential vapor intrusion COCs.

Releases occurred to the subsurface soils and groundwater from past GE operational practices at the former GE 220 S. Dawson Street facility or released from the aquifer as a result of changes in geochemical conditions resulting from those releases. Chemical data and other characterization information collected during site investigations have delineated the extent of contaminated groundwater, soil, and air at the Site. The following subsections provide an overview of the information presented in the above-referenced documents.

The source area of the TCE, 1,1,1-TCA and TPH groundwater and soil contamination is the north section of the 220 South Dawson Street property where spillage and leakage of TCE, 1,1,1-TCA and petroleum hydrocarbon products occurred as a result of using chlorinated solvent degreasers and cutting machinery; leakage and spills of TCE and 1,1,1- TCA solvent product and RCRA waste; and leakage and spills of machine oils and engine oils within the north section of the building. The quantity of the solvent products spilled and leaked to subsurface and absorbed to vadose soil was unknown. Some of the contaminated vadose zone soil was excavated but approximately 100 cubic yards remained because of building foundation stability concerns. Chlorinated solvents and petroleum hydrocarbons migrated through the vadose soils into the groundwater (approximately 7-10 feet below ground surface). The solvent and petroleum hydrocarbon products may have spread during the vertical infiltration through the vadose zone because of discontinuous thin layers of silt. The chlorinated VOC and petroleum hydrocarbon contaminants adsorbed onto the organic contents of soil will become a secondary source of the contamination. Absorbed soil concentrations and dissolved groundwater concentrations do not indicate the presence of dense aqueous phase liquid (DNAPL) at the Site.

Migration of chlorinated solvents and petroleum hydrocarbon products in groundwater are mainly through the dissolved phase. Fate and transport of dissolved contaminants are primarily controlled by groundwater advection, dispersion/diffusion, retardation due to sorption, and degradation (reductive dechlorination). Reductive dechlorination of PCE and TCE by natural attenuation (NA) processes may have occurred at the Site, but effectiveness of the NA has not been determined. Dissolved chlorinated VOC plumes have spread and migrated under the southern portion of the 220 S. Dawson Street building, and the southern portion of the McKinstry building (to the north), and westwardly past First Avenue South. The dissolved CVOC plume continued to migrate westwardly and vertically, and in the downgradient area near First Ave S, to a depth of approximately 45 to 55 feet bgs most likely through groundwater advection and dispersion. The current groundwater extraction system serves to reduce the footprint of the chlorinated solvent contaminated groundwater plume beneath the 220 South Dawson Street building and reduce the spreading via dispersion of groundwater contamination to the north and migration via advection westerly beyond the 220 South Dawson Street property. The groundwater extraction system has also reduced the footprint for vapor intrusion in buildings above the on-property and off-property groundwater plume. Ecology's data analysis shows complete hydraulic containment of the on-property groundwater plume is not achieved; however, there is significant mass flux reduction to off-properties.

3.4.1 Soil

Following the interim action soil removal, described in Section 3.1.2, above, it is estimated that less than 100 cubic yards of chlorinated solvent contaminated soil remain above the water table in the inaccessible areas beneath the building and electrical poles located adjacent to the building. The amount of chlorinated solvent contaminated soil below the water table that exceeds current cleanup standards is currently unknown. However, because the actions selected in this CAP should remediate the contaminated saturated zone soils as further explained in Section 6.0, Ecology has determined that further investigation into the soil volume in the saturated zone is unnecessary at this time. Soil results collected during the 1995/6 independent interim action are summarized below.

TPH-Diesel and Heavy Oil Range – The Method A Cleanup Level for TPH gasoline without benzene is 100 mg/kg. TPH detected at the Site was in the heavy oil range (with a MTCA Method A Cleanup Level of 2,000 mg/kg). Only post-excavation samples in Areas 1 and 9 were above 100 mg/kg. A limited amount of inaccessible soil with TPH concentrations exceeding 100 mg/kg was left in place along the north and west side-walls at the northwestern corner of Area 1 (concentrations ranged from 167 to 356 mg/kg). The building foundations prohibited further excavation in Area 1. Soil with TPH concentrations exceeding 100 mg/kg was also left in place in Area 9 along the east and south side-walls (the maximum concentration detected was 10,900 mg/kg). At the time, soil was inaccessible in this area because of an active transformer and an adjacent power pole. Excavation areas are shown on Figure 3-1.

CVOCs – The sample detection limit for the 1995-6 independent excavation for TCE was 0.05 mg/kg. TCE above the 1995 cleanup level applicable at the time of the removal (0.398 mg/kg), was left in place beneath the footing of a load-bearing exterior wall and in the north-central side wall (maximum values of TCE detected at 1.16 mg/kg) and the north-eastern side wall (maximum values of TCE detected a 0.67 mg/kg in Area 7. Residual TCE in soils in the former underground storage tank area (Area 8) are also present (just north of MW-5) at 15.3 mg/kg. All post-excavation samples in Area 7 were below PCE cleanup levels that were applicable at the time of sampling (0.086 mg/kg). The sample detection limit for the 1996 excavation for PCE was 0.05 mg/kg. One floor soil sample from Area 7 at 10 feet bgs reported a value of 0.06 mg/kg (sample ID S-7-34). All other samples were reported to be at or below the laboratory detection limit of 0.06 mg/kg. As indicated earlier, the current TCE soil cleanup levels (protective of indoor air and groundwater cleanup levels) have decreased since the 1995-6 independent action. The TCE soil cleanup level under this CAP is 0.044 µg/L for protection of groundwater only. TCE soil cleanup levels under this CAP for the protection of indoor air are evaluated per Section 4.2 of this CAP. Excavation areas are shown on Figure 3-1.

- **Inorganic –** Confirmation sampling of Areas 1 through 12 produced inorganic concentrations consistently below the applicable cleanup level for soil. The cleanup levels for arsenic, cadmium, and lead were at or below the current MTCA Method A or B standards for unrestricted land use. Barium was excavated to a cleanup level of 112 mg/kg. Barium does not have a MTCA Method A soil cleanup level; the MTCA Method B standard for barium is 16,000 mg/kg. Based on the 1996 reports, soil in the excavated areas does not contain inorganics above the current MTCA Method A or B soil cleanup levels. Excavation areas are shown on Figure 3-1.

3.4.2 Groundwater

The monitoring well network is shown on Figure 1-2 and includes the following wells. Wells were initially installed in 1992 and 1994 as part of an independent action. Subsequently, additional groundwater wells were installed under the 2002 Ecology-GE Agreed Order:

- **Shallow (Water Table) Wells –** MW-1 through MW-13, MW-21S and EPI-MW-3S and -4S, are all screened across the water table, to a total depth of 15 to 20 feet bgs
- **Intermediate Wells –** MW-8M, -14M, -15M, -16M, -17M, -18M, -19M, and -20M are all screened from approximately 20 to 30 feet bgs. EPI-MW-2D, -3D and -4D are all screened 25 to 30 feet bgs
- **Deep Wells –** MW-14D, -15D -16D, -17D, and -18D are all screened from 45 to 55 feet bgs.

Groundwater is routinely analyzed for CVOCs including: TCE, PCE, 1,1-Dichlororethene, 1,1-DCA,1,1,1-TCA, cis-1,2-DCE, trans-1,2-dichloroethene, and VC. Several groundwater samples were analyzed for 1,4 dioxane and arsenic.

Groundwater cleanup levels are discussed in Section 4. Ecology has determined that shallow zone groundwater, which includes the water at the water table to 20 feet bgs will be expected to meet cleanup levels that are protective of indoor air, surface water receptors- area-specific consumption of fish, and ecological receptors. These cleanup levels are referred to as "shallow site-specific MTCA Method B cleanup levels. Groundwater in the "intermediate" and "deep" aquifer zones (all groundwater below 20 feet) will be expected to meet cleanup levels that are protective of surface water receptors- area-specific consumption of fish, and ecological receptors. These cleanup levels are referred to as "deeper site-specific MTCA Method B cleanup levels." Figures 3-2 through 3-8 provide plan and cross section views of the current CVOC distribution.

3.4.2.1 Shallow Zone Groundwater

Trichloroethylene – Chlorinated degreaser solvent used at the 220 S. Dawson Street facility. TCE is present at concentrations above the shallow site-specific MTCA Method B cleanup level (6.6 µg/L) in the following shallow wells, MW-1, MW-2, MW-3, MW-4, MW-6, MW-7, MW-8S, MW-11, MW-21S, EPI-MW-3S and EPI-MW-4S. TCE concentrations detected above the cleanup level range from a minimum value of 6.7 µg/L (MW-2, 1993) to a maximum value of 720 µg/L (MW-1, 1992). Figures 3-3a and b show TCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Cis-1,2-Dichloroethylene – A degradation product of TCE. The shallow site-specific MTCA Method B cleanup level for cis-1,2 DCE is 590 µg/L. The cis-1,2-DCE concentrations detected range from a minimum value of 210 µg/L (MW-8S, 8/12-1998 and 6/8-1999) to a maximum value of 370 µg/L (MW-8S, 1994). Figures 3-4a and b show cis-1, 2-DCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1,1-Trichloroethane – Chlorinated degreaser solvent used at the 220 S. Dawson Street facility. The shallow site-specific MTCA Method B cleanup level for 1,1,1-TCA is 11 µg/L. Exceedance of this cleanup level has been detected in well MW-1, MW-2, MW-4, MW-5, MW-6, MW-7 and historically at MW-8S.1,1,1-TCA concentrations detected above the cleanup level range from a minimum value of 12 µg/L (MW-4, 2004, 2005, 2006; MW-7, 2002) to a maximum value of 2600 µg/L (MW-1, 1992). Figure 3-5 shows 1,1,1-TCA concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1-Dichlororethene – A degradation product of 1,1,1-Trichloroethane. The shallow site-specific MTCA Method B cleanup level for 1,1-DCE is 3.2 µg/L. 1,1-DCE concentrations detected above the cleanup level range from a minimum value of 3.3 µg/L (MW-4, 2001) to a maximum value of 360 µg/L (MW-6, 1995). Figure 3-6 shows DCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1-Dichloroethane – No shallow site-specific MTCA Method B cleanup level exists for 1,1-DCA.

Vinyl Chloride – A degradation product of trichloroethene and cis-1,2-DCE. VC was detected above the shallow site-specific MTCA Method B cleanup level of 1.0 µg/L in well MW-4, MW-6, MW-7, and MW-8S of the shallow wells. VC concentrations detected above the cleanup level range from a minimum value of 1.1 µg/L (MW-6,1997) to a maximum value of 8.6 µg/L (MW-8S (duplicate),1997). Figure 3-7 shows vinyl chloride concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Tetrachloroethylene – A product that is frequently found with trichloroethene solvents. The shallow site-specific MTCA Method B cleanup level for PCE is 3.3 µg/L. Concentrations above this cleanup level were detected in wells: MW-1, MW-4, and MW-6 historically. PCE concentrations detected above the cleanup level range from a minimum value of 3.4 µg/L (MW-1; 2002) to a maximum value of 22 µg/L (MW-1, 1992). Figure 3-8 shows PCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Trans-1,2-Dichloroethylene – A degradation product of trichloroethene. The shallow site-specific MTCA Method B cleanup level for trans-1,2-Dichloroethylene is 163 µg/L. No trans-1,2-Dichloroethylene concentrations in shallow wells exceeded this cleanup level.

Arsenic – The shallow site-specific MTCA Method B cleanup level (based on natural background) for Arsenic is 5 µg/L. Dissolved arsenic was detected in groundwater above the cleanup level in groundwater collected from well MW-6, MW-13, EPI-MW-3S, and EPI-MW-4S. Dissolved arsenic is likely a result of the locally geochemically reduced shallow aquifer conditions that accompany the degradation of trichloroethene. Arsenic concentrations detected above the cleanup level range from a minimum value of 5 µg/L (MW-6, 2003 and MW-13, 2003 and 2004) to a maximum value of 26 µg/L (EPI-MW-4S, 2008).

1,4-Dioxane – A chemical stabilizer that is mixed in small concentrations with trichloroethene and 1,1,1-trichloroethane. The shallow site-specific MTCA Method B cleanup level for 1,4-Dioxane is 69 µg/L. 1,4-dioxane was not found above the 1.0 µg/L reporting limits in the shallow zone groundwater and does not exceed the MTCA Method B cleanup level in any of the shallow wells.

3.4.2.2 Intermediate and Deep Zone Groundwater

Trichloroethylene – The deeper site-specific MTCA Method B cleanup level for TCE is 30 µg/L. Concentrations above this cleanup level have been detected in the following intermediate and deep wells: MW-14M, MW-15M, MW-15D, and EPI-MW-2D. TCE concentrations detected above the cleanup level range from a minimum value of 36 µg/L (MW-15D, 2010) to a maximum value of 150 µg/L (MW-15M, 2005). Figures 3-3a and b show TCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Cis-1,2-Dichloroethylene – The deeper site-specific MTCA Method B cleanup level for cis-1,2-DCE is 450 µg/L, this cleanup level is not exceeded in any intermediate or deep wells. The maximum cis-1,2-dichloroethene concentration in groundwater was 110 µg/L (EPI-MW-2D, 2012). Figures 3-4a and b show 1,2-DCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1,1-Trichloroethane – The deeper site-specific MTCA Method B cleanup level for 1,1,1-TCA is 11 µg/L, and showed no concentrations in intermediate or deep wells above the reporting limits (0.1 to 10 µg/L). Figure 3-5 shows 1,1,1-TCA concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1-Dichlororethene – The deeper site specific MTCA Method B cleanup level for 1,1-DCE is 3.2 µg/L. Concentrations above this cleanup level were detected in the following intermediate and deep wells: MW-14M, EPI-MW-2D and EPI-MW-3D. The maximum 1,1-DCE concentration in groundwater was 33 µg/L (EPI-MW-2D, 2009). Figure 3-6 shows 1,1-DCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

1,1-Dichloroethane – No deeper site-specific MTCA Method B cleanup level exists for 1,1-DCA.

Vinyl Chloride – The deeper site-specific MTCA Method B cleanup level for VC is 2.4 µg/L. The maximum detection in intermediate or deep wells is at EPI-MW-2D, detected at 1.6 µg/L (November 2004). Figure 3-7 shows VC concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Tetrachloroethylene – The deeper site-specific MTCA Method B cleanup level for PCE is 3.3 µg/L. No detected concentrations in intermediate or deep wells currently exceed this cleanup level. The maximum PCE concentration in groundwater was 0.046 µg/L (MW-14D, 2008). Figure 3-8 shows PCE concentrations measured in February 2008, after 12 years of operation of the groundwater extraction system.

Trans-1,2-Dichloroethylene – The deeper site-specific MTCA Method B cleanup level for trans-1,2-Dichloroethylene is 590 µg/L. The highest detected value of this compound is 50 µg/L (EPI-MW-2D, 2012), which is below the 590 µg/L cleanup level.

Arsenic – The deeper site-specific MTCA Method A cleanup level (based on natural background) for Arsenic is 5 µg/L. The maximum Arsenic concentration was 6 µg/L (totals, MW-14D, 2003) and 4 µg/L (filtered, MW-14D, 2003).

1,4-Dioxane – The deeper site-specific MTCA Method B cleanup level for 1,4-Dioxane is 69 µg/L. The maximum concentration of 1,4-dioxane found was 27 µg/L (MW-17D, 2005). The cleanup level has not been exceeded in any of the intermediate or deep wells.

3.4.3 Vapor

3.4.3.1 Subslab Vapor

Subslab samples were collected in the December 2005 sampling event (Table 3-1). Both 1,1,1-TCA and TCE were consistently detected in subslab samples. 1,1,1-TCA concentrations ranged from 15 to 6,900 $\mu g/m^3$, but were well below the interim action derived screening level of 220,500 $\mu g/m^3$. TCE concentrations ranged from 44 to 3,700 $\mu g/m^3$, exceeding the interim action derived screening level of 22 $\mu g/m^3$. Ecology used a site specific sub-slab vapor screening level equal to 100 times the Method B indoor air cleanup levels effective at that time to determine if an interim action (such as installation of a vapor intrusion mitigation system) was required prior to implementation of the final cleanup. Ecology notes that the sub-slab vapor screening level for determining if an "interim action" vapor intrusion mitigation system installation is required is not identical (and a higher threshold concentration) than sub-slab vapor concentrations used in the MTCA cleanup level analysis for the Site.

3.4.3.2 Indoor Air

Between 2005 and 2007, five rounds of indoor air samples were collected at the former GE building, located at 220 South Dawson Street. Indoor air samples collected resulted in TCE detections (up to 0.515 µg/m^3 TCE) above the applicable MTCA Method B cleanup levels and the site-specific interim action levels in several areas of the building (Table 3-2). At the time interim action levels were established at a total excess cancer risk of 1EE-05. Based on the result of the indoor air sampling data, Ecology required that GE install a subslab depressurization system (see Section 3.1.1).

After the installation of the subslab depressurization system, ambient air and indoor air samples were collected on in November 2007. TCE was detected in all indoor samples with the exception of IA-3. TCE indoor air concentrations corrected for ambient air detections ranged from 0.04 µg/m^3 (IA-5) to 0.50 µg/m^3 (IA-4)[1]. Sub-slab negative pressure data collected on two occasions (2007, 2009) since installation of the VIM system indicate a downward pressure gradient across the 220 South Dawson Street floor slab. Based on these results and the current use of occupants in the building, additional interim actions were not required. System performance monitoring will continue to assess that the VIM system is operating as designed, and other monitoring will be conducted as described in Section 6.0. At the immediate downgradient and newly constructed building owned by Liberty Ridge, LLC located at 5050 1st Avenue South, above the off-property groundwater plume, indoor air engineering controls were estimated and conservative modeling was conducted to predict concentrations of TCE in the building indoor air. Modeling was approved by Ecology and showed predicted indoor air concentrations below applicable interim action screening levels (based on a total excess cancer risk of 1EE-05).

Indoor and ambient air samples collected from the former Interior Environments building located at 5033 1st Avenue South showed no CVOCs were detected above the reporting limits (0.19-0.22 µg/m^3). The results were satisfactory to Ecology to determine that an interim action (vapor intrusion mitigation system installation) was not required. Ecology notes that the indoor air screening level for determining if an "interim action" vapor intrusion mitigation system installation is required is a higher threshold concentration than the indoor air cleanup level established for the Site. Shallow zone groundwater (protective of indoor air cleanup levels) and indoor air cleanup standards must ultimately be met in order to meet the cleanup requirements of this CAP.

3.5 Exposure Assessment

This section identifies potential human and ecological exposures to contaminated media at the Site. As the Site is located in a highly urbanized, industrial area, exposure pathways for terrestrial ecological receptors are not complete and are not considered further. WAC 713-340-7491(1)(b). Contaminated media include soil, groundwater, and indoor air.

Current and Future Exposure Pathways:

Direct contact with soil – In this exposure pathway, we must evaluate whether a receptor could come in direct contact with soil containing COCs. COCs exceeding cleanup levels in soil at the 220 South Dawson Street property that remained in place after a site-wide excavation. Remaining

---

[1] TCE concentrations detected in indoor air are estimates due to lack of upwind ambient air TCE concentrations data for the sampling period.

contaminated soils are located at the contamination source areas where chemicals were released on the 220 South Dawson Street property. Additionally, the former GE on-property area located at 220 South Dawson Street is completely paved with asphalt or concrete. Therefore, under the current land uses and activities, the future complete exposure pathway scenario is limited to construction or utility worker (including excavation) contact with the soils during future construction or maintenance activities. Exposure routes include dermal contact, incidental ingestion, and inhalation. If the land use and activities were to change, additional potential exposure pathways would exist.

Non-potable Groundwater – In this exposure pathway, we must evaluate whether a receptor could come in direct contact with CVOC-affected groundwater (one example is if an excavation is extended below the water table). Direct contact with CVOC-affected groundwater is a future complete exposure scenario for a construction worker, utility worker, or tenant that withdraws contaminated groundwater for non-drinking water purposes. Exposure routes could include dermal contact, incidental ingestion, and inhalation.

Groundwater as a drinking water source – In this exposure pathway, we must evaluate whether a CVOCs could migrate from the source via groundwater to a drinking water well, where it could be used for residential consumption The City of Seattle has an ordinance restricting use of groundwater as a drinking water source in this industrial area of Seattle. Drinking water wells are not lawfully authorized. However, if these zoning laws were to be changed in the future, this exposure pathway could be completed. The current non-potability determination is premised at least in part on this prohibition.

Vapor intrusion to indoor air – In this exposure pathway, we must evaluate whether CVOCs would volatilize from soil and groundwater and migrate through the unsaturated zone via vapor gas and enter the indoor or ambient air. A receptor could then inhale the CVOC-contaminated air. Prior to the implementation of the air mitigation interim action at the former GE building, concentrations measured in selected indoor air samples in the 220 South Dawson Street building were higher than the MTCA Method B cleanup levels and separately established interim action screening concentrations established for the Site. Based on these detected concentrations, without adequate hydraulic control and operation of the VIM system, this exposure pathway is complete for soil and shallow groundwater. In addition, the potential pathway is complete for CVOC vapor intrusion into (a) new constructed buildings (without mitigation systems) near or above the CVOC groundwater plume, (b) the 220 S. Dawson Street property if tenants could choose to not operate their existing mitigation system, or (c) existing buildings without mitigation systems if shallow CVOC groundwater concentrations increase above current levels or new vapor intrusion pathways are created within those existing buildings.

Consumption of fish and aquatic ecological exposure – In this exposure pathway, we must evaluate whether CVOCs that are dissolved in groundwater would migrate via groundwater 690 feet to Slip 1 or other entry points of the Duwamish Waterway (measured from the furthest downgradient portion of the plume), where they would be released to the surface water environment. Potential receptors are the ecological organisms in the waterway and human receptors that catch and consume potentially CVOC-contaminated fish. Current sampling data shows that the CVOC-contaminated groundwater does not extend to the waterway and this pathway is not currently complete. The westernmost detected concentrations (demonstrated by the results from MW-16M and MW-16D) are 690 feet from Slip 1 of the waterway. However, persistent elevated CVOC concentrations near the leading edge of the plume indicate that there is a future potential for downgradient plume migration to the river at concentrations above or below the groundwater cleanup levels. Therefore this is a future potentially complete pathway for ecological and human receptors.

4.0 Cleanup Standards and Immediate Action Levels

This section describes the principal regulatory considerations for Site cleanup and specifies the performance standards that the cleanup must meet. Cleanup levels and points of compliance for each contaminated environmental media are provided in Table 4-1. The rationale for these cleanup standards is provided in the following subsections.

Under the MTCA Cleanup Regulations, there are specific minimum requirements for cleanup actions, WAC 173-340-360(2). All cleanup actions must meet these threshold requirements.

- Protect Human Health and the Environment and ensure the cleanup actions achieve cleanup levels (Table 4.1) at the standard point of compliance.
- Comply with Cleanup Standards and Applicable State and Federal Laws
- Provide for Adequate Compliance Monitoring to ensure human health and the environment are protected during the construction, operation and maintenance activities; to confirm that the actions have attained cleanup levels at the point of compliance; and confirm long-term effectiveness of the cleanup action.

Additionally, all cleanup actions must meet these additional requirements:

- The cleanup action must be permanent to the maximum extent practicable.
- Provide for a reasonable restoration timeframe.
- Consider public comments.

Ecology carefully considered these minimum requirements when selecting the cleanup action for the GE Site from among alternatives, technologies, and information presented in the Focused Feasibility Study (FFS). Ecology subsequently modified and then approved the FFS (Ecology 2009b). Through this CAP, Ecology is hereby making the determination that this cleanup action plan meets the minimum requirements for a cleanup found in WAC 173-340-360.

4.1 Groundwater Cleanup Levels and Points of Compliance

Under MTCA and where groundwater is not a current drinking water source or has a low future probability for use as a drinking water source as defined by WAC 173-340-720(2), the groundwater cleanup levels may be defined under WAC 173-340-720(6). In the case of this Site cleanup, the groundwater cleanup levels must be protective of both the vapor intrusion pathway and the surface water cleanup levels based on the consumption of fish/aquatic exposure pathway.

4.1.1 CVOCs, semi-volatiles and metals

Per the requirements of WAC 173-340-720(2) and (6), the groundwater cleanup levels for TCE, PCE, VC, 1,1,1-TCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, arsenic, TPH-heavy oil, TPH-diesel, and 1,4-dioxane at the Site need to be based on the lower of the following:

- Surface water concentrations that are protective of consumption of fish. The criteria for consumption of fish must consider Asian Pacific Islander (API) consumption rates as previously defined by Ecology (Ecology 2008/2009). These are MTCA Method B surface water cleanup levels, adjusted for API fish ingestion pathway.

- Surface water concentrations protective of ecological receptors.
- Groundwater concentrations that are protective of Method B air cleanup levels.
  - Groundwater concentrations that are protective of construction/utility/site worker direct contact and inhalation. As discussed in the FFS and the associated Ecology comment letters, cleanup levels for protection of construction/utility/site worker direct contact are higher than other cleanup levels for other pathways. Therefore, these construction/utility/site worker based cleanup levels are considered met if the other more stringent cleanup levels for other required pathway receptors are met. (AECOM 2008; Ecology 2008/2009).
- Concentrations established by applicable federal and state laws.
- For the case of arsenic, groundwater cleanup levels are based background as defined by the MTCA Method B cleanup levels.

As discussed above, the vapor intrusion exposure pathway is only complete for shallow zone groundwater. Based on site-specific conditions, shallow zone groundwater has been defined as that groundwater between the water table and 20 feet below bgs. Under normal current and likely future groundwater conditions, the intermediate and deep aquifer zone groundwater does not mix with shallow zone groundwater in sufficient quantities to create a complete pathway from the intermediate and deep aquifer zone to indoor air. GE will need to ensure institution controls are in place to prevent mixing of the intermediate and deeper contaminated aquifer zones with the shallower contaminated aquifer zone , The site cleanup levels for shallow zone groundwater (water table to 20 feet) are the lower of groundwater cleanup levels protective of indoor air cleanup levels, concentrations established by applicable federal and state laws, and surface water cleanup levels protective of API fish consumption and ecological aquatic criteria. In most cases, groundwater cleanup levels protective of indoor air, as calculated using the PSC-Georgetown inhalation pathway interim measure action levels (IPIMALs[2]) are lower than API surface water, other federal/state criteria and ecological aquatic criteria, therefore are the shallow site-specific MTCA Method B groundwater cleanup levels.

---

[2] Ecology is approving the same concentrations used as the PSC Georgetown groundwater IPIMALs for the shallow GW CUL (for further discussion see Ecology's July 13, 2009 response letter). These IPIMALs were the result of an empirical study correlating groundwater VOC data with indoor air VOC data, that then attempted to develop a mathematical relationship between the two (an "attenuation factor"). Ecology believes these are applicable to the GE site because the two cleanup sites lie above the same aquifer, have similar vadose zone characteristics, and share the same COCs (chlorinated volatile contaminants such as PCE, TCE, 1,1,1-TCA, and decomposition products of each). Based on Ecology's current understanding, Ecology does not believe there are significant geological differences in the vadose zones at the PSC-G and GE sites.

The site groundwater cleanup levels for intermediate and deeper zone groundwater (below 20 feet bgs) are the lower of groundwater surface water cleanup levels for API fish consumption, other federal/state criteria, and ecological aquatic criteria (Ecology 2009a).
For the shallow, intermediate and deeper zones of the aquifer, the standard point of compliance applies and is defined as throughout the Site groundwater.

4.1.2 TPH

TPH in the heavy oil range (TPH-heavy oil) and diesel (TPH-diesel) remains in the saturated and unsaturated soil zones at selected locations at the former GE building, located at 220 South Dawson Street. It is unlikely that the TPH-heavy oil and TPH-diesel soil and groundwater cleanup levels to drive site cleanup actions because ISCO chemicals are expected to treat both the chlorinated solvent contaminants and TPH in groundwater. However, TPH groundwater cleanup levels are required under the MTCA for this Site cleanup. The MTCA Method A unrestricted groundwater cleanup level for TPH-heavy oil and TPH-diesel of 500 μg/L each applies to the shallow, intermediate, and deeper zones of the aquifer, throughout the groundwater. Compliance will be evaluated by collecting groundwater samples in or immediately downgradient of the TPH contamination (standard point of compliance).

4.2 Soil Cleanup Levels and Point of Compliance

4.2.1 CVOC

The MTCA requires that soil cleanup levels for TCE, PCE, VC, 1,1,1-TCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE and 1,4-dioxane at the Site need to be based on the lower of the following:

- Concentrations protective of indoor air as determined based on soil concentrations protective of leaching to groundwater at concentration where groundwater would exceed cleanup criteria for indoor air (based on area-specific IPIMAL as discussed in Section 4.1.1).
- Concentrations protective of indoor air as a result of direct volatilization of chlorinated solvent constituents in the vadose zone with those volatiles migrating into buildings above.
- Concentrations established by applicable federal and state laws.
- Concentrations protective of site/utility/construction worker direct contact and inhalation. The Site is located in a commercial and industrial zoned area.

The site-specific soil cleanup levels protective of groundwater and indoor air are the lowest of these criteria.

Therefore, soil cleanup levels protective of groundwater and indoor air are the site-specific MTCA Method B soil cleanup levels. The standard point of compliance applies and is defined as the soils throughout the Site from the ground surface to the uppermost ground water saturated zone (e.g., from the ground surface to the uppermost water table), WAC 173-340-740(6)(c).

In order for the subsurface soil contamination to be considered protective of indoor air in current and future building scenarios (different building uses or new construction) in the specific context of this Site, thus meeting the soil cleanup level requirements of WAC 173-340-740(3)(c)(iv)(B), the measured and sustained sub-slab vapor concentrations must be less than an action level set at 33 times the MTCA Method B indoor air cleanup levels.[3] If indoor air cleanup levels are met for this building, without the VIM system operating, and sub-slab vapor concentrations for volatile CVOCs consistently meet this 33 times indoor air action level, Ecology does not anticipate a need for further institutional controls to address the soil to indoor air pathway. If indoor air cleanup levels are met for the current building, without the VIM system operating, but sub-slab vapors remain above the 33 times MTCA Method B indoor air cleanup level, additional action(s) must be implemented. These actions may include one or more of the following:

- Implement contingent remedial measures (e.g., vapor extraction) to remediate sources of sub-slab vapor for the purpose of protecting the indoor air pathway. This approach would be proposed by GE or Ecology for approval prior to implementation;
- Implement institutional controls to ensure that, for example: a) future changes to the building do not lead to vapor intrusion (VI) impacts leading to exceedances of the indoor air cleanup standard, b) new construction or property activities in the future do not create a new, or exacerbate an existing VI exposure pathway, and/or (c) routine indoor air sampling in the existing, new construction or renovated building is in place to ensure future protectiveness. If Ecology determines that indoor air is again contaminated above MTCA Method B indoor air cleanup levels, Ecology will determine if contaminated subsurface soils must be removed and/or sub-slab depressurization system must be restarted or installed.

At the time indoor air and shallow groundwater cleanup levels are attained, either Ecology or GE may revisit the 33 times sub-slab vapor to indoor air attenuation factor described in Section 4.2.1 and Section 6.0. If, at that time, EPA or Washington State Guidance provides a new or revised 95th percentile sub-slab vapor to indoor air attenuation factor for the Site, either Ecology may choose, or GE may recommend, using this attenuation factor in place of the 33 times attenuation factor to determine if soil contamination has met cleanup levels protective of indoor air.

As discussed in the FFS and the associated Ecology comment letters, criteria for protection of construction/utility/site worker direct contact and inhalation are higher than other cleanup levels for other pathways. Therefore, these construction/utility/site worker based cleanup levels are considered met if the other more stringent cleanup levels for other required pathway receptors (such as the soil to groundwater and soil to indoor building air cleanup levels) are met.

4.2.2 TPH

TPH in the heavy oil and diesel range remains in the unsaturated and saturated zones at selected locations at the former GE building, located at 220 South Dawson Street. It is unlikely that the TPH soil and groundwater cleanup levels to drive site cleanup actions. However, TPH soil cleanup levels are required under the MTCA for this Site cleanup. The MTCA unrestricted Method A soil cleanup level for TPH-heavy oil and TPH-diesel is based on protection of the TPH groundwater cleanup level defined in Section 4.1.2 above. The standard point of compliance applies and is defined as the soils throughout the Site, WAC 173-340-740(6)(b).

---

[3] This is based on the 95% Upper confidence limit on sub-slab to indoor air attenuation factors calculated in the USEPA Vapor Intrusion Database, Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings, March 2012.

4.3 Indoor Air Cleanup Levels, Immediate Action Levels, and Points of Compliance

Ecology has established cleanup levels and immediate action levels to protect human receptors

4.3.1 Cleanup Levels and Point of Compliance

Indoor air cleanup values are based on the lower of concentrations established by applicable federal and state laws, and MTCA Method B indoor air cleanup levels for unrestricted land use. The point of compliance for indoor air is the indoor air throughout the Site. Indoor air cleanup levels based on Method B cleanup levels are the most stringent and therefore the cleanup levels (refer to Table 4-1)

4.3.2 Indoor Air Immediate Action Level

Ecology has established a site specific indoor air immediate action level[4] (IAL) as the level that must immediately be met in indoor air to protect human health while the cleanup is progressing. At this time, based on operation of the two groundwater recovery wells, current groundwater contaminant concentrations and current building use/design, Ecology does not foresee the need for indoor air assessments in other buildings near and/or above the CVOC groundwater contamination. Should Ecology determine that IALs have been exceeded or that site conditions have changed during the remedial action (e.g., significantly increasing groundwater concentrations in areas where sufficient vapor mitigation has not been implemented, new vapor intrusion pathways introduced, etc.), Ecology may require an indoor air assessment and installation of a vapor intrusion mitigation system (VIM).

Table 4-1 Summary of Applicable Cleanup Levels and Points of Compliance for the Site

	Soil	Groundwater		Indoor Air	Indoor Air
	MTCA Method B (mg/kg)	Shallow[5] Site-Specific MTCA Method B (µg/L)	Deeper[6] Site-Specific MTCA Method B (µg/L)	MTCA Method B (µg/m^3)	Immediate Action Level (µg/m^3)
Trichloroethylene	0.044	6.6	30	0.37	1.30
Tetrachloroethylene	0.035	3.3	3.3	2.5	8.74
Vinyl Chloride	0.006	1	2.4	0.28	0.98
cis-1,2 dichloroethylene	2.95	590	450	none[7]	none[7]
trans 1,2 dichloroethylene	0.89	163	590	3.8	13.3

---

[4] The IAL is based on a typical working exposure, which assumes: 10 hour work day, 5 work days per week, and 50 work weeks per year. The establishment of this IAL serves as a protective interim measure, and does not substitute for the MTCA requirements to meet the Method B indoor air cleanup level at the Site through implementation of the Ecology selected remedy in a reasonable restoration timeframe.

[5] Defined as the "shallow zone" or the top of the water table down to approximately 20 feet bgs.

[6] Defined as both the "intermediate" and "deep" zones of groundwater from approximately 20 to 65 feet bgs.

[7] No toxicity data available

1,1-Dichloroethylene	0.023	3.2	3.2	12.74	44.52
1,1,1-Trichloroethane	0.09	11	11	332	1125
1,4-Dioxane	NA	69	69	NA	NA
Arsenic	NA	5	5	NA	NA
TPH-Heavy Oil Range TPH-Diesel Range	2000*	500	500	NA	NA
Point of Compliance	Standard Point of compliance for all media	Standard Point of compliance Water table to 20 feet bgs	Standard Point of compliance Below 20 feet bgs	Standard Point of compliance Indoor air throughout the Site	NA (see section 4.3.2 above)

Notes:

NA – Not applicable
µg/L – micrograms per liter
µg/m^3 – micrograms per cubic meters
mg/kg – milligrams per kilogram
bgs – below ground surface

4.4 Applicable State and Federal Laws

MTCA requires that all cleanup actions comply with applicable state and federal laws (WAC 173-340-360(2), WAC 173-340-710 and RCW 70.105D.090. Under MTCA, all cleanup actions conducted shall comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that the department determines, based on consideration of the criteria in WAC 173-340-710(4), are relevant and appropriate requirements. Legally applicable requirements include those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations adopted under state or federal law that specifically address a hazardous substance, cleanup action, location or other circumstances at the site.

Table 4-2 Applicable State and Federal Laws

Law/Regulation	Requirements
Federal Water Pollution Control Act Clean Water Act (CWA) 40 CFR 100-149 Washington State Water Quality Standards for Surface Waters WAC 173-201A Washington State Underground Injection Program, Chapter 173-218 WAC	Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and establishes standards for the protection of surface water quality. The cleanup action will comply with these regulations through the implementation of best management practices and a water quality monitoring program. The installation of the ISCO injection wells shall meet all applicable regulations of the UIC Program
National Pretreatment Standards (40 CFR 403) Metro District Wastewater Discharge Ordinance	Establishes pretreatment requirements for discharge to a municipal sewer. For water discharged to the Metro sanitary or combined sewer system, all conditions of the current permit must be met under future actions, or a new permit must be obtained.
Resource Conservation and Recovery Act (RCRA) (40 CFR 260 – 268) Washington Dangerous Waste Regulations (WAC 173-303)	Establishes requirements for identification of Dangerous Wastes based on whether or not the waste contains a listed waste, or if it displays a dangerous waste characteristic, for example by the Toxicity Characteristic Leaching Procedure. These regulations may be applicable for the storage, treatment, and disposal of the excavated/extracted material.
Solid Waste Handling Standards (RCW 70.95; WAC 173-350)	Establishes the requirements for solid waste management and disposal.
Clean Air Act, National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61) State Emission Standards for Hazardous Air Pollutants (WAC 173-400-075)	Establishes emission standards as well as ambient air quality standards. These requirements may be applicable to releases of hazardous air pollutants from remedial actions.

Relevant and appropriate requirements include those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

The currently identified permits and approvals applicable to this CAP will be listed in an exhibit to either a judicially-approved Consent Decree (if negotiated), or an Ecology-issued administrative order.

Substantive Requirements: The currently identified substantive requirements of procedurally exempt permits or approvals will be listed in an exhibit to either a judicially-approved Consent Decree (if negotiated), or an Ecology-issued administrative order.

5.0 Cleanup Alternatives

GE's FFS included a screening and evaluation of potential remedial technologies. Based on the screening of technologies, six proposed alternatives were evaluated under WAC 173-340-360. They include:

Alternative 1 – Optimized Hydraulic Control, Soil Vapor Extraction combined with Air Sparge (SVE/AS), Subslab Depressurization System, and Institutional Controls

Alternative 2 – Optimized Hydraulic Control, *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls

Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls

Alternative 4 – SVE/AS, and Institutional Controls

Alternative 5 – *In situ* Chemical Oxidation, Subslab Depressurization System, and Institutional Controls

Alternative 6 – Enhanced Anaerobic Bioremediation, Subslab Depressurization System, and Institutional Controls.

In developing the CAP, Ecology additionally considered an alternative that, while not identical to any of the six alternatives considered by GE, is based largely on Alternative 2 with some modifications. Ecology will refer to this alternative as **Modified Alternative 2.**

5.1 Alternative 1 – Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging and Subslab Depressurization System[8]

The technologies included in Alternative 1 are optimized hydraulic control (containment and groundwater extraction), soil vapor extraction/air sparging (SVE/ AS), the continued operation of the existing subslab depressurization system, and institutional controls. An alternative that includes SVE/AS was selected because it is proven to be an effective technology for the treatment of TCE at other sites with similar contaminants. Alternative 1 includes:

---

[8] In the early FFS remedy alternative evaluation Ecology agreed with GE that this technology has the potential to result in slightly longer restoration timeframes than in-situ chemical oxidation (ISCO) or enhanced anaerobic bioremediation (EAB). However, the restoration timeframe would not be so much longer as to immediately eliminate the technology from consideration. Ecology did not further comment nor require GE to revise the FFS sections on Alternative #1 to incorporate additional supporting data or information on restoration timeframe, threshold criteria, or other details of the alternative 1 because Ecology agreed to further narrow the scope of the final FFS to GE's preferred ISCO with and without optimized hydraulic control technology, therefore more full evaluation of Alternative #1 was not required. A full evaluation of ISCO with and without optimized hydraulic control is included in the FFS report and further explained in later section of this CAP.

- Optimizing the existing pump and discharge system
- Installation of a SVE/AS system (at the on-property and off-property areas)
- The continued operation of the subslab depressurization system
- Institutional controls.

5.1.1 Optimized Hydraulic Control

Currently groundwater is recovered from two extraction wells (RW-2 and RW-3) and extracted contaminated groundwater is discharged to King County sewerage treatment system. In an effort to increase the performance of the current hydraulic control system, in a phased approach, the existing recovery wells will be abandoned and replaced with two new recovery wells installed along the western side of the former GE building, shown on Figure 5-2.

5.1.2 Soil Vapor Extraction/Air Sparging

Conceptually, Alternative 1 includes 2 phases of treatment. During Phase 1 both on-property and off-property areas will be targeted, using 2 separate skid mounted catalytic oxidizers. For the on-property area, Alternative 1 includes an SVE system that consists of lateral wells installed in the alley (between MW-1 and MW-4). The lateral wells will be installed approximately 6 feet bgs between MW-1 and MW-4, Figure 5-1 shows the proposed well network. Lateral wells are proposed to increase coverage in the shallow zone using a small above ground foot print. The SVE system will be plumbed to a thermal catalytic oxidizer with a granular active carbon (GAC) bags or scrubbers to treat the extracted vapor before release into the atmosphere (as required by the permits). The current paved alley will remain as is; the pavement serves as a cover to minimize volatile emissions escaping, to minimize short circulation within the SVE network, and to minimize the height of the top of the wet, or saturated, soil zone by minimizing infiltration. The AS system is proposed to be paired with the SVE system to remove COCs from the saturated zone, installed in close proximity to the SVE system, operating under the same electric power system and control devices. It is assumed that the space for the treatment unit could be rented from the current property owners. The on-property area system is expected to run for 36 months, based on the potential contaminated soils under the building footings and based on data from similar sites. The exact duration of the operation of the SVE/AS system may change after monitoring data are collected during implementation.

Due to the extent of contaminated groundwater in the off-property area, and based on the major roadway (1st Avenue South) separating MW-14 and MW-15, two separate SVE/AS treatment systems are proposed. The first treatment system will be operated during the on-property area, Phase 1 of this Alternative. Phase 1 includes treatment associated with MW-14; Phase 2 includes treatment of the MW-15 area. Similar to the on-property area, a skid-mounted treatment unit will be installed on the east side of 1st Avenue South and will target the MW-14 well cluster. Vertical SVE wells, which have been proven effective as deep as 300 feet, will be installed near and around MW-14. Vertical SVE wells are proposed extending to approximately 8 feet bgs; AS wells are proposed to extend to approximately 45 feet bgs. Six SVE wells will be placed along the center line of the plume, as shown on Figure 5-1. The placement of the treatment unit will be determined in final design, but mostly likely will require access negotiations to enable the rental of a portion of the parking lot. GE will work with local building owners and Ecology to balance the best possible location with the least amount of disturbances to local business.

Conceptually, Phase 2, which will start after the termination of Phase 1, will target the off-property area on the west side of 1st Avenue South. The same SVE/AS system will be installed in the vicinity of MW-15. The well network is similar to the wells proposed for the MW-14 treatment area, as shown on Figure 5-1. Phase 2 is expected to run for 36 months (the time frame is based on performance at similar sites). The design details may change after monitoring data are collected during implementation.

A revised groundwater and indoor air and subslab vapor sampling monitoring plans will be included in the EDR.

5.1.3 Subslab Depressurization System

Alternative 1, includes the operation of the existing subslab depressurization system, which was installed in August 2007 and subsequently modified in 2009 to minimize vapor intrusion from the subslab into the former GE building, located at 220 South Dawson Street. No modifications are planned to the depressurization system unless Ecology determines that its effectiveness has diminished to the point where an IAL is triggered or improvements are needed to help meet indoor air cleanup levels in a reasonable timeframe. Figure 5-3 shows the existing subslab depressurization system configuration.

The subslab depressurization system will continue to operate at the same time as the ISCO treatments and performance monitoring and will be terminated when concentrations inside the former GE building reach the Method B indoor air cleanup levels for indoor air, subject to the requirements stated in Section 4.2.1.

5.1.4 Institutional Controls

Institutional controls shall be included to protect human health and the environment from exposure to contaminated soil which is located beneath the building foundations.. Institutional controls for soil will identify areas that exceed soil cleanup levels and ensure that these contaminated soils are managed in a manner protective of human health and the environment if the building is removed, renovated or the area is excavated.

Institutional controls shall used included to protect human health and the environment from exposure to contaminated groundwater above potable cleanup levels and contaminated indoor air above Method B cleanup levels.

5.2 Alternative 2 – Optimized Hydraulic Control, *In situ* Chemical Oxidation, Subslab Depressurization System, Institutional Controls

The technologies included in Alternative 2 are optimized hydraulic control (containment and groundwater extraction), *in situ* chemical oxidation, continued operation of the existing subslab depressurization system, and institutional controls. The use of potassium

permanganate was selected because of its rapid degradation of TCE, ease of application method, and because this results in degradation of TCE without accumulation of daughter chemicals of 1.2-DCE and VC.
Alternative 2 includes:

- A phased approach for eventually relocating the existing groundwater extraction wells. The phasing and design of the on-site ISCO injections with the timing of moving both groundwater extraction wells shall consider (1) maximal optimization of the effectiveness of on-site hydraulic control and (2) as ISCO injection proceed near/adjacent to the groundwater recovery wells, minimize any possible interferences between ISCO contact with subsurface chlorinated solvent contaminants AND the operation of the groundwater extraction wells, and (3) consideration of the potential for unacceptable vapor intrusion in the 220 South Dawson Street building, McKinstry buildings to the north, and other nearby buildings. The timing of when each of the extraction wells is relocated is based on the results of the phase 1-small scale ISCO treatment, phase 2 and/or possibly subsequent injections.
- Optimizing the hydraulic control (pump and discharge) system;
- Phased approach for ISCO treatments (at the on-property and off-property areas);
- The continued operation of the subslab depressurization system with maintenance and optimization as necessary;
- Institutional controls
- Groundwater, soil, indoor air and sub-slab vapor monitoring as required in Section 6.0.

5.2.1 Optimized Hydraulic Control

Alternative 2 includes the optimized hydraulic control elements presented in Alternative 1.

5.2.2 *In Situ* Chemical Oxidation

The following equations show the chemical equation for the complete reaction of TCE and vinyl chloride with potassium permanganate:

- $2KMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ + 2K^+$
- $10KMnO_4 + 3C_2H_3Cl \rightarrow 6CO_2 + 10MnO_2 + 10K^+ 3Cl^- + 7OH^- + H_2O$.

Where:

- TCE = C_2HCl_3
- Potassium Permanganate = $KMnO_4$
- Vinyl Chloride = C_2H_3Cl.

The details of exact ISCO injection sequencing and location/depth; ISCO oxidant dosing, groundwater monitoring locations; and other design/implementation details will be defined in the Ecology approved EDR.

The implementation of Alternative 2 is proposed to occur in a phased approach; Phase 1 includes a bench scale test followed by a small scale ISCO treatment. The purpose of Phase 1 is to gather additional information regarding the radius of influence, destruction efficiency, and oxidant demand for the site. Phase 2 includes a full scale treatment in the entire on-property and off-property areas, and Phase 3 focuses on any remaining areas that required additional treatment. The data collected during each ISCO treatment phase will be used to inform and revise as needed the design of all subsequent ISCO treatment phases. The approximate ISCO injection and observation well locations are shown in Figure 5-2. Each ISCO treatment phase shall be performed in accordance with Ecology approved plans.

Depending on the results of the monitoring after the third ISCO treatment phase, Ecology may determine that additional ISCO treatment phases and monitoring is required to target any residual TCE, CVOCs and TPH remaining above the cleanup levels. As such, those work plans shall be submitted to Ecology for review and approval, prior to implementation.

5.2.3 Subslab Depressurization System

Alternative 2 includes the vapor mitigation systems elements presented in Alternative 1.

5.2.4 Institutional controls

Alternative 2 includes the institutional control elements presented in Alternative 1.

5.3 Modified Alternative 2 – Optimized Hydraulic Control, In-Situ Chemical Oxidation, Sub-Slab Depressurization System, and Institutional Controls

The main difference between this alternative and Alternative 2 as defined in the Feasibility Study is that under this alternative, Ecology would be willing to consider turning one or more groundwater extraction wells off before meeting the groundwater cleanup standards after completing one small scale ISCO injection and bench scale test and two full scale ISCO injections phases, provided that GE can demonstrate at that time that the requirements for a MTCA cleanup action will continue to be met, as described in more detail in Section 6. Other main modifications from the original Alternative 2 include:

a. Allows ISCO treatments to begin with the optimized groundwater hydraulic control system in its current location, with phased groundwater extraction well relocation during future ISCO treatments in order to optimize treatment.

b. Prior to each Ecology Five Year review, GE shall prepare and submit a WAC 173-340-720(2)(b) and (d) groundwater potability analyses report to Ecology for review and approval to confirm the original potability analysis which supports this CAP.

5.4 Alternative 3 – Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation and Subslab Depressurization System[9]

The technologies included in Alternative 3 are optimized hydraulic control (containment and groundwater extraction) enhanced bioremediation, the continued operation of the existing subslab depressurization system, and institutional controls.

An alternative that includes bioremediation was selected because it is technically feasible, has been proven to be an effective technology for the treatment of TCE at similar sites and it can target a large area without disturbing aboveground structures. Alternative 3 includes:

- Optimizing the existing pump and discharge system
- Electron donor injection into the on-property and off-property areas
- The continued operation of the subslab depressurization system
- Institutional controls.

5.4.1 Optimized Hydraulic Control

Alternative 3 includes the optimized hydraulic control elements presented in Alternative 1.

5.4.2 Enhanced Anaerobic Bioremediation

The enhanced bioremediation portion of Alternative 3 includes the injection of a combination of soluble and slow-release (or insoluble) electron donors. This combination of electron donors allows for a larger treatment area. The soluble donors release high concentrations of hydrogen and intermediate volatile organic acids (which ferment to hydrogen) downgradient of the injection wells. Slow-release electron donors ferment near the injection well, resulting in a continuous supply of hydrogen and intermediate volatile organic acids moving downgradient with groundwater flow. The proposed[10] soluble donor selected for Alternative 3 is sodium lactate, and the proposed slow-release electron donor selected is vegetable oil emulsion. A yeast extract will be added to the injection slurry to enhance bacterial growth.

The required injection slurry volume needed for injection and the required injection network varies at each site. The implementation of Alternative 3 is proposed in a phased

---

[9] In the early FFS remedy alternative evaluation stages, Ecology stated that it believed this technology was a feasible technology for the site cleanup. However, Ecology and GE did not further evaluate or explore the details of this alternative or how to optimize the Alternative 3 to incorporate additional supporting data or information on restoration timeframe, threshold criteria, or other details of the Alternative 3 because Ecology agreed to further narrow the scope of the final FFS to the GE's preferred ISCO with and without optimized hydraulic control technology, therefore further full evaluation of Alternative #3 was not required. A full evaluation of ISCO with and without optimized hydraulic control is included in the Ecology modified and approved FFS report and further explained in later section of this CAP.

[10] The final selected soluble and insoluble donors may change based on availability and effectiveness; the proposed donors presented in this FFS are used for costing purposes. Final selected donors will be similar (in terms of donor properties) to these proposed.

approach; Phase 1 includes a small scale injection to evaluate the natural bacteria conditions, evaluate the effectiveness of the selected donors, estimate the ROI, determine the injection slurry volume, and evaluate the effects of the hydraulic recovery system. Injection and monitoring during Phase 1 is limited to the on-property area; the data collected during Phase 1 will be applied to both the on-property and off-property areas during Phase 2.
Conceptually, Phase 1 includes an initial evaluation of the microbial counts in the groundwater from the on-property and off-property area. This CAP assumes that natural bacteria are present in sufficient numbers and type. If results of the microbial counts dispute this assumption, the injection will include electron donors, yeast, and bacterial augmentation. After results are evaluated, Phase 1 will include the installation of injection wells located in the on-property area. Five injection wells are proposed on 10-foot centers, installed 30 feet upgradient of MW-1, as shown on Figure 5-4. All injection wells will be installed outside of the footprint of the existing buildings. On-property area injection locations will be screened across two intervals: the water table to 4 feet below the water table, and 12-16 feet bgs. Chemical data will be collected from monitoring wells and used to determine the effectiveness of the injection by evaluating CVOC concentrations. Based on the results of Phase 2, the remaining TCE concentrations will be targeted in the third phase of injection. After Phase 3, it may be necessary to apply additional injection compounds or adjust the treatment to target any potential byproducts that may be present. Additional treatment could target VC, as this is a byproduct that can result from incomplete degradation.

Phase 1 will also include a tracer study to better understand groundwater movement within the treatment area. Sodium bromide will be dissolved into the injection solution and delivered across the treatment area. Regular bromide samples will be collected in the nearest downgradient wells (MW-4, MW-6, MW-8M, and MW-8S) until breakthrough of bromide is observed.

Phase 2 includes injection of electron donors in both the on-property and off-property areas. Injection in the on-property area includes the same network used in Phase 1, plus an additional 8 injection wells, on 10-feet centers located within the alley and upgradient of MW-1. All injection wells will be installed outside of the footprint of the existing buildings. Similar to Phase 1, on-property area injection locations will be screened across two intervals: the water table to 4 feet below the water table, and 12-16 feet bgs. Injection depths and the total number of injection wells may be altered depending on the results of the Phase 1.

The pump and discharge system will remain on during each phase of injection.
The off-property area will include 10 injection wells on 10-foot centers located around monitoring wells MW-14M/D and MW-15M/D. Figure 5-4 shows the configuration of the off-property area injection wells, which will include 5 injection wells located around well MW-14M/D and 5 wells located around MW-15M/D. Off-property area injection locations will be screened at two intervals: 20-24 feet bgs, and 26-30 feet bgs. Injection depths and the total number of injection wells may be altered depending on the results of Phase 1. All injection wells will be installed outside of the footprint of the existing buildings.

Phase 3 includes subsequent injections. The extent of Phase 3 will be dependent on the results of Phase 2. For the purpose of this CAP, a general cost estimate is included for

Phase 3, assuming that the injection volume will be 30% of the Phase 2 volume, cover the same injection network, and not include any well construction.

Monitoring will be performed during and after injections (a full monitoring schedule will be developed as part of the final design). Temporary observation wells may be installed to monitor injection flow rates at the off-property area. Existing monitoring wells will be used to monitoring flow paths and trends during and after injection.

5.4.3 Subslab Depressurization System

Alternative 3 includes the subslab depressurization system elements presented in Alternative 1.
Methane produced by methanogenic aquifer conditions (induced by electron donor amendment) has the potential to migrate to enclosed spaces located below ground and adjacent to the treatment zone. No basements, tunnels, or below grade location exist onsite; thus, the production of methane is unlikely considering site conditions and will not be monitored. In the event that building owners/tenants request air monitoring, monitoring will occur during the performance monitoring. If methane is detected (at or near 20% of the lower explosive limit [LEL]) at any location, the area will be vented to prevent methane buildup and eliminate any potential explosive risk.

5.4.4 Institutional Controls

Alternative 3 includes the institutional control elements presented in Alternative 1.

5.5 Alternative 4 – Soil Vapor Extraction/ Air Sparging

The technologies included in Alternative 4 are SVE/AS, the continued operation of the existing subslab depressurization system, and institutional controls.
Alternative 4 includes:

- Installation of a SVE/AS system (at the on-property and off-property areas)
- The continued operation of the subslab depressurization system
- A revised groundwater monitoring program
- Institutional controls.

5.5.1 SVE/AS System

Alternative 4 includes the SVE/AS elements presented in Alternative 1.

5.5.2 Institutional Controls

Alternative 4 includes the institutional controls elements presented in Alternative 1.

5.6 Alternative 5 – *In Situ* Chemical Oxidation, Subslab Depressurization System and Institutional Controls

The technologies included in Alternative 5 are oxidation (using $KMnO_4$), the continued operation of the existing subslab depressurization system, and institutional controls.

- *In situ* chemical oxidation injection (at the on-property and off-property areas)
- The continued operation of the subslab depressurization system
- A revised groundwater monitoring program
- Institutional controls.

5.6.1 *In Situ* Chemical Oxidation

Alternative 5 includes the *in situ* chemical oxidation elements presented in Alternative 2. The recovery wells will be turned off when injections are initiated. Recovery wells will remain and will be used, as necessary to reduce chemical travel time during injection only (based on the results of Phase 1) or to prevent any unacceptable downgradient plume migration identified based on monitoring results. Recovery well locations will be evaluated during remedial design to assess whether one or both wells should be relocated to optimize potential risk management. Injection and performance monitoring location and frequency will be finalized during remedial design, (locations shown on Figure 5-6).

5.6.2 Subslab Depressurization System

Alternative 5 includes the subslab depressurization system elements presented in Alternative 1.

5.6.3 Institutional Controls

Alternative 5 includes the institutional controls elements presented in Alternative 1.

5.7 Alternative 6 – Enhanced Anaerobic Bioremediation, Subslab Depressurization System and Institutional Controls

The technologies included in Alternative 6 are enhanced anaerobic bioremediation, the continued operation of the existing subslab depressurization system, and institutional controls.

- Electron donor injection into the on-property and off-property areas
- The continued operation of the subslab depressurization system
- Institutional controls.

5.7.1 Enhanced Anaerobic Bioremediation

Alternative 6 includes the enhanced bioremediation elements presented in Alternative 3. This alternative does not include the optimization of the recovery wells; recovery wells RW-2 and RW-3 will remain in the current locations. Alternative 6 includes recirculation of the injection solution in the on-property area. The recirculation allows for longer contact time, increased hydraulic control during injection, and a more effective distribution of the treatment solution. The recirculation will be implemented with a small scale mobile unit; using a small scale treatment trailer will minimize site disturbances, reduce risk (pre-assembled control panel with built-in safety features) and allow for flexibility during injection. Injection rates and discharges can be controlled with the computer interface. The existing recovery well, RW-3, will be retrofitted for the recirculation process. RW-2 may also be used during Phase 2 depending on performance during Phase 1.

Similar to Alternative 5, this alternative also includes the flexibility to turn on the pump and discharge system for use as containment in the on-property area, if conditions in the groundwater unit change significantly. Changing aquifer conditions could include the mobilization of metals or the production of incomplete degradation byproducts.

Figure 5-7 provides a summary of the proposed design.

5.7.2 Subslab Depressurization System

Alternative 6 includes the subslab depressurization system elements presented in Alternative 1.

5.7.3 Institutional Controls

Alternative 6 includes the institutional controls elements presented in Alternative 1. Alternative 6 introduces "recirculation of the injection solution" in the On-Site Area. However, the assessment by GE had insufficient information for Ecology to fully understand the technical principals/concepts and benefits/disadvantages associated with a recirculation system. It is unclear, for example, how and when existing extraction wells RW-3 and RW-2 would be "retrofitted" into the recirculation operation. Ecology was unable to fully evaluate the threshold criteria (WAC 173-340-360(2)(a)) and other requirements (WAC 173-340-360(2)(b)) for this alternative. Due to a lack of optimized hydraulic control (for the reasons previously stated by Ecology as required), however, Ecology would not select this option as the final remedy. Thus, Ecology saw no reason to provide further comment on this section and Ecology eliminated this alternative from further consideration.

5.8 Summary of Rationale for Selected Cleanup Action

For purposes of remedy selection, this section compares only Alternative 2(unmodified or modified) and Alternative 5. This is because early in the remedy screening process, Ecology agreed to GE's request to use in-situ chemical oxidation (ISCO) as the sub-surface treatment chemical as opposed to enhanced anaerobic bioremediation (EAB) or soil vapor extraction plus air sparging (SVE/AS). Based on initial evaluations, Ecology believed that all three technologies (EAB, ISCO and SVE/AS) with optimized hydraulic control could be an effective Site remedy that could be designed and optimized to meet the requirements of WAC 173-340-360. Ecology did not comment nor require GE to revise the final FFS sections on Alternatives #1, #3, #4 and #6 to incorporate Ecology's comment to explore the details of how to optimize these alternatives under a more complete FS analysis. Ecology agreed to further reduce the scope of the final FFS to the MTCA analysis of alternatives that included GE's preferred use of ISCO with and without optimized hydraulic control. Therefore, the detailed remedy selection analysis in the final FFS was further screened to focus primarily on evaluating the need for optimized hydraulic control concurrent with ISCO treatment (Alternative 2) versus ISCO treatment without optimized hydraulic control (Alternative 5).

5.8.1 Threshold Requirements-Initial Assessment of Alternatives

Cleanup actions selected under MTCA must comply with several basic requirements. This evaluation was completed by first conducting an initial assessment of whether each proposed cleanup alternative met all the threshold (minimum) requirements for cleanup actions required by the MTCA cleanup regulations. Alternatives that do not comply with these criteria are not acceptable cleanup actions under MTCA. Alternatives that pass this initial assessment were evaluated based on the additional criteria of WAC 173-340-360(2)(b). WAC 173-340-360(2)(a) states that any cleanup action must meet the following four threshold requirements:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws
- Provide for compliance monitoring.

5.8.1.1 Protect Human Health and the Environment and Comply with Cleanup Standards

Ecology determined that optimized hydraulic control is a necessary component to protect human health and comply with cleanup standards. Alternative 2 (unmodified or modified) adequately protect human health and the environment by reducing the footprint of the on-property chlorinated solvent groundwater plume so that the vapor intrusion mitigation (VIM) system operates effectively at the 220 South Dawson Street property to reduce the indoor air contaminant concentrations to acceptable and below interim action levels. The optimized hydraulic control system also prevents the migration of contaminated groundwater to other adjacent or downgradient properties and thus minimizes the potential for adversely contaminating building indoor air above cleanup levels and/or immediate action levels (IALs). The use of optimized hydraulic control to cut off the chlorinated solvent plume along 2nd Avenue South, is important for effective on- and off-property ISCO treatment in meeting the cleanup standards. Hydraulic control prevents additional chlorinated solvent contaminated groundwater from migrating beyond 2nd Avenue and creates a smaller and more treatable groundwater plume footprint east of 2nd Avenue South by preventing plume expansion. ISCO treatment on a further expanded and diluted plume would remove less contaminant mass in the groundwater, thus making the treatments less effective.

GE has expressed concerns about negative impacts of the optimized hydraulic control system on ISCO injections. However, in Ecology's opinion, operation of the optimized hydraulic control system during ISCO treatments is not expected to negatively impact the effectiveness of the ISCO treatments for the following reasons: (1) the Ecology capture zone analysis (CZA) indicates that there is a very limited radius of influence (ROI) around recovery wells; (2) ISCO injection zones of influence are typically no more than 25-30 feet in highly conductive aquifers; (3) we expect the reagent travel distance from the injection well toward the recovery wells to be no more than 7.5 feet before it is completely consumed (this is based on the AECOM's stated groundwater flow velocity range of 0.3 – 1.5 ft/day and the stated maximum ISCO chemical lifespan in the aquifer of five days); and (4) the cleanup action will require moving the operating recovery well RW-3 further west (near 2nd Avenue South) after the ISCO injections proceed from the east to the west side of the alley. For these reasons, the distance between ISCO injection wells and recovery wells is too far to result in ISCO short-circuiting.

The use of institutional controls under Alternative 2 (unmodified or modified) for residual chlorinated solvent and petroleum hydrocarbon vadose zone soil contamination provide further protection by informing the current building owner of hazards and limiting activities that may result in exposures to chemicals at the Site.

Optimized hydraulic control is necessary to meet the threshold requirements of WAC 173-340-360(2)(a)(i) and (ii): protect human health and the environment AND comply with cleanup standards. Under Alternative 2 (unmodified or modified), GE may turn off one or more groundwater extraction wells after the cleanup standards are met. Modified Alternative 2 may allow for turning off one or more extraction wells after completing a small scale ISCO treatment and two full-scale ISCO treatments, but only if GE can demonstrate at that time that the requirements of WAC 173-340-360(2) will continue to be met. Alternative 5 allows additional CVOC groundwater contamination to expand vertically and laterally at the 220 South Dawson Street property and allows additional CVOC groundwater contamination to migrate off-property. Under Alternative 5, the current 220 South Dawson Street building VIM system will be under-designed for a widening groundwater plume with higher TCE groundwater concentrations (which we expect to occur when the optimized hydraulic control system is shut off). Cross gradient (McKinstry) and downgradient buildings will also be threatened by vapor intrusion if underlying TCE groundwater concentrations increase. Alternative 5 does not meet the threshold criteria of (i) protection of human and the environment and (ii) compliance with cleanup standards by allowing unfavorable Site conditions that Alternative 2 (unmodified or modified) with optimized hydraulic control, as discussed above, is designed to prevent. In fact, the only practicable means of modifying Alternative 5 to meet these threshold criteria is to add the optimized hydraulic control and other criteria that would, in fact, essentially transform it into Alternative 2 (unmodified or modified) .

5.8.1.2 Comply with Applicable Laws

Not including Federal and State cleanup laws, Alternatives 2 (modified and unmodified) and 5 comply with other applicable state and federal laws.

5.8.1.3 Provide for Compliance Monitoring

Alternative 2 (unmodified or modified) meets the compliance monitoring requirements. Alternative 5 complies with compliance monitoring requirements, although the remedy does not meet the threshold requirements of Section 5.8.1.1.

5.8.1.4 Summary of Initial Assessment of Alternatives

Under Alternative 2 (unmodified or modified),ISCO treatment with concurrent optimized hydraulic control meets the threshold requirements of WAC 173-340-360(2)(a)(i) *protect human health and the environment, (b) comply with cleanup standards, (c) comply with applicable state and federal laws, and (d) provide for compliance monitoring.* Ecology's August 14, 2008 and July 13, 2009 letters to GE also explain this conclusion. ISCO treatments without optimized hydraulic control (alternative 5) do not meet the threshold requirements and therefore this remedial alternative is eliminated from consideration as the final remedy.[11]

5.8.2 Additional Criteria

Only Alternative 2 (unmodified or modified) meets the threshold criteria and therefore pass through to the evaluation for "other requirements" in WAC 173-340-360(2)(b). Under MTCA (WAC 173-340-360(2)(b)), when selecting from alternatives that meet the threshold requirements, the selected action must also address the following three criteria:

- Use permanent solutions to the maximum extent practicable
- Provide a reasonable restoration time frame
- Consider public concerns.

5.8.2.1 Use Permanent Solutions to the Maximum Extent Practicable

Under Alternative 2 (unmodified or modified), ISCO treatment with concurrent optimized hydraulic control uses permanent solutions to contain and chemically destroy CVOCs from groundwater at the Site. Pursuant to WAC 173-340-360(3)(d), only Alternative 2 (unmodified or modified) meets threshold criteria. Therefore, there is no need for a detailed disproportionate cost analysis to select the most "permanent to the maximum extent practicable" alternative from among two or more alternatives that meet threshold criteria. The use of optimized hydraulic control results in a permanent remedy by containing the on-property chlorinated solvent contaminated groundwater plume during ISCO groundwater treatments and not allowing further expansion and dilution of the CVOC groundwater plume on-property and off-property (west of 2nd Avenue South) Because this remedy is fully permanent for the existing land use, with the exception of subsurface contaminated soil that remains underneath or near the 220 South Dawson Street building (for which costs of a fully permanent solution would be grossly

---

[11] For purposes of full discussion and vetting of the issues with GE during the feasibility study, Ecology engaged in some analysis comparing Alternatives 2 and 5 against the detailed disproportionate cost analysis criteria found in WAC 173-340-360(3)(e). See Ecology comment letter dated July 13, 2009. However, this detailed analysis is ultimately unnecessary as part of Ecology's final remedy selection, both because Ecology and GE have agreed to a permanent remedy for the existing land use (except for a small amount of remaining soil contamination for which a more active remedy would be clearly disproportionate), and because in Ecology's opinion Alternative 5 does not meet threshold criteria.

disproportionate – see further discussion below), Ecology has determined that Alternative 2 (unmodified or modified) use permanent solutions to the maximum extent practicable.

Groundwater Contamination: For chlorinated solvent contaminated groundwater, Alternative 2 (unmodified or modified) are permanent remedies because they both utilize ISCO groundwater treatments that are designed to chemically destroy the organic contaminants in groundwater.

Contaminated Soils: ISCO treatments are expected to treat TPH and CVOC contaminated soil below the water table in order to meet groundwater cleanup standards. Residual subsurface vadose zone chlorinated solvent and petroleum hydrocarbon soil contamination near and under the building will not be removed. Areas with TPH and CVOC contaminated soils on the east side of the building will be paved. Areas of TPH and CVOC contaminated soils remaining underneath the footprint of the 220 South Dawson Street building will remain capped by a concrete floor.

Subject to the conditions described in Section 6.0, paragraph 13, Ecology has determined that the incremental costs of removing this remaining contaminated soil are grossly disproportionate and far exceed the incremental degree of benefit achieved by leaving those remaining contaminated soils in place. Institutional controls and groundwater monitoring shall be in place to protect human health and the environment. Those institutional controls are further explained in Section 6.0.

5.8.2.2 Provide a Reasonable Restoration Time Frame

The expected restoration time frame for Alternative 2 (unmodified or modified) are considered reasonable based on the estimates provided in the Ecology modified and approved FFS report. GE estimates that the cleanup will take 6 years (ISCO treatment and post-treatment monitoring) assuming only one small scale ISCO treatment and two full-scale ISCO treatments are required.
Ecology understands that the estimated restoration time frame for Alternative 2 (unmodified or modified) are based on similar sites and previous experience; however, a site-specific restoration time frame will be revised after the cleanup action system is operating and contaminant response to treatment can be better evaluated. Initial data will be collected to evaluate the performance of the cleanup action on groundwater, soil and vapor concentrations at the conclusion of Phases 1 and 2 to revise the projected restoration time frame. Ecology will continue to evaluate moving forward whether the restoration timeframe remains reasonable.

5.8.2.3 Consider Public Concerns

Public review comments were received several times previously (for example, pertaining to the vapor intrusion exposures to building tenants and during Ecology review of the draft focused feasibility study) and were invited as part of the review process for this CAP, as required under WAC 173-340-380.

Alternative 2 (unmodified or modified) meets the concerns voiced by the tenants and owners of buildings located above the chlorinated solvent contaminated groundwater plume. During Ecology discussions with GE on the need to install the vapor intrusion mitigation (VIM) at the 220 South Dawson Street building, Ecology received comments from Mason Supply Company on their concurrence to install the VIM system. The Mason Supply business communicated to Ecology its concerns regarding CVOC vapor intrusion into its offices and they supported the installation of the vapor intrusion mitigation system. Alternative 2 (unmodified or modified) requires the concurrent operation of the existing vapor intrusion mitigation system at the 220 South Dawson Street property.

During the Ecology comment on the draft FFS report, the owners of the buildings at 5033 and 5050 1st Avenue South (Liberty Ridge, LLC as represented by its environmental consultant, Environmental Partners, Inc) provided comments[12] on the draft FFS and revised draft FFS reports. These comments stated a clear preference for maintaining optimized hydraulic control over the chlorinated solvent groundwater plume during on-property ISCO treatments and post-injection monitoring. Liberty Ridge, LLC states that eliminating hydraulic control of the on-property CVOC groundwater plume presents an unacceptable risk to Liberty Ridge due to the spread of additional contamination onto its downgradient property. Liberty Ridge, LLC disagrees that the current hydraulic control system is effective in preventing the CVOC groundwater plume from migrating off-property and recommends that the system be "enhanced". Liberty also states that if hydraulic control is eliminated, it will not be readily possible to recover spreading groundwater contaminants by restarting the groundwater recovery wells. Alternative 2 (unmodified or modified) meets this public concern as it requires concurrent operation of an optimized hydraulic control system during ISCO treatment.

Liberty Ridge, LLC expressed its preference for SVE/AS as the treatment technology with optimized hydraulic control (Alternative 1) versus ISCO with optimized hydraulic control. SVE/AS, as discussed in previous sections above, was not selected as the in-situ treatment component for the final site remedy. Ecology believes both SVE/AS and ISCO treatment systems could be effective technologies for the Site. However, as explained in Section 5.1, the burden of proof that would be needed to justify the selection of this remedy was not fully met in the FS, and ultimately Ecology agreed with GE's preference to use ISCO (with optimized hydraulic control) as the treatment technology.

Ecology also considered all additional public comments received during the public comment on the draft CAP.

5.9 Selecting the Preferred Alternative

The Ecology selected remedy is Modified Alternative 2. The Ecology selected final remedy meets the threshold requirements under WAC 173-340-360(2)(a), is permanent to the maximum extent practicable, allows for reasonable restoration timeframe and considers public concerns. After careful consideration, Ecology has determined that Modified Alternative 2 is the most practical and efficient method of implementing ISCO treatment and monitoring at the Site. Although both utilize optimized hydraulic control concurrent with ISCO treatment, Modified Alternative 2 offers more implementation flexibility than Alternative 2.

---

[12] Technical memorandums from Environmental Partners, Inc. dated August 25, 2008 and November 17, 2008

6.0 Ecology Final Site Cleanup Action –Modified Alternative 2

Ecology has selected Modified Alternative 2 as the cleanup action for the Site. Modifications and additional details to Alternative 2 (Figure 6-1) that form Modified Alternative 2, the Ecology selected cleanup action are described in detail in this section. The approximate Site boundaries are shown on Figure 6-1. The Ecology selected final cleanup action summary points includes the elements of Alternative 2 AND the following:

1. Submit a draft Engineering Design Report (EDR), Construction Plans and Specifications (CPS), and Operation and Maintenance Plans (OMP) which meet the requirements of WAC 173-340-400.

2. The current recovery system will operate in its current location, with optimized groundwater extraction rates to maximize the capture of the chlorinated solvent groundwater plume and minimize migration of the plume to off-properties, during the start of ISCO treatments in and near the source area (alley). Propose optimized groundwater extraction rates as part of the EDR submitted to Ecology for review and approval.

3. Relocation of Optimized Hydraulic Control System: Propose the timing and relocated optimized hydraulic control system including the final pumping rate, well locations, and the phased timing and specific details of the abandonment and replacement of the hydraulic control system as ISCO injections proceed from the east end of the alley to the west end. Evaluate a range of new pumping rates and may include a higher rate than the current design based on the initial ISCO operation results. Groundwater extraction flow rates for the relocated recovery wells will be based on an optimization evaluation to maximize the capture of the chlorinated solvent groundwater plume and minimize migration of the plume to off-properties. The groundwater extraction well relocation will occur in a phased manner to maximize the effectiveness of the ISCO treatment. As ISCO treatments proceed closer to RW-3, relocate this extraction well near the east side of 2nd Avenue South. RW-1 will remain intact and maintained for potential future use in the event Ecology requires that it be used to optimize hydraulic control over the on-property contaminated groundwater plume.

4. ISCO treatment shall consist of one small scale ISCO treatment and at least 2 full scale phases and possibly more depending on the results of each phase. The phase 1 small scale ISCO treatment, baseline monitoring, protection monitoring, performance monitoring, engineering design, construction and implementation work shall also be a component of the EDR for Ecology review and approval.

   Conceptually, Phase 1 will be limited to the vicinity around monitoring well MW-1, which is located in the eastern portion of the alley. Phase 1 uses a combination of conventional and temporary monitoring wells for injection locations. Because of space constraints within the footprint of the alley, temporary injection and monitoring wells are probable within this location. In areas outside of the alley, conventional injection wells will be installed; these conventional injection wells will also be used for future injections. On-property area injections will include the area inside the alley extending to the east towards monitoring well MW-5 and other areas as appropriate. Separate injection locations will are expected for shallow and intermediate depths (e.g., screened at 9-13 and 16-20 feet bgs). Observation wells, used to evaluate the performance of the injection locations, will likely be screened at 9-13, 16-20, and 24-28 feet bgs. Figure 6-2 shows the likely proposed injection and observation wells (including depths and lateral treatment areas).

During injection, the $KMnO_4$ radius of influence[13] (ROI) will be estimated colorimetrically to identify distribution to the observation wells. Field data will be collected daily for the first 5 days after each injection. It is anticipated that after 5 days the $KMnO_4$ will be consumed. If $KMnO_4$ remains additional field data will be collected prior to collecting analytical parameters. During Phase 1, concentrations of $KMnO_4$ are expected to range between 1.0% and 3.0%. Based on previous experience, this range of concentrations is expected to be sufficient to overcome oxidant demand of the aquifer media and the concentration of CVOC and TPH by several orders of magnitude. This concentration range allows for a range of injection concentrations (between 1.0% and 3.0%) to be evaluated during Phase 1.

5. Prior to conducting Phase 1, a baseline data set will be generated. Groundwater will be collected from select observation wells and nearby existing monitoring wells and analyzed for CVOCs, metals (potassium, iron, manganese, arsenic [total and dissolved]), cadmium, chromium, nickel, selenium, chloride and general water quality parameters.

6. After completion of the Phase 1 small scale ISCO treatment, submit a Phase 1 ISCO treatment and performance monitoring summary report to Ecology for review and approval. This report will include at a minimum, tabulated groundwater chemical data, groundwater elevation contour figures, groundwater contaminant concentration contour figures, narrative discussion of the results of the ISCO treatment, recommendations for the next phase of ISCO treatments, problems encountered and how resolved.

7. After Ecology written approval of the Phase 1 report, submit a Phase 2 ISCO full scale treatment and performance monitoring work plan for Ecology review and approval. At a minimum, the work plan shall use previous ISCO data from earlier phases to propose injection locations and depths, ISCO concentrations, injectant volumes, monitoring locations and depth intervals or other design parameters to maximum the effectiveness of these additional ISCO treatments.

   On-property area injection locations are planned to be screened across two intervals: 9-13 and 16-20 feet bgs. At this time, off-property area injection locations are planned to be screened at three approximate intervals: shallow

[13] Refer to previous Ecology comments on the standard operating procedure (SOP) for measurement of permanganate colorimetrically in the Ecology November 21, 2007 letter to GE.

interval (20 - 24 feet bgs), intermediate interval (26-30 feet bgs), and deeper interval (51-55 feet bgs). Ecology will determine the need to inject at intervals between 30 and 50 feet bgs after Phase 1 ISCO treatment and monitoring data is analyzed. Injection locations proposed on the east side of the Liberty Ridge Buildings (formally the Western Cartage building) are planned to be screened across the shallow interval. At this time, suggested injection locations are shown on figure 6-1. GE has thus far proposed only two injection points on 2nd Avenue South. Ecology may require additional injection locations, based on the results of the Phase 1 ISCO treatment and monitoring results.

During Phase 2, chemical data will be collected from monitoring wells and evaluated to estimate the effectiveness of the ISCO treatment by evaluating CVOC and TPH concentrations and field measurements. Ecology may require the installation of new monitoring wells to evaluate the effectiveness of the Phase 2 ISCO treatment.

8. After completion of the Phase 2 work, submit a Phase 2 full scale ISCO treatment and performance monitoring summary report to Ecology for review and approval. This report will include at a minimum, tabulated groundwater chemical data, groundwater elevation contour figures, groundwater contaminant concentration contour figures, narrative discussion of the results of the ISCO treatment, recommendations for the next phase of ISCO treatments, problems encountered and how resolved.

9. After Ecology written approval of the Phase 2 full scale report, unless Ecology determines cleanup standards have been met in groundwater and indoor air, submit a Phase 3 ISCO treatment and performance monitoring work plan for Ecology review and approval. At a minimum, the work plan shall use previous ISCO data from earlier phases to propose injection locations and depths, ISCO concentrations, injectant volumes, monitoring locations and depth intervals or other design parameters to maximum the effectiveness of these additional ISCO treatments. At this time, suggested injection locations are shown on figure 6-1.

10. After completion of the Phase 3 full scale work, submit a Phase 3 full scale ISCO treatment and performance monitoring summary report for Ecology review and approval. This report will include at a minimum, tabulated groundwater chemical data, groundwater elevation contour figures, groundwater contaminant concentration contour figures, narrative discussion of the results of the ISCO treatment, recommendations for the next phase of ISCO treatments, problems encountered and how resolved.

11. After Ecology written approval of the Phase 3 full scale report unless Ecology determines that cleanup standards have been met in groundwater and indoor air, submit to Ecology a work plan for additional ISCO treatment for Ecology's review and approval. At a minimum, the work plan shall include revised analysis of the restoration timeframe, injection locations and depths, ISCO concentrations, injectant volumes, monitoring locations and depth intervals or other design parameters to maximum the effectiveness of the ISCO treatment.

12. After completion of any additional phase ISCO treatment work, submit a treatment and performance monitoring summary report to Ecology for review and approval. This report will include at a minimum, tabulated groundwater chemical data, groundwater elevation contour figures, groundwater contaminant concentration contour figures, narrative discussion of the results of the ISCO treatment, recommendations for the next phase of ISCO treatments, problems encountered and how resolved.

13. In order for the subsurface soil contamination to be considered protective of indoor air in current and future building scenarios in the context of this site, thus meeting the soil cleanup level requirements of WAC 173-340-740(3)(c)(iv)(B), the measured and sustained sub-slab vapor concentrations must be less than an action level set at 33 times the indoor air cleanup levels. If indoor air cleanup levels are met for the current building without the VIM system operating, but sub-slab vapors remain above the 33 times indoor air cleanup level, GE shall implement the steps identified in Section 4.2.1.

14. Prior to each Ecology Five Year review, prepare and submit WAC 173-340-720(2)(b) and (d) groundwater potability analyses to confirm the original potability analysis which supports this CAP. At the same time, submit to Ecology for review and approval, a plan to perform routine follow-up notifications with on- and off-property owners and tenants to ensure that the institutional controls are understood and upheld.

15. Ecology also is willing to consider, the possibility of turning the one or more of the groundwater extraction wells off before meeting the groundwater cleanup standards, pursuant to the terms of this paragraph. Ecology will only consider this possibility, after the completion of the bench scale test, small scale ISCO treatment and two full scale injections. In considering such a plan, Ecology would evaluate whether turning off the one or more of the groundwater extraction wells is likely to result in unacceptable impacts at the Site, whether the optimized groundwater extraction system is interfering unnecessarily with ISCO performance, and the overall effectiveness of continuing ISCO treatments with all the wells on versus turning one or more wells off. Ecology would evaluate the plan against applicable regulatory criteria, as needed to meet the minimum cleanup requirements specified in WAC 173-340-360(2). The work plan shall evaluate the possibility of turning one or more pumps off for short and/or long durations before meeting cleanup standards against the unacceptable impact criteria and other Ecology evaluative criteria listed above. If Ecology does not approve the work plan, the cleanup shall continue to operate all of the groundwater extraction wells in accordance with this Cleanup Action Plan until Ecology determines that groundwater cleanup standards are met based on ISCO treatment and performance monitoring.

16. Monitoring
Implement monitoring in accordance with WAC 173-340-410. The objective of monitoring is to confirm that human health and the environment are adequately protected; acceptable ongoing effectiveness of the treatment and groundwater containment and eventually that cleanup levels are achieved at the points of compliance, and also to confirm the long-term effectiveness of cleanup actions at

the Site. The EDR will contain discussions on duration and frequency of monitoring; the trigger for contingency response actions; and the rationale for terminating monitoring.

WAC 173-340-410 requires three general types of compliance monitoring: 1) protection monitoring, 2) performance monitoring, and 3) confirmational monitoring. The following subsections describe how these monitoring requirements will be met in implementing the Ecology cleanup action.

The three types of compliance monitoring required at the Site are:

Protection Monitoring: The purpose of protection monitoring is to confirm that human health and the environment are adequately protected during implementation of the cleanup action. Monitoring for this purpose will include personal monitoring of workers during construction. It will also include groundwater, indoor air, and sub-slab vapor sampling during implementation to make sure on and off-site receptors are protected and that wastes generated are properly disposed of.

Performance Monitoring: The purpose of performance monitoring is to confirm that the cleanup action effectively attains its objectives and is in compliance with the CAP. Performance monitoring plans are submitted as part of each subsequent phase 1, 2, and 3 (and for any additional phases) ISCO treatment plans.

The frequency of the routine sampling and the details of all monitoring shall be included in the phased ISCO treatment and monitoring work plans. Performance monitoring will include at a minimum:

- Routine indoor air samples shall be collected in addition to routine negative pressure field extension testing conducted to verify progress of the cleanup action and eventual attainment of cleanup levels. Routine negative pressure field extension testing at the 220 South Dawson Street building is also required to confirm effectiveness of the VIM system.
- Sub-slab vapor samples will be collected with the first indoor air sampling event. Subsequently, sub-slab vapor samples shall be collected under the following circumstances to determine attainment of the sub-slab vapor action level of 33 times the MTCA Method B indoor air cleanup level:
    - Indoor air samples indicated that indoor air exceeds the MTCA Method B indoor air cleanup level;
    - Structural changes to the building are proposed, including building renovation or replacement; or
    - Relief is requested from a requirement to maintain institutional controls, as described in Section 4.2.1.
- Monitoring quantity and concentrations of contaminants in extracted groundwater discharged to the King County sanitary sewer.

- Routine groundwater elevation and chemical analysis to verify progress of the cleanup action and eventual attainment of cleanup levels at the standard point of compliance. Following each phased ISCO treatment, at least two additional rounds of analytical parameters (analyzed for the same list of parameters as the baseline) will be collected to assess changes in water quality and reduction of CVOC concentration (and therefore mass). In addition, samples will be pulled from downgradient wells to measure the arrival time of un-reacted $KMnO_4$ against predicted arrival time. Ecology expects a minimum post injection monitoring period of 3 to 6 months, required to evaluate *in situ* chemical oxidation effectiveness, for each phase of the ISCO treatment.
- Monitoring groundwater discharge flow rates and contaminant concentrations for compliance with any King County discharge authorization or permit.
- Revised Long-term Operation, Inspection, Maintenance, and Monitoring Plan (O&M Plan)

Confirmation Monitoring: The purpose of confirmational monitoring is to confirm the long-term effectiveness of the cleanup action once cleanup standards have been achieved. This monitoring will include long-term groundwater monitoring at the Site and in groundwater bounding the Site. Confirmation monitoring will also include indoor air and soil vapor sampling.

17. Financial Assurance
Maintain financial assurance sufficient to cover all costs for construction and implementation of the final CAP, and post cleanup monitoring at the Site in compliance with WAC 173-340-64620(1) and WAC 173-340-440(11).

18. Other Institutional Controls:
Institutional controls shall comply with the requirements of WAC 173-340-440 and shall:

a. restrict withdrawal of groundwater at the Site;
b. prevent subsurface activities that mix the contamination in the intermediate and
c. deeper zone groundwater with contamination in the shallow zone groundwater;
d. restrict future activities which have the potential to exacerbate the vapor intrusion pathway;
e. restrict subsurface activities conducted within the soil and groundwater contaminated areas.

GE will make a good faith effort to secure an environmental covenant (in a form that has been approved by Ecology and that is consistent with WAC 173-340-440) on all the properties associated with the Site before seeking Ecology approval to resort to other legal or administrative mechanisms to meet institutional control requirements.

7.0 Contingent Remedy

Should Ecology determine that the Ecology Final Site Cleanup Action –Modified Alternative 2, with optimized or not-optimized hydraulic control will not achieve the Site cleanup levels in a reasonable timeframe, GE shall implement a contingent remedy, as approved by Ecology, under the process below.

GE shall continue to operate and maintain the optimized or not-optimized hydraulic control system in accordance with the approved Modified Alternative 2 EDR O&M plan or as stated in Exhibit C Scope of Work, Paragraph 3 if the Modified Alternative 2 EDR O&M plan is not approved.

GE shall continue to implement Groundwater hydraulic and chemical monitoring in accordance with the approved Modified Alternative 2 EDR Groundwater Monitoring Plan, SOPs, and QAPP or as stated in Exhibit C Scope of Work, Paragraph 2 if the Modified Alternative 2 EDR is not approved.

GE shall operate and maintain the vapor intrusion mitigation system in accordance with the approved Modified Alternative 2 EDR plan or as stated in Exhibit C Scope of Work, Paragraph 1 if the Modified Alternative 2 EDR plan is not approved .

1. Within 45 days after Ecology determination that the Ecology Final Site Cleanup Action –Modified Alternative 2, ISCO with optimized or not-optimized hydraulic control, will not achieve the Site cleanup levels in a reasonable timeframe, GE shall submit a summary technical memorandum to present all of the results of the bench scale tests, ISCO pilot testing, and following injections for Ecology review and approval.

2. GE shall resubmit a revised summary technical memorandum within 30 days following receipt of Ecology comments. GE shall revise the technical memorandum per Ecology comments.

3. Within 45 days of Ecology approval of this summary technical memorandum, GE shall submit to Ecology a contingent remedy technical memorandum that includes possible contingent remedy options for implementation. The contingent remedy technical memorandum shall include (a) Optimized Hydraulic Control, Enhanced Anaerobic Bioremediation, Subslab Depressurization System and Institutional Controls (dCAP Section 5.4, Alternative 3) with optimized hydraulic control for at least the first two full scale on- and off-property injections; (b) Optimized Hydraulic Control, Soil Vapor Extraction/Air Sparging, Subslab Depressurization System and Institutional Controls (dCAP Section 5.1, Alternative 1) with optimized hydraulic control until cleanup levels are achieved; (c) monitored natural attenuation with optimized hydraulic control (on-property source control) until cleanup levels are achieved (d) optimized groundwater extraction and treatment system for groundwater treatment and hydraulic control, and (e) other viable treatment technologies, not included above but applicable to the site, as required by Ecology or recommend by GE. The technical memorandum shall evaluate these contingent remedy options under the threshold criteria of WAC 173-340-360(2) (a)

and the "other requirements" under WAC 173-340-360(2) (b) and (b) recommend a contingent remedial action to Ecology. Any decision to turn-off one or more groundwater extraction wells under contingent remedy option (a) shall be justified by meeting all cleanup levels or using the criteria in Section 6.0, paragraph 15, as applied to the contingent remedy.

4. Ecology will select the contingent remedy based on review of the contingency remedy technical memorandum and consideration of public comment on the contingency remedy technical memorandum.

5. Upon Ecology selection of the contingency remedy, GE shall submit a revised EDR/CPS/O&M plan with schedule for design and implementation for Ecology review and approval within 60 days.

6. GE shall resubmit a revised EDR/CPS/O&M plan and schedule for design and implementation within 45 days following receipt of Ecology comments. GE shall revise the EDR/CPS/O&M plan per Ecology comments.

GE shall implement the Ecology approved EDR/CPS/O&M plan in accordance with the Ecology approved schedule for design and implementation.

8.0 References

Dames & Moore 1996. *Independent Interim Remedial Action of Soils – GE Plant 1 Facility*. Dames and Moore. December 1996

Duwamish Study, 1998. *Duwamish Basin Groundwater Pathways Conceptual Model Report*. City of Seattle Office of Economic Development and the King Country Office of Budget and Strategic Planning in April 1998.

Ecology, 2002. Agreed Order No. DE 02HWTRNR-4686. State of Washington Department of Ecology, November 13, 2002.

Ecology, 2008a. Letter RE Evaluation of Transmissivity at GE 220 South Dawson Street Site. State of Washington Department of Ecology, February 19, 2008.

Ecology, 2008b. Letter RE Ecology comments on the *Draft Focused Feasibility Study Report* dated June 17, 2008. State of Washington Department of Ecology, August 14, 2008.

Ecology, 2009a. Letter RE Ecology comments on the *Draft Focused Feasibility Study Report* dated October 17, 2008. State of Washington Department of Ecology, July 13, 2009.

Ecology, 2009b, Letter, Ecology Determination that the Focused Feasibility Study is Approved With Revisions and Ready for Public Comment, State of Washington Department of Ecology Dated December 24, 2009.

ENSR 2007. *Final Engineering Report – Vapor Intrusion Mitigation System*. ENSR. October, 2007.

EPI 2001. *Phase II Environmental Site Assessment, McCanta Property*. Environmental Partners, Inc., February 12, 2001.

Fabritz, J., J. Massman, D. Booth 1998. Development of a three-dimensional numerical groundwater flow model for the Duwamish River Basin. Center for Urban Water Resources Management, University of Washington. Prepared for the Duwamish Basin Groundwater Pathways Study, City of Seattle and King County. August 1998.

GE Aviation. Letter RE 220 South Dawson Street, Seattle WA. Dated November 30, 2009.

RETEC, 2006. *Evaluation of the Potential for Subsurface Vapor Intrusion at the Interior Environments Building*. The RETEC Group, Inc. July 18, 2006.

RETEC, 2007. Capture Zone Analysis Scope of Work. The RETEC Group, Inc., April 12.

Figures

EXHIBIT C

Scope of Work and Schedule

EXHIBIT C SCOPE OF WORK AND SCHEDULE

A. GE shall conduct a final cleanup at the Site by implementing the Modified Alternative 2 remedy under the CAP, Exhibit B, in accordance with the following requirements:

1. Until such time as the Operation and Maintenance plan for the vapor intrusion mitigation (VIM) system is approved by Ecology in the EDR and implemented by GE, GE shall continue to operate and maintain the VIM system located at the 220 South Dawson Street building in accordance with the Ecology contingent approved Final Engineering Report – Vapor Intrusion Mitigation System, Sections 6.0 through 6.1, Operation and Maintenance, dated October 2007, as modified by the Ecology letters dated December 4, 2007 and March 7, 2011. Refer to Exhibit G. GE shall be responsible for ensuring that the VIM system operates as designed and constructed in the Final Engineering Report –Vapor Intrusion Mitigation System and subsequently modified as described in the May 28, 2009 VIMS modification memorandum. The requirements of the VIM system Operation and Maintenance plan in the approved EDR will replace the requirements of this paragraph upon the implementation of such plan.
2. Until such time as groundwater monitoring plans, a Quality Assurance Project Plan (QAPP), and Standard Operating Procedures (SOPs), are approved by Ecology in the EDR and implemented by GE, GE shall implement hydraulic and chemical monitoring of groundwater in accordance with the Schedule in Exhibit H, in accordance with the procedures and reporting requirements found in the Ecology-approved Groundwater Sampling and Analysis Plan, Revision 1 and Quality Assurance Project Plan, dated February 2008 in Exhibit H, and in accordance with the quality assurance procedures found in the Ecology-approved QAPP and SOPs in Exhibit H. GE shall submit quarterly groundwater monitoring reports to Ecology within 60 days after completing the sampling event. In addition, GE shall include a short summary of the data validation results from both its contractor laboratory and ENSR. This summary shall be included in the main discussion section of each quarterly groundwater monitoring report and include at a minimum: a discussion of any discrepancies, unusual results, data rejected, and reasons for the data being rejected, and a discussion of any data qualified and the reason for the data qualification. The requirements of the groundwater monitoring plans, QAPP, and SOPs, in the approved EDR will replace the requirements of this paragraph upon the implementation of such plans.
3. Until such time as the EDR is approved by Ecology and implemented by GE, or another Ecology directive requires or provides for modification or shut down of the ground water extraction system, the facility ground water extraction system will remain operational under the following conditions: (a) GE shall use best efforts to maintain the design groundwater and extraction rate of 10 gallons per

minute (gpm) at RW-3 and 6 gallons per minute at RW-2, and GE will operate the groundwater extraction system in accordance with the Operation & Maintenance Plan, dated March 2010 and approved by Ecology's letter dated March 25, 2010 attached as Exhibit I; (b) GE will not abandon ground water extraction well RW-1 in case Ecology decides it should be operational in the future based on the effectiveness of the overall ground water extraction system or if required as part of the final remedy; and (c) in the event that construction activities or other requirements of the current owner at the Site preclude the operation of all or a part of the ground water extraction system, GE will provide written notice of the construction impacts or requirements to Ecology within 15-calendar days of first being aware of this change. The ground water extraction system requirements in the approved EDR will replace the requirements of this paragraph upon the implementation of the EDR.

4. GE shall submit a draft Engineering Design Report (EDR), Construction Plans and Specifications (CPS), and Operation and Maintenance Plans (OMP) which meet the requirements of WAC 173-340-400 and the Ecology CAP, Section 6.0 paragraph 1, in accordance with the List and Schedule of Deliverables below. GE shall include in the EDR an implementation schedule that includes a critical-path Gantt chart timeline showing anticipated dates and timeframes for all post-CAP deliverables and cleanup action elements. GE shall revise the draft EDR/CPS/OMP to address all Ecology comments in accordance with the List and Schedule of Deliverables below. GE shall begin construction and implementation of the cleanup action in accordance with the Ecology approved EDR/CPS/OMP in accordance with the List and Schedule of Deliverables below.

5. GE shall submit a draft engineering as-built report per the List and Schedule of Deliverables below. GE shall revise the draft engineering as-built report to address all Ecology comments in accordance with the List and Schedule of Deliverables below.

6. As part of the EDR submitted to Ecology for review and approval, GE shall propose optimized groundwater extraction rates for operating the groundwater recovery wells in the current locations in accordance with the Ecology CAP, Section 6.0 paragraph 2.

7. Relocation of Optimized Hydraulic Control System: As part of the EDR, GE shall submit for Ecology's review and approval a work plan that discusses the timing and relocated optimized hydraulic control system in accordance with the Ecology CAP, Section 6.0 paragraph 3, including the final pumping rate, well locations, and the phased timing and specific details of the abandonment and replacement of the hydraulic control system as ISCO injections proceed from the east end of the alley to the west end.

8. GE shall submit work plans for Ecology review and approval to perform Phase 1, Phase 2, Phase 3, and all other additional ISCO injection phases described in the Ecology CAP, Section 6.0 paragraphs 4, 7, 9 and 11, in accordance with the List and Schedule of Deliverables below. GE shall address all Ecology comments into a revised report for Ecology review and approval in accordance with the List and Schedule of Deliverables below.

9. Prior to conducting Phase 1, GE shall submit as part of the EDR, a work plan to collect baseline data as described in the Ecology CAP, Section 6.0 paragraph 4 and 5.

10. After completion of the Phase 1 small scale ISCO treatment, Phase 2 full scale ISCO treatment, Phase 3 full-scale treatment, and any additional Ecology required ISCO treatments, GE shall submit an ISCO treatment and performance monitoring summary report, as described in the Ecology CAP, Section 6.0 paragraphs 6, 8, 10, and 12, to Ecology for review and approval in accordance with the List and Schedule of Deliverables below. GE shall address all Ecology comments into a revised report for Ecology review and approval in accordance with the List and Schedule of Deliverables below.

11. In accordance with the Ecology CAP, Section 6.0 paragraph 14, and the List and Schedule of Deliverables below, GE shall submit the groundwater potability analysis to Ecology four years and six months after the consent decree is originally signed by the Court or after Ecology issues an alternative administrative order, and thereafter every five years from the date the first report is due. Additionally, within 60 calendar days of an Ecology written request for a potability analysis, GE shall submit such analysis to Ecology for review and approval. GE is required to continue these reports in accordance with this schedule until MTCA Method B potable groundwater cleanup standards are attained at the Site.

12. In accordance with the Ecology CAP, Section 6.0 paragraph 14, and the List and Schedule of Deliverables below, GE shall submit to Ecology for review and approval, a plan to perform routine follow-up notifications with on- and off-property owners and tenants to ensure that the institutional controls are understood and upheld. GE shall implement the Ecology approved plan.

13. In accordance with the Ecology CAP, Section 6.0 paragraph 15, at any time after the completion of the bench scale test, small scale ISCO treatment, and two full scale ISCO treatments (after Phase 3), GE may submit to Ecology for review and approval a work plan proposing to turn off one or more pumps. GE shall base its analysis in the work plan on all site data available at the time of

the submission. If Ecology approves the work plan to turn off one or more pumps, then GE shall implement said work plan in accordance with its terms. If Ecology does not approve the work plan, GE shall continue to operate all of the groundwater extraction wells in accordance with the Ecology CAP until Ecology determines that groundwater cleanup standards are met based on ISCO treatment and performance monitoring.

14. Monitoring

GE shall implement monitoring in accordance with WAC 173-340-410. GE shall submit the following detailed monitoring work plans as part of the EDR (or as an addendum to the EDR, as specified) in accordance with the Ecology CAP, Section 6.0 paragraph 16, and the List and Schedule of Deliverables below:

Protection Monitoring: GE shall submit a protection monitoring plan as part of the EDR to Ecology for review and approval. GE shall implement the Ecology approved protection monitoring plan.

Performance Monitoring: The EDR submitted to Ecology for review and approval shall contain the performance monitoring plan as part of the Phase 1 ISCO treatment and monitoring plan. GE shall submit subsequent phase 2, 3 (and for any additional phases) performance monitoring plans as part of those phased ISCO treatment and monitoring plans, as addendums to the EDR. GE shall implement the Ecology approved performance monitoring plan.

Confirmation Monitoring: When Ecology determines that cleanup standards are achieved without further ISCO treatment, GE shall submit the confirmation monitoring plan for review and approval as an addendum to the EDR. GE shall address all Ecology comments into a revised work plan for Ecology review and approval in accordance with the List and Schedule of Deliverables, below. GE shall implement the Ecology approved confirmation monitoring plan.

List and Schedule of Deliverables

Milestone/Deliverable	Due/End date	Duration
Draft Bench Scale Testing Work Plan and Schedule	GE shall submit within 45 days following Ecology approval of the Cleanup Action Plan (CAP).	
Implement Bench Scale Testing	GE shall initiate implementation of the bench scale testing within 45 days following approval of the Work Plan.	

Bench Scale Testing Report	GE shall submit within 45 days following finalization of the bench scale testing.	
Draft Engineering Design Report (EDR/CPS/OMP)	GE shall submit within 90 days following Ecology approval of the bench scale testing report.	
Draft Revised EDR/CPS/OMP which addresses Ecology's comments	GE shall submit within 45 days following receipt of Ecology comments on the draft EDR/CPS/OMP. GE shall revise the EDR/CPS/OMP per Ecology comments.	
Construction and implementation per detailed EDR schedule (phase 1 ISCO treatment)	GE shall initiate construction and implement the EDR/CPS/OMP within 60 days following approval of Final EDR/CPS/OMP.	Per EDR schedule
Institutional controls per the approved EDR and its schedule	GE shall complete implementation of institutional controls within one year following finalization of the EDR.	Until Ecology determines institutional controls are no longer needed at the Site.
Draft phase 1 ISCO treatment and performance monitoring report	GE shall submit within 45 days after Ecology determines that phase 1 work is complete.	
Draft phase 2 ISCO treatment and performance monitoring plan (EDR addendum)	GE shall submit within 60 days after Ecology written approval of the phase 1 ISCO treatment and performance monitoring report.	
Implement phase 2 ISCO treatment and performance monitoring work plan	GE shall initiate implementation within 60 days after Ecology written approval of the phase 2 ISCO treatment and performance monitoring work plan.	
Draft phase 2 ISCO treatment and performance monitoring report	GE shall submit within 45 days after Ecology determines that phase 2 work is complete.	
Draft phase 3 ISCO treatment and performance monitoring plan (EDR addendum)	GE shall submit within 60 days after Ecology written approval of the phase 2 ISCO treatment and performance monitoring report.	
Implement phase 3 ISCO treatment and performance monitoring work plan	GE shall initiate implementation within 60 days after Ecology written approval of the phase 3 ISCO treatment and performance monitoring work plan.	
Draft phase 3 ISCO treatment and performance monitoring report	GE shall submit within 45 days after Ecology determines that phase 3 work is complete.	
Additional ISCO treatment and performance monitoring plans (EDR addendum)	GE shall submit within 60 days after Ecology written notice if Ecology determines that cleanup standards are not met.	
Implement additional phase ISCO treatment and performance monitoring work plan	GE shall initiate implementation within 60 days after Ecology written approval of the additional phase ISCO treatment and performance	

	monitoring work plan.	
Draft ISCO treatment and performance monitoring reports (subsequent to phase 3 if required by Ecology)	GE shall submit within 45 days after Ecology determines that each applicable phase of ISCO work is completed.	
Revised phased ISCO treatment and performance monitoring work plans and reports.	GE shall submit within 45 days following receipt of Ecology comments on each respective draft work plan and report. GE shall revise the work plans and reports per Ecology comments.	
Draft As-built Report	GE shall submit per the schedule in the Ecology approved EDR.	
Revised Final As-Built Report	GE shall submit within 45 days following receipt of Ecology's comments on the draft As-built Report. GE shall revise the As-built Report per Ecology comments.	
Protection Monitoring	GE shall initiate implementation of protection monitoring within 60 days after monitoring plan in the EDR is approved by Ecology.	Until Ecology determines that protection monitoring is no longer required.
Performance Monitoring	GE shall implement immediately after phased ISCO injections are complete. Each phase of the ISCO treatment will have a specified performance monitoring plan.	Until Ecology determines that performance monitoring is complete.
Draft Confirmation Monitoring Work Plan	GE shall submit within 60 days after Ecology written request.	
Revised Confirmation Monitoring Work Plan	GE shall submit within 45 days following receipt of Ecology comments on the draft work plan. GE shall revise the work plan per Ecology comments.	
Confirmation Monitoring	GE shall initiate implementation of approved Confirmation Monitoring Work Plan within 30 days after Ecology determines that performance monitoring is complete.	Until Ecology determines that residual hazardous substance concentrations no longer exceed site cleanup levels.
Other Deliverables	Unless otherwise stated, GE shall resubmit revised deliverables per all Ecology comments within 45 days.	

EXHIBIT D-1

<u>Restrictive Covenant</u>

After Recording Return to:
Katherine Seiler, Program Manager
Hazardous Waste and Toxics Reduction Program
Department of Ecology
300 Desmond Drive SE
Lacey, WA 98504-7600

Environmental Covenant

Grantor:	[insert]
Grantee:	State of Washington, Department of Ecology
Legal:	[insert]
Tax Parcel Nos.:	[insert]
Cross Reference:	none

Grantor, ___________________, hereby binds Grantor, its successors and assigns to the land use restrictions identified herein and grants such other rights under this environmental covenant (hereafter "Covenant") made this _____ day of ___________, 2013 in favor of the State of Washington Department of Ecology and its successors and assigns (Ecology). Ecology shall have full right of enforcement of the rights conveyed under this Covenant pursuant to the Model Toxics Control Act (MTCA), RCW 70.105D.030(1)(g), and the Uniform Environmental Covenants Act, RCW 64.70.110.

This Covenant is made pursuant to RCW 70.105D.030(1)(f) and (g) and WAC 173-340-440 by ____________, its successors and assigns, and Ecology.

A remedial action (hereafter "Remedial Action") is occurring at the area Ecology has designated as the General Electric Aviation Site (Site). The Site as defined by WAC 173-340-200 includes the property at [insert address] (Property). The Property is the subject of this Covenant. The Remedial Action is described in the following documents: Consent Decree in *State of Washington, Department of Ecology v. General Electric Co., GE Aviation*, King

County Superior Court No. [insert], entered [insert , 2013], and all exhibits attached thereto, including Exhibit B, Cleanup Action Plan, GE South Dawson Street, Seattle, Washington, dated ____________, 2013. These documents are on file at Ecology's Northwest Regional Office.

This Covenant is required because of soil and groundwater contamination. Site-specific MTCA Method A and B soil and groundwater cleanup levels have been established for the Site based on protection of indoor air, protection of surface water, and potable groundwater (for arsenic and total petroleum hydrocarbons [TPH] only). The site-specific soil cleanup levels for TPH and trichloroethylene (TCE) are currently exceeded at the Property. The site-specific groundwater cleanup levels for TCE are currently exceeded at the Property. Even after the cleanup meets the Ecology cleanup requirements, contaminants may still exceed unrestricted MTCA Method A soil cleanup levels (total petroleum hydrocarbon and MTCA unrestricted Method A or B groundwater potability cleanup levels (trichloroethylene, vinyl chloride, 1,4-dioxane, trans-1,2-DCE, and cis 1,2–DCE), since the Ecology cleanup action plan allows contaminated soils to be capped in place and allows residual contaminant concentrations to meet site-specific groundwater cleanup levels that are primarily based on protection of surface water and indoor air.

The undersigned, ______________, is the fee owner of the Property that is subject to this Covenant. The Property is legally described in Attachment A to this Covenant and made a part hereof by reference. A figure depicting the Property is attached to this Covenant as Attachment B.

______________________ makes the following declaration as to limitations, restrictions, and uses to which the Property may be put and specifies that such declarations shall constitute covenants to run with the land, as provided by law and shall be binding on all parties and all persons claiming under them, including all current and future owners of any portion of or interest in the Property (hereafter "Owner").

Section 1. No groundwater may be taken from the Property for domestic, agricultural, or any other use.

Section 2. Any activity on the Property that may interfere with the integrity of the Remedial Action and continued protection of human health and the environment is prohibited without prior written approval from Ecology. This includes, but is not limited to: 1) any activities that may compromise the integrity of any groundwater extraction well or groundwater monitoring well; and 2) any activities that may compromise any vapor intrusion mitigation equipment and monitoring gauges associated with the Remedial Action.

Section 3. Any activity on the Property that may result in the release or exposure to the environment of a hazardous substance that remains on the Property as part of the Remedial Action, or create a new exposure pathway, is prohibited without prior written approval from Ecology. Such activities include, but are not limited to: 1) any subsurface activities that may mix contamination in the intermediate and deeper zone groundwater with contamination in the shallow zone groundwater; 2) any activities that have the potential to exacerbate the vapor intrusion pathway; 3) the alteration, modification, or removal of any existing structure[s], including building floors, that may result in the release or exposure to the environment of a hazardous substance that remains on the Property (e.g., through dermal contact, ingestion, and vapor intrusion); and 4) any drilling, digging, bulldozing, or sub-surface earthwork that may result in the release or exposure to the environment of a hazardous substance that remains on the Property. Construction and development are not prohibited on the Property when performed in compliance with the terms of this Covenant. Drilling, digging, bulldozing, or sub-surface earthwork may not proceed without provision for worker safety and health as described in WAC 173-340-810 and compliance with applicable worker safety law (e.g., the Occupational Safety and Health Act of 1970, 29 U.S.C. Sec. 651 et seq., and the Washington Industrial Safety and Health Act and its implementing regulations, chapter 49.17 RCW and chapter 296-62 WAC).

Section 4. The Owner of the property must give thirty (30) day advance written notice to Ecology of the Owner's intent to convey any interest in the Property. No voluntary conveyance of title, easement, lease, or other interest in the Property shall be consummated by the Owner without adequate and complete provision for continued monitoring, operation, and maintenance of the Remedial Action. Owner shall include in any instrument conveying any ownership interest in any portion of the property notice of this covenant.

Section 5. The Owner must restrict leases to uses and activities consistent with this Covenant and notify all lessees of the restrictions on the use of the Property.

Section 6. The Owner must notify and obtain approval from Ecology prior to any use of the Property that is inconsistent with the terms of this Covenant. Ecology may approve any inconsistent use only after public notice and comment.

Section 7. The Owner shall allow authorized representatives of Ecology the right to enter the Property at reasonable times and with reasonable advance notice for the purpose of evaluating the Remedial Action; to take samples, to inspect remedial actions conducted at the property, to determine compliance with this Covenant, and to inspect records that are related to the Remedial Action, to the extent such records are kept by the Owner.

Section 8. The Owner of the Property reserves the right under WAC 173-340-440 to record an instrument that provides that this Covenant shall, in part or in whole, no longer limit use of the Property or be of any further force or effect. However, such an instrument may be recorded only if Ecology, after public notice and opportunity for comment, concurs.

[NAME OF GRANTOR]

____
[Name of Signatory]
[Title]

Dated: __________________

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

____

Katherine Seiler, Program Manager
Hazardous Waste and Toxics Reduction Program
Department of Ecology

Dated: ____________________

[INDIVIDUAL ACKNOWLEDGMENT]

STATE OF ____________________.
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ personally appeared before me, and acknowledged that **he/she** is the individual described herein and who executed the within and foregoing instrument and signed the same at **his/her** free and voluntary act and deed for the uses and purposes therein mentioned.

____
Notary Public in and for the State of
Washington, residing at ______________.
My appointment expires______________.

[CORPORATE ACKNOWLEDGMENT]

STATE OF ____________________
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ personally appeared before me, acknowledged that **he/she** is the ____________________ of the corporation that executed the within and foregoing instrument, and signed said instrument by free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and on oath stated that **he/she** was authorized to execute said instrument for said corporation.

____
Notary Public in and for the State of
Washington, residing at

_______________.
My appointment
expires_______________.

[REPRESENTATIVE ACKNOWLEDGEMENT]

STATE OF ____________________
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ ______ personally appeared before me, acknowledged that **he/she** signed this instrument, on oath stated that **he/she** was authorized to execute this instrument, and acknowledged it as the ________________________ [type of authority] of ______________________ [name of party being represented] to be the free and voluntary act and deed of such party for the uses and purposes mentioned in the instrument.

____
Notary Public in and for the State of
Washington, residing at ____________.
My appointment expires ____________.

EXHIBIT D-2

Restrictive Covenant

After Recording Return to:
Katherine Seiler, Program Manager
Hazardous Waste and Toxics Reduction Program
Department of Ecology
300 Desmond Drive SE
Lacey, WA 98504-7600

Environmental Covenant

Grantor:	[insert]
Grantee:	State of Washington, Department of Ecology
Legal:	[insert]
Tax Parcel Nos.:	[insert]
Cross Reference:	none

Grantor, [insert], hereby binds Grantor, its successors and assigns to the land use restrictions identified herein and grants such other rights under this environmental covenant (Covenant) made this _____ day of ___________, 2013 in favor of the State of Washington Department of Ecology and its successors and assigns (Ecology). Ecology shall have full right of enforcement of the rights conveyed under this Covenant pursuant to the Model Toxics Control Act (MTCA), RCW 70.105D.030(1)(g), and the Uniform Environmental Covenants Act, RCW 64.70.110.

This Covenant is made pursuant to RCW 70.105D.030(1)(f) and (g) and WAC 173-340-440 by , its successors and assigns, and Ecology.

A remedial action (hereafter "Remedial Action") is occurring at the area Ecology has designated as the General Electric Aviation Site (Site). The "Site" as defined by WAC 173-340-200 includes the property at [insert address] (Property). The Property is the subject of this Covenant. The Remedial Action is described in the following documents: Consent Decree in *State of Washington, Department of Ecology v. General Electric Co., GE Aviation*, King

County Superior Court No. [insert], entered [insert , 2013], and all exhibits attached thereto, including Exhibit B, Cleanup Action Plan, GE South Dawson Street, Seattle, Washington, dated ____________, 2013. These documents are on file at Ecology's Northwest Regional Office.

This Covenant is required because of groundwater contamination. Site-specific MTCA groundwater Method B cleanup levels have been established for the Site based on protection of indoor air cleanup levels, protection of surface water cleanup levels, and potable groundwater cleanup levels (for arsenic and total petroleum hydrocarbons [TPH] only). The site-specific groundwater cleanup levels for trichloroethylene (TCE) and 1,1-dichloroethylene (DCE) are currently exceeded at the Property. Even after groundwater on the Property meets the Site-specific cleanup levels, residual concentrations of TCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, and 1,4-dioxane may still exceed MTCA Method A or B unrestricted groundwater potability cleanup levels since the Ecology cleanup action plan allows residual concentrations to meet the Site-specific cleanup levels for groundwater that are primarily based on protection of surface water and indoor air.

The undersigned, [insert], is the fee owner of the Property that is subject to this Covenant. The Property is legally described in Attachment A to this Covenant and made a part hereof by reference. A figure depicting the Property is attached to this Covenant as Attachment B. "G

[Insert] makes the following declaration as to limitations, restrictions, and uses to which the Property may be put and specifies that such declarations shall constitute covenants to run with the land, as provided by law and shall be binding on all parties and all persons claiming under them, including all current and future owners of any portion of or interest in the Property (hereafter "Owner").

<u>Section 1</u>. No groundwater may be taken from the Property for domestic, agricultural, or any other use.

Section 2. Any activity on the Property that may interfere with the integrity of the Remedial Action and continued protection of human health and the environment is prohibited without prior written approval from Ecology. This includes, but is not limited to: 1) any activities that may compromise the integrity of any groundwater extraction well or groundwater monitoring well; and 2) any activities that may compromise any vapor intrusion mitigation equipment and monitoring gauges associated with the Remedial Action.

Section 3. Any activity on the Property that may result in the release or exposure to the environment of a hazardous substance that remains on the Property as part of the Remedial Action, or create a new exposure pathway, is prohibited without prior written approval from Ecology. Such activities include, but are not limited to: 1) any subsurface activities that may mix contamination in the intermediate and deeper zone groundwater with contamination in the shallow zone groundwater; 2) any activities that have the potential to exacerbate the vapor intrusion pathway; 3) the alteration, modification, or removal of any existing structure[s], including building floors, that may result in the release or exposure to the environment of a hazardous substance that remains on the Property (e.g., through dermal contact, ingestion, and vapor intrusion); and 4) any drilling, digging, bulldozing, or sub-surface earthwork that may result in the release or exposure to the environment of a hazardous substance that remains on the Property. Construction and development are not prohibited on the Property when performed in compliance with the terms of this Covenant. Drilling, digging, bulldozing, or sub-surface earthwork may not proceed without provision for worker safety and health as described in WAC 173-340-810 and compliance with applicable worker safety law (e.g., the Occupational Safety and Health Act of 1970, 29 U.S.C. Sec. 651 et seq., and the Washington Industrial Safety and Health Act and its implementing regulations, chapter 49.17 RCW and chapter 296-62 WAC).

Section 4. The Owner of the Property must give thirty (30) day advance written notice to Ecology of the Owner's intent to convey any interest in the Property. No voluntary conveyance of title, easement, lease, or other interest in the Property shall be consummated by the Owner without adequate and complete provision for continued monitoring, operation, and maintenance of the Remedial Action. Owner shall include in any instrument conveying any ownership interest in any portion of the property notice of this covenant.

Section 5. The Owner must restrict leases to uses and activities consistent with the Covenant and notify all lessees of the restrictions on the use of the Property.

Section 6. The Owner must notify and obtain approval from Ecology prior to any use of the Property that is inconsistent with the terms of this Covenant. Ecology may approve any inconsistent use only after public notice and comment.

Section 7. The Owner shall allow authorized representatives of Ecology the right to enter the Property at reasonable times and with reasonable advance notice for the purpose of evaluating the Remedial Action; to take samples, to inspect remedial actions conducted at the property, to determine compliance with this Covenant, and to inspect records that are related to the Remedial Action, to the extent such records are kept by the Owner.

Section 8. The Owner of the Property reserves the right under WAC 173-340-440 to record an instrument that provides that this Covenant shall, in whole or in part, no longer limit use of the Property or be of any further force or effect. However, such an instrument may be recorded only if Ecology, after public notice and opportunity for comment, concurs.

[NAME OF GRANTOR]

____
[Name of Signatory]
[Title]

Dated: ________________

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

____
Katherine Seiler, Program Manager
Hazardous Waste and Toxics Reduction Program
Department of Ecology

Dated: __________________

[INDIVIDUAL ACKNOWLEDGMENT]

STATE OF ____________________
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ personally appeared before me, and acknowledged that **he/she** is the individual described herein and who executed the within and foregoing instrument and signed the same at **his/her** free and voluntary act and deed for the uses and purposes therein mentioned.

____
Notary Public in and for the State of Washington, residing at ______________.
My appointment expires______________.

[CORPORATE ACKNOWLEDGMENT]

STATE OF ____________________
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ personally appeared before me, acknowledged that **he/she** is the ____________________ of the corporation that executed the within and foregoing instrument, and signed said instrument by free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and on oath stated that **he/she** was authorized to execute said instrument for said corporation.

____
Notary Public in and for the State of Washington, residing at
_______________.
My appointment expires_______________.

[REPRESENTATIVE ACKNOWLEDGEMENT]

STATE OF ____________________
COUNTY OF __________________

On this ______ day of __________________, 2013, I certify that _____________ ______ personally appeared before me, acknowledged that **he/she** signed this instrument, on oath stated that **he/she** was authorized to execute this instrument, and acknowledged it as the ___________________________ [type of authority] of _________________________ [name of party being represented] to be the free and voluntary act and deed of such party for the uses and purposes mentioned in the instrument.

____
Notary Public in and for the State of
Washington, residing at _____________.
My appointment expires ______________.

EXHIBIT E

Public Participation Plan

EXHIBIT E
GENERAL ELECTRIC AIRCRAFT ENGINES - DAWSON PLANT

PUBLIC PARTICIPATION PLAN

PREPARED BY
WASHINGTON STATE DEPARTMENT OF ECOLOGY
3190 160TH AVENUE SE
BELLEVUE, WA 98008-5452
JUNE 2012

I. INTRODUCTION AND OVERVIEW

This plan applies to the required remedial actions at the former General Electric Aircraft Engines Facility (Plant) located at 220 South Dawson Street, Seattle, Washington.

Ecology is committed to providing public participation opportunities during the remedial action activities required under the Model Toxics Control Act (MTCA). The public participation plan is intended to promote public understanding of Ecology's responsibilities, planning activities and remedial activities at such facilities. It also provides an opportunity for Ecology to learn information from the public that will enable the Ecology to develop a comprehensive cleanup plan that is protective of both human health and the environment.

A. The purpose of this public participation plan is to ensure that the public is kept informed of the consent decree and required cleanup activities conducted at the former General Electric Aircraft Engines Company Facility located at 220 South Dawson Street, Seattle, Washington. This plan discusses the community's concerns and outlines public involvement activities to be conducted for the phases of the consent decree and required cleanup actions. This Public Participation Plan was prepared by the Department of Ecology, Hazardous Waste and Toxics Reduction Program - Northwest Regional Office. All public involvement activities will be carried out by Ecology and if necessary include the General Electric (GE) Company.

B. The plan is organized as follows:

I. Introduction and Overview of Plan

II. Site Background

III. Community Concerns

IV. Public involvement activities

V. Glossary

C. This Public Participation Plan addresses public involvement activities that will take place during the remedial actions required by the MTCA consent decree. The plan has been tailored to the needs of the public based on the nature and phase of the cleanup process, level of public concern, and the risks posed by the site.

II. SITE BACKGROUND

The former General Electric (GE) Aircraft Engines Facility (Plant) was located at 220 South Dawson Street, Seattle, Washington. GE occupied the premises in 1949 and began to manufacture and repair aircraft engine parts in 1959. Manufacturing operations ceased in 1994. GE continued to use the property for office and warehouse space through 1996. It is now occupied by another tenant.

As the result of producing and testing aircraft parts, hazardous substances were released to the soils and groundwater beneath the building from routine spills and from leaks from sumps and tanks. The main contaminants are trichloroethylene (TCE), 1,1,1-trichloroethane (1,1,1 TCA), 1,4 dioxane, fuels, and oils.

TCE located in the soil and groundwater beneath the 220 S. Dawson Street building can change to a gas and move upwards through the soil, into the building work spaces. This can contaminate indoor air. The contamination in the groundwater has also migrated offsite (westerly).

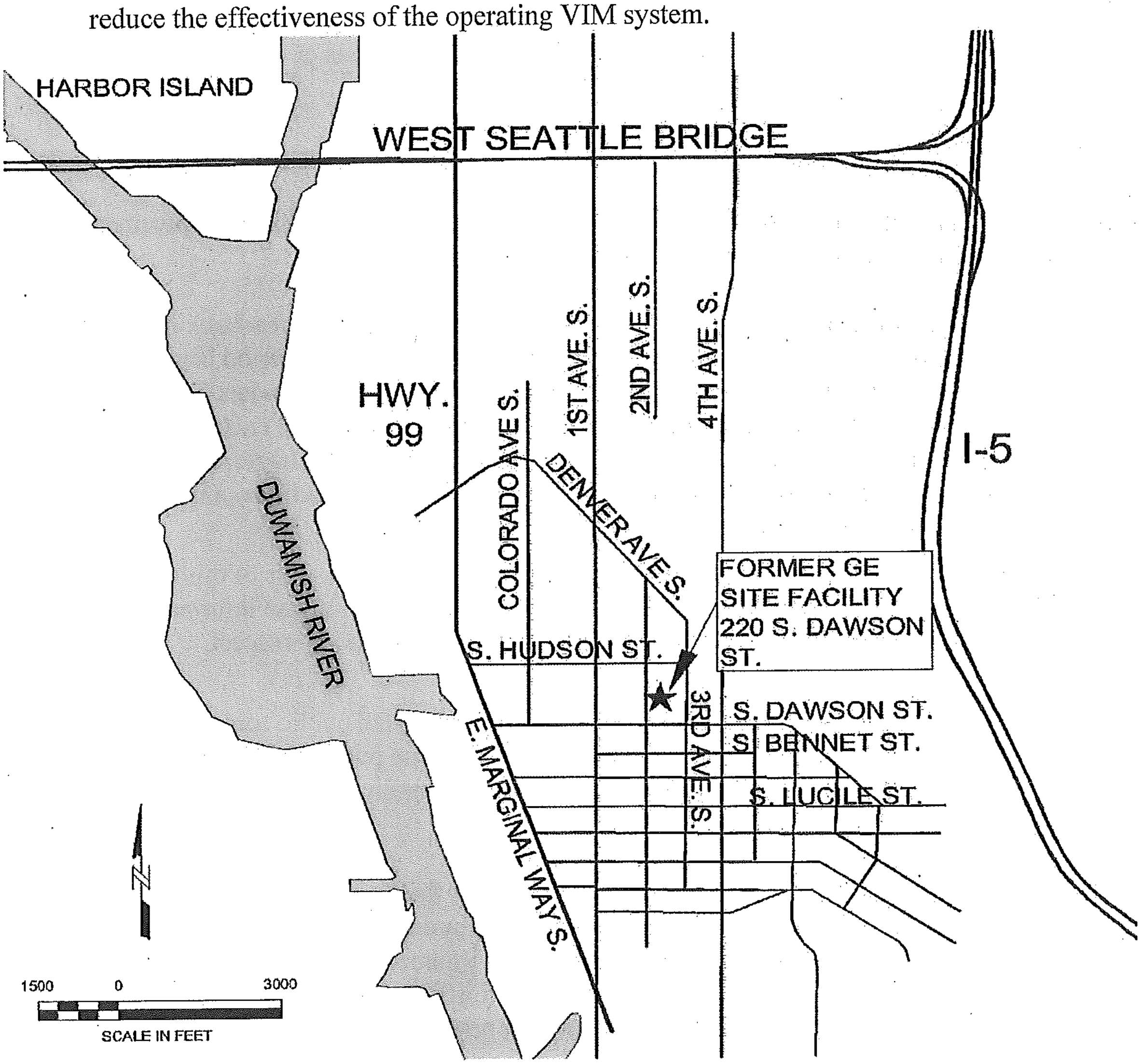
Based on the air and soil gas sampling results, the Washington State Department of Ecology ("Ecology") directed the General Electric Company (GE) to submit an interim action work plan (Vapor Intrusion Mitigation Work Plan) with a detailed design and cost estimate for a *mitigation system* at the 220 S. Dawson St. building. This system would <u>protect</u> the building's occupants from contaminated vapors that might otherwise be coming inside from beneath the ground surface. This interim action required the construction, operation and maintenance of this vapor intrusion mitigation system per the work plan. Installation of this vapor intrusion mitigation system was completed in August 2007. These requirements were part of the MTCA Agreed Order amendment effective May 10, 2007.

GE entered into a MTCA Agreed Order effective May 13, 2008 that required GE to conduct the following work:

- Submitted a focused feasibility study (FFS) to Ecology. The FFS described cleanup options that GE evaluated to cleanup dangerous wastes and dangerous constituents at and from the former 220 S. Dawson Street facility. Ecology reviewed several revised FFS reports and eventually modified and approved a final FFS report which described the Ecology selected Site remedy.
- Continue groundwater monitoring at the Site and submit reports that updates the extent of groundwater contamination at the Site and effectiveness of the groundwater extraction system operation.

The current proposed Consent Decree requires GE to conduct the following work as described in the Ecology cleanup action plan (CAP):

- Require the submittal of design and monitoring documents to construct, operate and maintain a remediation system to treat the chlorinated solvent contaminated groundwater plume under the 220 S. Dawson Street property and groundwater contamination that has migrated offsite (westerly).
- Operate and maintain the current vapor intrusion mitigation (VIM) system at the 220 South Dawson Street property to prevent unacceptable entry of chlorinated solvent vapors into the building.
- Implement institutional controls to prevent the extraction and use of contaminated groundwater; prevent contact with contaminated soils beneath the 220 South Dawson Street building; and prevent modifications to the 220 South Dawson Street building that would reduce the effectiveness of the operating VIM system.



III. COMMUNITY CONCERNS

This public participation plan is effective for the work described in the consent decree.

Ecology and as necessary, the General Electric Company, will address these community concerns by keeping site investigation/remediation reports and work plans accessible to interested community members. These documents will be kept at the Ecology-Northwest Regional Office and at the New Holly Library (see addresses below). Interest parties can review these documents and provide written or verbal comments to Ecology. Public comments will be considered in the decisions made by Ecology. Those on the Site Mailing list will be notified by mail of any new proposed remedial action decisions.

Point of Contact: Interested parties may contact the Ecology Project Manager, Dean Yasuda by phone (425.649.7264) or by email at dyas461@ecy.wa.gov with questions or comments regarding this consent decree.

IV. PUBLIC INVOLVEMENT ACTIVITIES

Ecology proposes the following public involvement activities for the site. Public involvement for this proposed consent decree consists of the following activities:

A. Comment periods are the primary method Ecology uses to get feedback from the public on proposed cleanup decisions. The public comment period begins on December 18, 2013 and ends on January 16, 2014. Ecology invites and will consider public comments on the proposed documents up to the end of the comment period. Interested parties may contact the Ecology Project Manager, Dean Yasuda by phone (425.649.7264) or by email at dyas461@ecy.wa.gov with comments or questions regarding this consent decree.

   Ecology reserves the right to modify or withdraw any provisions of this consent decree and draft cleanup action plan if public comments disclose information indicating these documents are inadequate or improper in any respect.

B. If ten or more people request a public hearing during the public comment period, Ecology will organize and hold one. If required, the public meeting will be announced in a fact sheet sent to those on the site mailing list, and in advertisements in the local paper.

C. Ecology will notify residences and businesses in the vicinity of the site of the 30-day public comment period for this proposed consent decree by a mailed fact sheet. Ecology mailed fact sheets to individuals, environmental groups, public officials, public agencies and private firms that have expressed an interest in the site. Ecology may also mail fact sheets about the progress of site activities.

D. The public comment period will be advertised in the Seattle Times through a display advertisement.

E. The public has the opportunity to review the consent decree and proposed work in the draft cleanup action plan (dCAP) at the following locations:

Department of Ecology
Northwest Regional Office
Attn: Sally Alexander
3190 160th Avenue SE
Bellevue, WA 98008-5452
(425) 649-7239

New Holly Library
7058 32nd Ave. S.,
Seattle, WA 98118
(206) 386-1905

F. All comments received during the public comment period will be maintained for the administrative record. A formal **Responsiveness Summary** will be prepared addressing all written comments received during the public comment period. The summary will be placed with the other site documents in the information repositories listed above. A copy of the Responsiveness Summary will also be sent to all who commented.

G. Persons requesting to be placed on the mailing list of the site will receive updates on site activities as new information becomes available. Those on the initial mailing list will receive all future mailings regarding this site. To have your address added or deleted from this mailing list, please contact Dean Yasuda by phone (425.649.7264) or by email at dyas461@ecy.wa.gov.

H. When additional public involvement activities are needed, the public will be notified through additional fact sheets, notification in Ecology's Site Register and in advertisements in the Seattle Post-Intelligencer, Seattle Times or other local newspapers. The Public Participation Plan will be updated and placed in the information repositories listed above.

Ecology will use its Toxics Cleanup Program bimonthly *Site Register* to announce all of its public meetings and comment periods, as well as many other activities. The Site Register is available on Ecology's web site at http://www.ecy.wa.gov/programs/tcp/pub_inv/pub_inv2.html

I. If Ecology makes substantial changes to the Consent Decree and draft cleanup action plan (CAP), Ecology shall provide additional public notice and opportunity to comment.

V. GLOSSARY

Consent Decree: A legal document between Ecology and GE that outlines the process and schedule for cleanup activities at the Site.

Comment Period: A time when the public can review and comment on documents and proposed actions. For example, a comment period may allow community members to review and comment on proposed cleanup action alternatives and plans.

DNS: "Determination of Non-significance" (DNS) is the written decision by the responsible official of the lead agency that a proposal is not likely to have a significant adverse impact on the environment.

Groundwater: Water found beneath the earth's surface that fills pores between materials such as sand, soil, or gravel. In some places (aquifers), ground water occurs in quantities sufficient to use for drinking water, irrigation and other purposes.

Information Repository: A file containing current information, technical reports, and reference documents available for public review. It is usually in a public building convenient for local residents such as a school, city hall, or library.

Interim action: An action necessary to reduce a threat to human health and the environment. This is done by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance at a facility.

Model Toxics Control Act (MTCA): Legislation requiring identification, investigation, and clean up at facilities where hazardous substances were released. It defines the role of Ecology and invites public involvement in the decision making process. MTCA regulations are administered by the Washington State Department of Ecology. The legislation was passed by citizens of the State of Washington through an initiative in 1988.

Potentially liable person: Any person who is responsible for cleaning up a contaminated site.

Public Notice: Adequate information mailed to people who have made a request of Ecology and to persons in the potentially affected vicinity of the proposed action. Also includes a mailing to appropriate news media; a publication in the local (city and county) newspaper of largest circulation; and the opportunity for the interested persons to comment.

Responsiveness Summary: A summary of oral and/or written public comments received by Ecology during a comment period on key documents, and Ecology's responses to those comments. The responsiveness summary is especially valuable during the Cleanup Action Plan phase at a site when it highlights community concerns.

SEPA: State Environmental Policy Act: A state policy requiring state and local agencies to consider the likely environmental consequences of a proposal before approving or denying the proposal.

Tetrachloroethylene (also known as perchloroethylene or PCE): A solvent used for metal parts cleaners. This chemical causes cancer.

Trichloroethylene (TCE): A solvent used typically as a metal parts cleaner. This chemical causes cancer.

1,1,1-Trichloroethane (1,1,1-TCA): A solvent used typically as a metal parts cleaner.

1,4 dioxane: A chemical stabilizer used in 1,1,1-TCA solvents and also found in smaller concentration in TCE solvents. This chemical causes cancer.

PUBLIC PARTICIPATION PLAN - APPENDIX A

SITE MAILING LIST

EXHIBIT F

Required Permits and Substantive Requirements
of Procedurally Exempt Permits or Approvals

Exhibit F
Required Permits and Substantive Requirements of Procedurally Exempt Permits or Approvals

Required Permits:

1. Permit or Authorization for the discharge of contaminated groundwater to the King County Sewer Line. King County has issued Discharge Authorization #543-03 for contaminated water discharged to the sanitary or combined sewer system. All conditions of the current authorization must be met under future actions, or a new permit must be obtained. Renewal of the Discharge Authorization or Issuance of a Discharge Permit is required after August 2, 2014.

Substantive Requirements of Procedurally Exempt Permits or Approvals:

1. Underground Injection Permit for the installation and operation of the in-situ chemical oxidation (ISCO) injection wells used for groundwater treatment. GE shall identify in the EDR report, and thereafter meet in undertaking future actions, all applicable substantive regulations of the Washington State Underground Injection Program, Chapter 173-218 WAC, that would otherwise be included in an Underground Injection Permit.

2. Permits – City of Seattle Building Permit: GE shall identify in the EDR report, and thereafter meet in undertaking future actions, all applicable substantive requirements that would otherwise be included in a City of Seattle Building Permit.

EXHIBIT G

Final Engineering Design Report—Vapor Intrusion Mitigation System,
Sections 6.0 through 6.1 as approved by Ecology letters dated
December 4, 2007 and March 7, 2011

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

December 4, 2007

CERTIFIED MAIL
7007 0220 0004 7250 2587

Mr. Jim Sumner, Manager
Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way, MD T165
Cincinnati, OH 45215

Dear Mr. Sumner:

Re: Approval with Ecology Modifications of Engineering Design Report-Vapor Intrusion Mitigation System, dated October 19, 2007

Thank you for submitting the Engineering Design Report-Vapor Intrusion Mitigation System, dated October 19, 2007 in accordance with the Agreed Order DE 4258, Section VII.G. The Washington State Department of Ecology (Ecology) received this document on October 22, 2007.

The Engineering Design Report (EDR) presents a good description of the Ecology required-vapor intrusion mitigation (VIM) installed at the 220 S. Dawson Street building. However, there are statements within the report where Ecology disagrees. Therefore, Ecology approves the engineering design report with the following revisions incorporated within:

Page 1-1, Section 1.0 Paragraph 2, first sentence: Ecology determined that trichloroethylene (TCE) vapor intrusion is occurring at the 220 S. Dawson building at unacceptable concentrations. Based on the sub-slab vapor and indoor air samples previously collected, Ecology required GE to install the VIM system as an interim action under an Agreed Order.

Page 3-1, Section 3.0, Paragraph 1: The purpose of the Ecology-required VIM system is to prevent unacceptable TCE vapor exposures to the occupants in the 220 S. Dawson Street building. This is based on the previous sub-slab vapor and indoor air samples. These are not "potential worker exposures" as stated in the report, but instead, actual exposures that have occurred and would continue to occur without the VIM system.

Page 3-1, Section 3.2.2: GE stated that an electrical permit was obtained for the VIM system installation. This permit was not included in the report as required by the Agreed Order and Ecology approved work plan.

Operation and Maintenance Plan:
Page 6-1, Section 6.1.1: GE shall include the following in the monthly inspections:

1. Check for (inside) pipe leaks (visible or audible).
2. Document, in writing, increasing and decreasing trends in vacuum at each sump manometer.
3. Brief discussion with all tenants (include their contact information) that operate parts of the building where the VIM system is installed. Ask, at a minimum, the following:
   a. Any problems with conducting business with the VIM system running.
   b. VIM system problems noticed.
   c. Damage to any part of the VIM.

<u>Page 6-1, Section 6.1.2</u>: GE shall inspect the VIM system every 12 months; before the building is re-occupied following any vacancy; **and** immediately after any significant modifications (including any dismantling and reconstruction of parts of the VIM system). Concrete joint seals shall be inspected annually for cracks.

GE shall provide Ecology with the results of the monthly inspections in the progress status reports. The results (including copies of the inspection forms) of the annual inspections shall be submitted to Ecology within 45-days of completion. The monthly inspections and annual inspection reports shall include recommendations for VIM system repair or modification, as necessary, based on VIM system observation.

The facility manager may conduct VIM operational checks. This is why the manometers were installed at each sump riser. However, operational checks by the facility manager are <u>in addition</u> to the required GE monthly and annual inspections. Perhaps GE meant to do this and Ecology did not fully understand the meaning of the statements.

Appendix A: Information Package

<u>Page 4 of 4, Paragraph 1</u>: If exposure to workers on the roof, near and downwind of the VIM exhaust vent, is for only a short period of time (a few days only) then the need for respiratory protection should be based on allowable TCE exposures under the Washington State Department of Labor and Industries, Division of Occupational Safety and Health. Roof workers exposed for longer periods of time near and downwind of the VIM exhaust vent should wear respirators if TCE levels are above MTCA Method C air cleanup levels.

Appendix D: Vapor System Inspection Form:

The vapor system inspection form shall include the following additional elements:
1. Fan and associated piping shall be inspected from the roof, including mounting frame
2. Check for (inside and outside) pipe leaks (visible or audible).
3. Document, in writing, increasing and decreasing trends in vacuum at each sump manometer.
4. Photographs of (a) each sub-slab sump and manometer, and (b) roof mounted fan.
5. Brief discussion with all tenants (include their contact information) that operate parts of the building where the VIM system is installed. Ask, at a minimum, the following:
   a. Any problems with conducting business with the VIM system running.
   b. VIM system problems noticed.
   c. Damage to any part of the VIM.

Please submit a copy of the electrical permit obtained for the installation of the VIM system, within 30-calendar days of your receipt of this certified letter as this is a requirement of the Ecology approved work plan and Agreed Order. Ecology is not requiring that GE re-submit this EDR. Instead, Ecology is modifying the EDR with all of the above corrections included, and approving this modified EDR.

If GE would like to discuss equally effective alternatives to the above described Ecology modifications, we can schedule a telephone conference call to discuss them.

Please contact me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste and Toxics Reduction Program

DY:SA

cc: Marcia Bailey, EPA-X
Tom Merriman, Masons Supply Company
Stephen Black, Black & Yund
Greg Murphy, NOVA Consulting
Alex Cordas, Keymac-LCC
Jim Schwartz, AAG-Ecology
Brien Flanagan, Schwabe, Williamson & Wyatt
Julie Sellick, Ecology
Ed Jones, Ecology
Jamie Stevens, RETEC
Bill Joyce, Salter, Joyce, Ziker- PLLC
Bill Teplicky, McKinstry Co.
James King, Hudson Bay Insulation
Bob Webber, Puget Sound Pipe and Supply
Jill Lantz, RETEC
Steve Webber, Puget Sound Pipe and Supply
Tong Li, GWS
Randy Maciel, Hudson Bay Insulation
Central Records: WAD009278706 HZW 6.2

General Electric
WAD009278706
HZW 6.7.2

Central Files Copy

GE
Aviation

James W. Sumner, Manager
Group Environmental Programs

One Neumann Way, M/D T165
Cincinnati, OH 45215

T 513-672-3986, DC 8*892-3986
F 513 552-8918, DC 8*892-8918
jim.sumner@ge.com

RECEIVED
OCT 22 2007
DEPT OF ECOLOGY

October 19, 2007

[redacted]
Washington Department of Ecology
Northwest Regional Office
3190 – 160th Avenue S.E.
Bellevue, Washington 98008-5452

Dear Mr. Yasuda:

As required by Agreed Order # DE 4258, Section VII. G. attached please find the Engineering Design Report prepared by ENSR. Per our telephone discussion on October 11th, the air monitoring data will not be included in this report as it is scheduled for November 5, 2007. The air monitoring report will be submitted within 45 days of completion of the sampling.

Should you have any questions please do not hesitate to call me at (513) 672-3986 or Jamie Stevens at (206) 624-9349.

Sincerely,

James W. Sumner

James W. Sumner

Attachment – VIMS Engineering Report

cc: Julie Selick, DOE
Bill Teplicky, McKinstry
Bill Joyce – Salter Joyce Ziker
Tong Li, Ground Water Solutions
Susanne Herald, Esq. – GE
Jim Swartz, Esq State of Washington Attorney General's Office
Jamie Stevens, Linda Baker – RETEC

Original Hand Signed letter sent separate from report

General Electric
WAD 009278706
AZW 6.7.2

RECEIVED
OCT 26 2007
DEPT. OF ECOLOGY

GE
Aviation

James W. Sumner, Manager
Group Environmental Programs

One Neumann Way, M/D T165
Cincinnati, OH 45215

T 513-672-3986, DC 8*892-3986
F 513 552-8918, DC 8*892-8918
jim.sumner@ge.com

October 19, 2007

Mr. Dean Yasuda
Washington Department of Ecology
Northwest Regional Office
3190 – 160th Avenue S.E.
Bellevue, Washington 98008-5452

Dear Mr. Yasuda:

As required by Agreed Order # DE 4258, Section VII. G. attached please find the Engineering Design Report prepared by ENSR. Per our telephone discussion on October 11th, the air monitoring data will not be included in this report as it is scheduled for November 5, 2007. The air monitoring report will be submitted within 45 days of completion of the sampling.

Should you have any questions please do not hesitate to call me at (513) 672-3986 or Jamie Stevens at (206) 624-9349.

Sincerely,

James W. Sumner

James W. Sumner

Attachment – VIMS Engineering Report

cc: Julie Selick, DOE
Bill Teplicky, McKinstry
Bill Joyce – Salter Joyce Ziker
Tong Li, Ground Water Solutions
Susanne Herald, Esq. – GE
Jim Swartz, Esq State of Washington Attorney General's Office
Jamie Stevens, Linda Baker – RETEC

From: Origin ID: BFIA (206)624-9349
Jamie Stevens
ENSR
1011 Southwest Klickitat Way #207

Seattle, WA 98134

FedEx. Express

E

CLS#####07/21/23

Ship Date: 19OCT07
ActWgt: 1 LB
System#: 1859212/INET7091
Account#: S *********

Delivery Address Bar Code

RECEIVED
OCT 22 2007
DEPT OF ECOLOGY

SHIP TO: (206)624-9349 BILL SENDER
Dean Yasuda
WA.Department of Ecology
3190 160th Avenue Southeast

Bellevue, WA 98008

Ref # 02978-415-753
Invoice #
PO #
Dept #

RECEIVED

OCT 22 2007

MON 22 OCT A2

TRK# 0201 7987 9076 6752 STANDARD OVERNIGHT

DEPT OF ECOLOGY

SEA
85-BVUA WA-US
98008

Shipping Label: Your shipment is complete

1. Use the 'Print' feature from your browser to send this page to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.

Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com. FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery, misdelivery, or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim. Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental, consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss. Maximum for items of extraordinary value is $500, e.g. jewelry, precious metals, negotiable instruments and other items listed in our Service Guide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

General Electric
WAD009278706
HZW 6.7.2

ENSR | AECOM

Prepared for:
General Electric Aviation
Cincinnati, Ohio

Central Files Copy

Final Engineering Report – Vapor Intrusion Mitigation System

The RETEC Group, Inc.
October 2007
Document No.: 02978-415-753

ENSR | AECOM

Prepared for:
General Electric Aviation
Cincinnati, Ohio

Final Engineering Report – Vapor Intrusion Mitigation System

Jamie C. Stevens

Prepared by Jamie C. Stevens, Project Manager

Reviewed by Mark Havighorst, P.E. Project Engineer

Jamie C. Stevens For:

Reviewed by Mark Hofferbert, P.E. Senior Project Engineer

The RETEC Group, Inc.
October 2007
Document No.: 02978-415-753

Contents

1.0 Introduction **1-1**
- 1.1 Supporting IRM Documents 1-1
- 1.2 Scope of Work 1-2

2.0 Project Management and Organization **2-1**

3.0 Description of Interim Remedial Action **3-1**
- 3.1 Site Preparation and Diagnostic Testing 3-1
- 3.2 Permitting 3-1
  - 3.2.1 Mechanical Permit 3-1
  - 3.2.2 Electrical Permit 3-1
  - 3.2.3 Air Permit 3-2
- 3.3 Utility Clearance, Combustion Devices Survey, and Back Drafting 3-2
- 3.4 Floor and Crack Sealing 3-2
- 3.5 Initial Design Testing 3-2
- 3.6 VIMS Construction and Installation 3-3
  - 3.6.1 VIMS Sumps 3-3
  - 3.6.2 VIMS Piping 3-3
  - 3.6.3 VIMS Fan 3-4
  - 3.6.4 Manometers and Sampling Ports 3-4
- 3.7 Waste Disposal 3-4
- 3.8 System Labeling 3-4
- 3.9 Monitoring 3-5

4.0 IRM Results **4-1**
- 4.1 Performance Testing 4-1
- 4.2 Confirmation Testing 4-1
- 4.3 Conclusions 4-1

5.0 Deviations from the IRM Work Plan **5-1**
- 5.1 Diagnostic Testing 5-1
- 5.2 Conceptual Design 5-1
  - 5.2.1 Total Number of Sumps 5-1
  - 5.2.2 VIMS Piping Diameter 5-1
- 5.3 Exhaust Pipe location 5-1
- 5.4 Verification of Effectiveness 5-1

6.0 Operation and Maintenance **6-1**
6.1 System Inspection and Monitoring 6-1
6.1.1 Monthly Checks 6-1
6.1.2 Annual Checks 6-1
6.2 System Modifications 6-2
7.0 References **7-1**

List of Appendices

Appendix A Information Package
Appendix B Photograph Log
Appendix C Mechanical Permit Details
Appendix D Manufacturer Specifications and O&M Forms
Appendix E RETEC Weekly Reports
Appendix F ART Certification of Completion

List of Tables

Table 1 Summary of PID Results
Table 2 Summary of Diagnostic and Performance Testing

List of Figures

Figure 1 Sub Slab Depressurization System
Figure 2 VIMS-3 Section Detail
Figure 3 VIMS-4 Section Detail
Figure 4 VIMS-1, VIMS-5A, and VIMS-5B Section Detail

Engineer's Certification

I certify that the Washington State Department of Ecology- (Ecology) approved *IRM Work Plan – Sub-Surface Vapor Intrusion Interim Measure Work Plan and Design*, dated January 29, 2007, Revision 1, including all subsequent errata and Ecology-approved changes, was implemented, and all construction activities were completed in accordance with the Work Plan, and were witnessed by me or by a person under my direct supervision.

Work for this project was performed in accordance with generally accepted professional practices for the nature and condition of work completed in the same or similar localities, at the time the work was performed.

No other warranty, express or implied, is made.

EXPIRES 4/14/09

Mark Havighorst, P.E. Project Engineer
Washington State PE Number: 42644
Expiration Date: April 14, 2009

1.0 Introduction

GE Aviation (GE) is currently addressing environmental impacts to groundwater, soil, and indoor air at its former facility, 220 South Dawson Street in Seattle, Washington. As of the submittal date of this report, the building is occupied by Hudson Bay Insulation, Puget Sound Pipe & Supply, and Masons Supply Company[1].

Based on the results of the 2006 and 2007 indoor air and soil vapor sampling events, the Washington State Department of Ecology (Ecology) determined that trichloroethylene (TCE), presumably originating from soil vapor from below the building's floor, was present in indoor air at unacceptable concentrations. Based on the concentrations, mitigation of the building was required. Ecology had also stated that addressing the indoor air issue would be a required element of any remedial plan for the site, and requested that the work be performed as an Interim Remedial Measure (IRM). GE complied with the regulatory requests and proceeded to address Ecology's concerns through an IRM.

The IRM included implementation of an active sub-slab vapor ventilation system, (referred to as a Vapor Intrusion and Mitigation System [VIMS]) and identification and elimination of preferential soil vapor intrusion pathways. This Engineering Report summarizes the scope of work completed as part of the IRM and describes the design, implementation, and operation of the VIMS.

1.1 Supporting IRM Documents

The design, implementation, and operation of the VIMS was based on information provided in the following:

- Department of Ecology Agreed Order Number 4258 (Ecology, 2007a)
- *Sub-Surface Vapor Intrusion Interim Measures Work Plan and Design* (IRM Work Plan), dated January 29, 2007, Revision 1 (RETEC, 2007a)
- Department of Ecology letter dated February 23, 2007 re: Conditional Approval of the GE Sub-Surface Vapor Intrusion Interim Measures Work Plan and Design, Revision 1. Dated January 29, 2007 (Ecology, 2007b)
- *Revised Technical Memorandum No. 1* and *Sampling and Analysis Plan*, dated May 14, 2007 (RETEC, 2007b)
- *Technical Memorandum No. 2*, dated May 18, 2007 (RETEC, 2007c)
- Department of Ecology letter dated May 29, 2007 re: Ecology Response and Comments to Agreed Order Technical Memorandum No. 1 and Sampling and Analysis Plan, dated May 14, 2007 (Ecology, 2007c)
- Department of Ecology letter dated May 29, 2007 re: Ecology Response and Comments to Agreed Order DE-4528 Technical Memorandum No. 2, dated May 18, 2007 (Ecology, 2007d)
- GE Aviation letter dated May 31, 2007 re: Deadline Extension Pursuant to Section VII.J of Agreed Order # DE 4258 (GE, 2007a)
- Department of Ecology letter dated June 5, 2007 re: Time Extension Approval (Ecology, 2007e)
- GE Aviation letter dated July 6, 2007 re: Deadline Extension Pursuant to Section VII.J of Agreed Order # DE 4258 (GE, 2007b)
- Department of Ecology letter dated July, 2007 re: Time Extension Approval (Ecology, 2007f)

[1] The property is currently owned by Keymac, LLC, the building is managed jointly by Keymac and McKinstry Company.

- *Technical Memorandum No. 3*, dated July 24, 2007 (RETEC, 2007d)
- Department of Ecology letter dated August 15, 2007 re: Washington State Department of Ecology Response and Approval of the Vapor Intrusion Mitigation System Installation (Ecology, 2007g)
- *Sampling and Analysis Plan – Vapor Intrusion Mitigation Interim Action*, dated September 4, 2007, Revision 1 (RETEC, 2007e)
- Department of Ecology letter dated September 25, 2007 re: Contingent Approval of Revised Draft Sampling and Analysis Plan, dated September 4, 2007 (Ecology, 2007h).

The IRM was also designed and constructed in general conformance with the U.S. EPA's Radon Mitigation Standards, Document #402-R-93-078 [USEPA, 1994].

1.2 Scope of Work

The scope of work for the IRM included the following actions:

- Perform a building investigation (December 2005 through March 2007)
- Prepare a Work Plan and conceptual design (completed January 29, 2007)
- Receive written regulatory approval of the Work Plan (received February 27, 2007)
- Submit additional documentation requested by Ecology (May 18, May 14, and July 24, 2007)
- Mobilize to the site and conducted pre design testing and install sumps (June 1 through June 7, 2007)
- Construct the piping and electrical components, and conduct performance testing (completed week of August 1, 2007)
- Prepare this Final Engineering Report and O&M Plan.

Additional work remaining includes the collection of the post-IRM air sampling, which is scheduled for November 5, 2007. Sample results will be submitted to Ecology within 45 days of the sampling event.

2.0 Project Management and Organization

The ENSR Corporation (dba The RETEC Group, Inc. [RETEC]) was retained by GE as the Engineer for the project. RETEC prepared the construction documents and design, oversaw the remediation activities, and served as a liaison between GE, subcontractors, and building tenants. Advanced Radon Technologies (ART) was the subcontractor selected for the installation of the VIMS.

ART was selected by RETEC from among qualified soil vapor mitigation companies. ART had current certification from The National Environmental Health Association's (NEHA) National Radon Proficiency Program. ART has installed similar IRM systems for the Phillip Services Corporation's Georgetown Facility, located to the south of the site. ART was responsible for the performance of the work in accordance with the drawings and specifications incorporated in the IRM Work Plan. ART was provided with a copy of the Agreed Order and IRM Work Plan and was required to comply with it as a condition of their contract.

Ecology reviewed and approved the VIMS plans, and specifications presented in the IRM Work Plan and subsequent submittals.

3.0 Description of Interim Remedial Action

The purpose of VIMS is to prevent migration of vapors from below the building to inside the building, thereby reducing potential worker exposure. This is achieved by actively extracting air from five sumps constructed below the slab through a piping network connected to an inline centrifugal fan. Extracting the air not only removes potentially harmful volatile organic compound (VOC) vapors, but also decreases the pressure under the slab so that it is lower than inside the building. This negative pressure gradient reduces air flow upward through the slab. The air extracted by the fan discharges to the atmosphere.

The VIMS installed at the former GE building consists of five separate pits, each connected to a 3-inch and 4-inch PVC pipe riser that extends up from the concrete slab to the roof. Two risers are located in the northwest portion of the building and three are located in the southwest portion of the building (Figure 1). These locations were determined by Ecology and corresponded to sampling locations where elevated concentrations of TCE were detected in the sub-slab and indoor air. Each riser is connected to piping routed to a single, roof-mounted centrifugal fan that extracts the air from under the building foundation. The extracted air is vented through a stack located on the southwest portion of the roof. As all potential concentrations are below permissible limits set by Puget Sound Clean Air Agency (PSCAA) no permitting or end of stack treatment is required.

The following sub sections describe the two-phase implementation of the VIMS. Phase 1 included site preparation and diagnostic testing completed from June 1 through June 7, 2007. Phase 2 included VIMS construction and verification testing, which was completed from July 30 through August 6, 2007.

Figures 1 through 4 provide details of the final VIMS. Appendix A contains a copy of the information package and Appendix B includes copies of the construction photographs documenting Phase 1 and Phase 2.

3.1 Site Preparation and Diagnostic Testing

RETEC and ART coordinated their activities with the on-site Keymac/McKinstry representative and worked with individual building tenants, including Puget Sound Pipe & Supply, Hudson Bay Insulation, and Masons Supply Company. Sumps and associated piping was installed only in the Hudson Bay Insulation warehouse and the Puget Sound Pipe & Supply warehouse. IRM work areas were secured by ART to ensure the safety of workers, visitors, and other personnel.

Site preparation and diagnostic testing did not significantly disrupt or hinder site operations, but did take longer to complete than initially scheduled. RETEC and ART worked with individual tenants to coordinate start and stop times during each phase of work to minimize disruptions.

3.2 Permitting

3.2.1 Mechanical Permit

City of Seattle Mechanical Permit (CAM 415) # 6149569 was obtained as part of the VIMS construction. Copies of the Mechanical Permit documentation are included in Appendix C.

3.2.2 Electrical Permit

McKinstry Company performed all electrical work. Electrical permits were obtained directly by McKinstry and all work was performed by a Washington Licensed Electrician.

3.2.3 Air Permit

PSCAA issues permits for and regulates the emissions of toxic compounds into the atmosphere. Under Regulation 1, Article 6, Section 6.03.c under the heading Water Treatment, the following exemption for permit application is cited:

- (94) Soil and groundwater remediation projects involving <15 pounds per year of benzene or vinyl chloride, <500 pounds per year of perchloroethylene (PCE), and <1,000 pounds per year of toxic air contaminants[2].

Based on data presented in the revised Technical Memorandum No 2, the total mass of CVOCs potentially released is conservatively estimated at 48 pounds per year, well below the 1,000 pounds per year regulation limit at the current design flow rate (RETEC, 2007). Since projected emissions are well below the 1000 pound per year threshold, no air permit is required from PSCAA. Additionally, site vapor data resulted in no detections of vinyl chloride. Benzene is not a consistent of concern for vapor at the site. PCE was detected at very low concentrations and was included in the total emissions (the total emissions were found to be 48 pounds per year, below the PCE 500 pound per year threshold).

3.3 Utility Clearance, Combustion Devices Survey, and Back Drafting

Prior to any floor penetration activities, a utility locate was performed by Applied Professional Services (APS) on June 4, 2007. No utilities or structures were damaged during the work. The locations of overhead and subsurface structures were identified in each work areas, and the VIMS was constructed around any existing overhead structures.

A preliminary survey was done to ensure that no combustion devices were located inside the Puget Sound Pipe & Supply warehouse, Hudson Bay Insulation warehouse, or Masons Supply. The survey identified specific building characteristics, configurations, and operational conditions that would affect the design, installation, and effectiveness of the VIMS. No significant point sources of TCE-impacted vapor entry were identified in the building based on conversation with representatives from each business and an inspection by RETEC field staff of the warehouse spaces.

ART evaluated back drafting conditions by conducted a building pressure test. Prior to testing, all doorways, windows, building garages, and other accessible openings were sealed. The testing occurred at the end of a business day. The pressure difference between the inside atmosphere and the outside atmosphere was measured using a micro-manometer. The testing identified that back drafting is not a concern at the site.

3.4 Floor and Crack Sealing

Prior to diagnostic testing, all accessible floor cracks within the remedial area were cleaned out and sealed with flowable polyurethane caulk. The selected sealant did not contain TCE or vinyl chloride. All cracks were allowed 2 full days of minimal site activities to dry completely before continuation of the diagnostic testing. The sealant was allowed to dry over the weekend to minimize traffic and work activities over the sealed areas.

3.5 Initial Design Testing

Initial design testing for the VIMS was conducted from June 1 through June 7, 2007 to approximate the zone of influence at each sump location, the total number of sub-slab penetrations, the exhaust pipe diameters required, and the capacity of the exhaust fan. These test procedures are described below and are summarized in Tables 1 and 2.

[2] PSCAA, 2006. Regulation 1. Puget Sound Clean Air Agency, October 26, 2006 (date of last revision to Section 6.03).

A diagnostic test fan, patented by ART and used on similar sites, was placed over the sump location. This test fan was used to simulate the negative pressure of a commercial fan when installed. Two ½-inch test holes were formed to evaluate the zone of influence around each sump location. The holes were placed around the perimeter of the concrete slab and formed to a depth equal to the sump excavation. The soil gas pressure was measured in each of the ½-inch holes. The test fan was then started and the static pressure and the air exhaust volume were gradually increased until negative air pressure (vacuum) was observed in each test hole. A DM1 Micro-Manometer by Infiltec was used to measure the pressure at each test hole.

The results of the diagnostic testing indicated that a subsurface vacuum of at least 1 Pascal (0.005 inches of water column) could be maintained throughout the targeted areas by installing 5 sumps and a single commercial VIMS fan.

Indoor air was periodically field-screened using a photoionization detector (PID) during initial design testing. Results of the PID monitoring are summarized in Table 1. The maximum value recorded was 0.6 ppm at location VIMS-5B, well below the OSHA permissible exposure limit.

3.6 VIMS Construction and Installation

3.6.1 VIMS Sumps

Five VIMS sumps were installed at the locations depicted on Figure 1. The sump locations are identified as:

- VIMS-1 and VIMS-5A – located in Puget Sound Pipe & Supply warehouse
- VIMS-3, VIMS-4, and VIMS-5B – located in Hudson Bay Insulation warehouse.

At each sump location selected an approximate 5-inch hole was drilled into the concrete slab with a diamond tip, non-impact core bore drill. To provide optimum pressure field extension below the slab, 3 cubic feet[3] (average) of soil was removed from the sub-surface immediately below each of the locations. The final sump shape consisted of flask type shape with an average depth of 3 feet.

3.6.2 VIMS Piping

Piping was installed to convey extracted air from the sumps to the exhaust fan and exhaust the air through the roof as shown on Figures 1 through 4. All 4-inch diameter piping is 3034 PVC sewer pipe, with the following exception of one section of the fan piping located outside on the roof. This one section of pipe is Schedule-40 PVC Water pipe (see Figure 1), which was selected over the 3034 PVC Sewer pipe because the pipe will be exposed to weather and vibrations. All 3-inch diameter piping is Schedule-40 PVC Water pipe.

The cleaning solvents and adhesives used to join PVC piping were recommended by the pipe manufacturers and were used in accordance with their directions.

VIMS piping was hung to the building structure using commercially available hangers and supports. Existing fixtures and mechanical equipment were not used to support VIMS piping. VIMS piping was installed with a slope which ensures that any rainwater or condensation within the pipes drains into the ground beneath the slab. Piping located west of the fan slope towards VIMS-4 and VIMS-3, all piping east of the fan slope towards VIMS-1, VIMS-5A, VIMS-5B. VIMS piping was installed along existing walls and does not significantly block access to any areas required by building tenants, or interfere with any light, door, window, or equipment access area.

---

[3] The amount of soil removed for each sump varied: VIMS-1 (2.1 cubic feet removed), VIMS-3 (3.3 cubic feet removed), VIMS-4 (3.3 cubic feet removed), VIMS-5A (2.7 cubic feet removed) and VIMS-5B (3.3 cubic feet removed).

3.6.3 VIMS Fan

Based on the results of the initial design testing, a commercial Cincinnati Fan model PB-9 was selected for the entire VIMS. Manufacturer specifications are included in Appendix D. The selected fan was sized to provide the required pressure difference and airflow characteristics necessary to achieve a minimum of 1 Pascal of vaccum across the system.

The fan was mounted on southeastern section of the roof. The fan was mounted on spring insulators to minimize noise and vibration and placed a minimum of 10 feet away from any other opening in the roof. The fan was placed in a watertight protective housing. The VIMS piping was run through a roof penetration and sealed with asphalt-based roofing mastic and flashing. The top of the fan exhaust pipe extends 6.08 feet above the roof.

The fan was wired to dedicated electrical circuits and circuit breaker in the existing electrical box located on the southern internal wall of the Hudson Bay Insulation warehouse. All electrical work was performed by a licensed electrician under the direct oversight of McKinstry Company.

3.6.4 Manometers and Sampling Ports

U-tube manometers were installed into the sides of riser pipes at all VIMS locations to verify system air flow; copies of the manufacturer specifications are included in Appendix D. The manometers were installed approximately 3 to 6 feet above the floor (Figure 1). In general, an observed difference in fluid height between the sides of the U-tube indicates that air is flowing and that VIMS system is working. The difference in the fluid level will be affected by changes in atmospheric pressure but the fluid level should always remain different between each side of the tube.

Two ¼-inch female National Pipe Thread (NPT) vapor sampling ports were installed on the vertical stack above and below the roofline on the Hudson Bay Building.

3.7 Waste Disposal

Soil removed from the sub-slab was containerized (in 55-and 35 gallon drums) and sampled for disposal characterization. The soil was classified as non-hazardous waste and is scheduled for off site disposal by Envirotech Systems. At the time of this report, the laboratory analytical reports are pending. Copies of the certified laboratory analytical reports will be included in the addendum submittal. The addendum will include the certified laboratory analytical reports for soil disposal and confirmation sampling (see Section 4.2).

The small quantity of concrete debris and other waste was considered non-impacted and was placed in the on-site solid waste dumpster for eventual off-site disposal at a solid waste landfill.

3.8 System Labeling

A "Soil Vapor Mitigation System" label was placed on each vertical VIMS riser pipe, and placed on select overhead piping. These labels included ART contact information. A label was also placed on the VIMS circuit breaker.

A Hazardous Warning label was placed on the fan exhaust pipe. The label indicates that only authorized personnel should be near the exhaust fan and that no work should be conducted in the near vicinity of the vent opening without proper air monitoring and PPE.

Photographs of these labels are included in Appendix B.

3.9 Monitoring

A portable vacuum was used to contain the dust generated from concrete boring and soil excavation activities. Vacuum exhaust was vented to outside the building. Noise generation was minimized to the extent practicable and PPE was worn during all construction activities.

RETEC periodically monitored the breathing zone and sump interior VOC concentrations using a photoionization detector (PID) with a 10.6 eV bulb. The maximum value recorded was 0.6 ppm at VIMS-5B below the OSHA permissible exposure limit (Table 1).

4.0 IRM Results

4.1 Performance Testing

Performance testing was completed immediately following VIMS installation to determine if the system met the performance criterion of at least 1 Pascal vacuum across the extent of the slab. Performance testing included the following:

- Measuring baseline pressures at each test hole with the fan de-energized
- Measuring pressures at each testing hole with the fan energized and after the system was allowed to equilibrate for approximately 10 minutes

The results of the performance testing indicated that a negative pressure differential of at least 1 Pascal, measured at each of the test holes after the fan was turned on, was achieved. This shows that the system is effectively working per the design and the system was fully operational when the contractors and RETEC left site on August 6, 2007.

RETEC field staff completed weekly performance monitoring for the six weeks following VIMS installation. During these weekly checks, field personnel observed fluid levels in each side of the "U" shaped manometer tubes to evaluate whether air was moving through the sub-surface. Observations indicated that air was flowing during the first six weekly checks. Copies of performance monitoring field notes are included in Appendix E.

Prior to demobilization from the site, ART inspected the integrity of the fan mounting seals and all joints in the interior and exterior VIMS piping system.

4.2 Confirmation Testing

GE submitted a revised sampling and analysis plan on September 4, which outlined the proposed approach and locations for conformational testing[4]. The conformational testing event is scheduled for November 5, 2007 and will include indoor air sampling, ambient air sampling, exhaust sampling, and air flow measurements. Certified laboratory analytical results and summary tables will be submitted to Ecology as an addendum to this report within 45 days of the sampling event.

4.3 Conclusions

The IRM successfully achieved a minimal pressure differential of at least 1 Pascal across all test holes. The average pressure differential across all test holes was 30 Pascal, which is 30 times greater than the design goal.

Written certification by ART of the system completeness, to the extent that is determined without the results of the indoor air sampling, is included in Appendix F.

[4] Ecology provided comments and contingent approval on this report on September 25, 2007.

5.0 Deviations from the IRM Work Plan

This section of the report summarizes deviations from the IRM Work Plan.

5.1 Diagnostic Testing

Section 2.2.1 of the IRM Work Plan state the following: Prior to diagnostic testing, all floor cracks within the remedial area shall be sealed with an applicable sealant.

On June 1, 2007 all accessible floor cracks within the estimated radius of influence of the proposed sump locations were sealed with polyurethane sealant. Due to the various stockpiled products and permanent fixed structures within the building, the complete floor area associated with the remedial area was not sealed. As summarized in Section 4, the overall pressure reading across the building slab exceeded the minimum design requirements called out in the IRM Work Plan. Because of this reason it was not necessary to go back into the building and seal all of the cracks that were inaccessible in June.

5.2 Conceptual Design

Section 2.1 of the IRM Work Plan stated the following in regards to the final conceptual design: The IRM will conceptually consist of one to four slab penetrations, each fitted with a 4-inch PVC riser VIMS pipe. The pipes will be vented together via a horizontal 6-inch PVC manifold located near the ceiling.

5.2.1 Total Number of Sumps

The VIMS included five separate sump locations, not four as was stated in the IRM Work Plan. The extra sump was added based on the zone of influence determined during initial design testing. Using diagnostic testers and a micro-manometer, ART determined that two sump locations (identified as VIMS-5A and VIMS-5B) were necessary to meet the design goal of a minimum of 1 Pascal of negative pressure across the building slab.

5.2.2 VIMS Piping Diameter

The IRM Work Plan stated that 4-inch PVC and 6-inch PVC would be used in the design. During diagnostic testing, it was determined that the desired zone of influence and flow rates with the selected commercial fan could be achieved using 3-inch and 4-inch pipe instead. The smaller pipe was utilized to reduce the overall system footprint and to save on installation cost.

5.3 Exhaust Pipe location

Section 2.2.2 of the IRM Work Plan states the following: The fan will exhaust vertically through the roof, approximately 24 inches above the roof line. The final exhaust stack location and exhaust stack height were modified to 6 feet 1 inch in accordance with the DOE letter dated May 29, 2007 (Ecology, 2007d).

5.4 Verification of Effectiveness

Pressure readings were measured at each test hole after construction in accordance with the IRM Work Plan to verify the VIMS zone of influence and performance, with the exception of TH-8 No initial reading was taken for TH-8 with the fan in the off position. Data from the 9 other test holes was used to determined the effectiveness of the VIMS.

6.0 Operation and Maintenance

The objectives of the following O&M activities are to:

- Ensure ongoing VIMS operation through scheduled checks;
- Provide repairs to the VIMS when problems arise; and
- Provide a timely response to building occupant concerns related to the VIMS.

6.1 System Inspection and Monitoring

The VIMS was designed and installed as a temporary, but integral addition to the building. The following inspection and monitoring activities should be completed to ensure that the VIMS remains operational and satisfies the design criteria.

6.1.1 Monthly Checks

The U-tube manometers will be checked every month[5] following installation by RETEC field staff. Documentation of the field inspection will include the following:

- Date and time
- Location identification
- Visual inspection and reading of U-tube manometer.

6.1.2 Annual Checks

The VIMS should be inspected annually (every 12 months), or before the building is re-occupied following a time when the building was vacant and the system was turned off.

The annual inspection should include a visual inspection of the complete system, both indoors and outdoors. Any actionable items found during inspections should be addressed immediately, if possible.

Inspection items should include, but not be limited to:

- Recording manometer vacuums;
- Inspecting the fan for mechanical operation, noise, and vibration;
- Inspecting all piping and piping connections (indoors and outdoors);
- Checking for new cracks in walls and floors; and
- Ensuring all piping supports are properly anchored.

Refer to the VIMS Inspection Form (provided in Appendix D) for a complete listing of items to be checked and documented during system inspections.

NOTE: The U-tube manometers located on each vent stack provide a quick check that the system is operating correctly. Building occupants should be advised and know that if the fluid in each side of the manometer is at a different height, then the system is functioning normally. If the fluid elevations are exactly

[5] The monthly checks follow the initial 6 weeks of weekly checks immediately following system installation.

even, then the system may be off (at the fan switch or the circuit breaker) or otherwise not functioning properly. In such instance, the building tenants were instructed to notify ENSR.

Following completion of any inspection or maintenance activities, the inspector should complete a VIMS Inspection Form. Any modifications or repairs performed should be noted on field sketches attached to the Form. The original VIMS Inspection Forms should be kept on file at the site, with a copy faxed to RETEC for their files (fax number 206-624-2839).

Inspection records will be compared to previous inspections to determine whether the system is performing within its acceptable range of operation. If it is determined that the system is not performing within its acceptable range, maintenance may be required.

Operational checks can be conducted by the property occupants or, typically, the facilities manager.

6.2 System Modifications

Keymac and McKinstry have indicated that the Puget Sound Pipe & Supply Office and Warehouse space will be renovated. The new space will be used by the McKinstry office staff located in the building to the north. The renovations are schedule to start in November of 2007 and will extend through January 2008. GE will work directly with Keymac/McKinstry and Ecology to ensure that any needed reconfigurations are done as needed and the system continues to operate to the extent possible considering the construction activities.

7.0 References

Ecology, 2007a. *Department of Ecology Agreed Order Number 4258.* State of Washington Department of Ecology, May 2007.

Ecology 2007b. Department of Ecology letter: Conditional Approval of the GE Sub-Surface Vapor Intrusion Interim Measures Work Plan and Design, Revision 1. Dated January 29, 2007. State of Washington Department of Ecology, February 23, 2007.

Ecology 2007c. Department of Ecology letter re: Ecology Response and Comments to Agreed Order Technical Memorandum No. 1 and Sampling and Analysis Plan, dated May 14, 2007. State of Washington Department of Ecology, May 29, 2007.

Ecology 2007d. Department of Ecology letter re: Ecology Response and Comments to Agreed Order DE-4528 Technical Memorandum No. 2, dated May 18, 2007. State of Washington Department of Ecology, May 29, 2007.

Ecology 2007e. Department of Ecology letter re: Time Extension Approval. State of Washington Department of Ecology, June 5, 2007.

Ecology 2007f. Department of Ecology letter re: Time Extension Approval. State of Washington Department of Ecology, July 2007.

Ecology 2007g. Department of Ecology letter re: Washington State Department of Ecology Response and Approval of the Vapor Intrusion Mitigation System Installation. State of Washington Department of Ecology, August 15, 2007.

Ecology 2007h. Department of Ecology letter dated September 25, 2007 re: Contingent Approval of Revised Draft Sampling and Analysis Plan. State of Washington Department of Ecology, September 4, 2007.

GE 2007a. GE Aviation letter re: Deadline Extension Pursuant to Section VII.J of Agreed Order # DE 4258. GE Aviation, May 31, 2007.

GE 2007b. GE Aviation letter re: Deadline Extension Pursuant to Section VII.J of Agreed Order # DE 4258. GE Aviation, July 6, 2007.

RETEC, 2007a. *Sub-Surface Vapor Intrusion Interim Measures Work Plan and Design (Work Plan).* The RETEC Group, Inc, January 29, 2007, Revision 1.

RETEC 2007b. *Technical Memorandum No. 1 and Sampling and Analysis Plan.* The RETEC Group, Inc, May 14, 2007

RETEC 2007c. *Technical Memorandum No. 2.* The RETEC Group, Inc, May 18, 2007

RETEC 2007d. *Technical Memorandum No. 3.* ENSR, July 24, 2007

RETEC 2007e. *Sampling and Analysis Plan – Vapor Intrusion Mitigation Interim Action.* ENSR, September 4, 2007, Revision 1.

Tables

Table 1: Summary of PID Results

Field Measurement for GE Dawson Sub-Surface Vapor Intrusion - Interim Measures

Location	PID reading (ppm)
VIMS-1	0.0
VIMS-3	0.0
VIMS-4	0.0
VIMS-5A	0.6
VIMS-5B	0.0

Notes:

1. RETEC periodically monitored the VOC concentration within the breathing zone area using a Multi-RAE photoionization detector (PID) with an 10.6 eV bulb. PID readings were taken during maximum soil disturbance while excavating each sump location. LEL levels were 0.0 for the entire field work duration. The action levels outlined in the site-specific Health and Safety Plan were not exceeded.

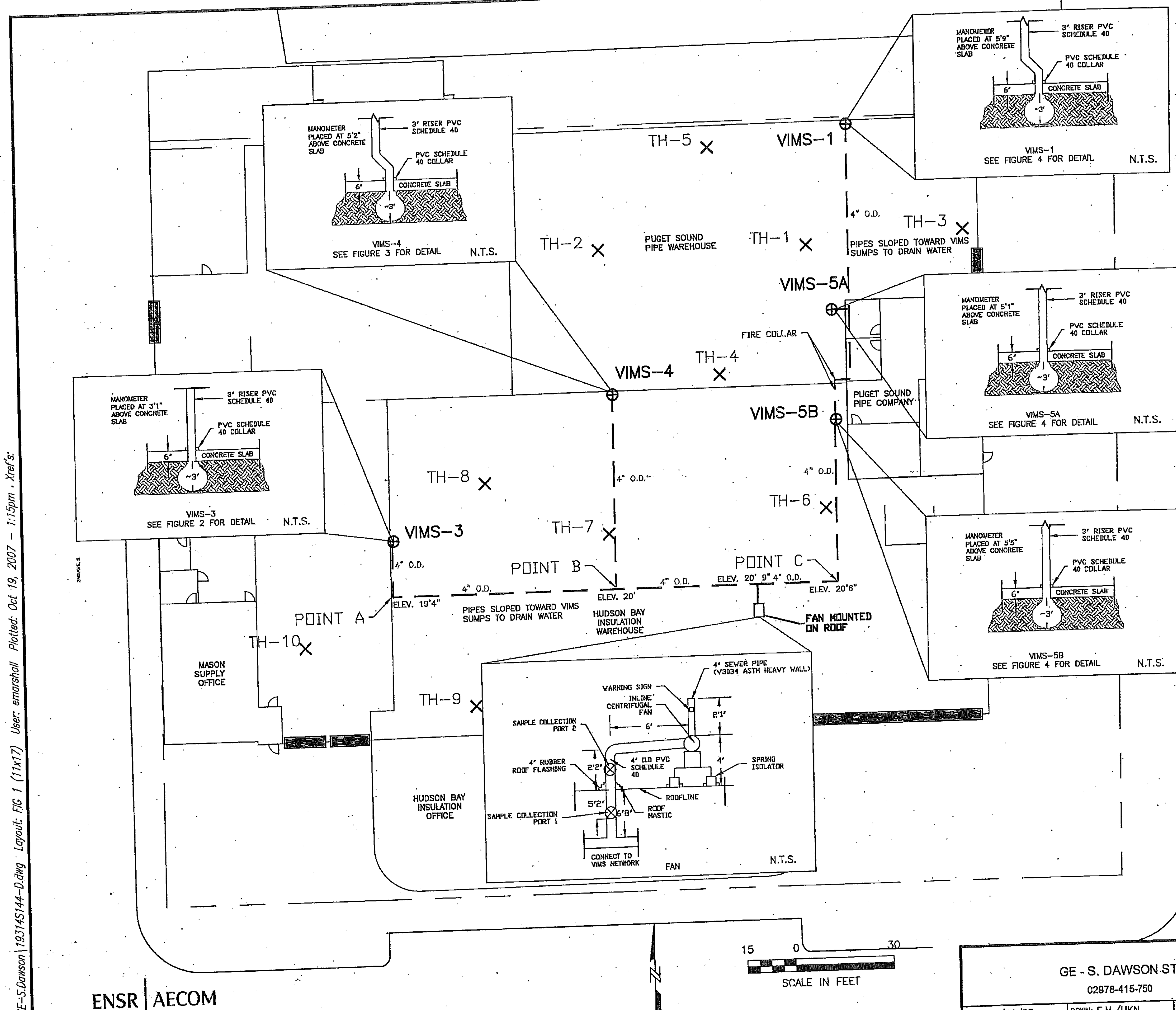
Table 2: Summary of Diagnostic and Performance Testing

Field Measurement for GE Dawson Sub-Surface Vapor Intrusion - Interim Measures

	Pre-Installation Pressure Static H_2O Pressure - 4"			Post-Installation Pressure Static H_2O Pressure - 5"			
	Fan On	Fan On	Fan Off	**Fan On**	**Fan On**	**Fan Off**	**Fan Off**
Units	Inches of H2O	Pascal	Inches of H2O	**Inches of H2O**	**Pascal**	**Inches of H2O**	**Pascal**
TH-1	-0.342	-85.158	NR	**-0.372**	**-92.628**	**0.013**	**3.237**
TH-2	-0.018	-4.482	NR	**-0.014**	**-3.486**	**0.010**	**2.49**
TH-3	-0.041	-10.209	NR	**-0.042**	**-10.458**	**0.011**	**2.739**
TH-4	-0.141	-35.109	NR	**-0.226**	**-56.274**	**0.000**	**0**
TH-5	-0.097	-24.153	NR	**-0.102**	**-25.398**	**0.012**	**2.988**
TH-6	-0.041	-10.209	NR	**-0.036**	**-8.964**	**-0.004**	**-0.996**
TH-7	-0.015	-3.735	NR	**-0.024**	**-5.976**	**-0.002**	**-0.498**
TH-8	-0.108	-26.892	NR	**-0.179**	**-44.571**	**NR**	**NR**
TH-9	-0.055	-13.695	NR	**-0.091**	**-22.659**	**0.000**	**0**
TH-10	-0.105	-26.145	NR	**-0.118**	**-29.382**	**0.008**	**1.992**

Note:
1. Pre Installation data was taken during diagnostic testing from 6-1-07 to 6-7-07.
2. Post Installation data was taken after the full system was installed on 8-6-07
3. 1 Inch of H20 = 249 Pascal
4. Section 2.2.3 of Work Plan required a negative pressure differential of at least 1 Pascal
5. NR - No reading taken

Figures



NOTES:

1. ALL 4" SEWER PIPE IS V3034 ASTM HEAVY WALL WITH THE EXCEPTION OF THE EXTERNAL FAN PIPING. PLEASE SEE INSERT FOR DETAILS.
2. ALL PIPING ELEVATIONS ARE MEASURED FROM THE TOP OF THE CONCRETE FLOOR.
3. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
4. LOCATIONS ARE APPROXIMATE.
5. N.T.S. = NOT TO SCALE
6. ELECTRICAL BOX IS LOCATED ON THE SOUTHERN INTERIOR HUDSON BAY WAREHOUSE WALL.

LEGEND

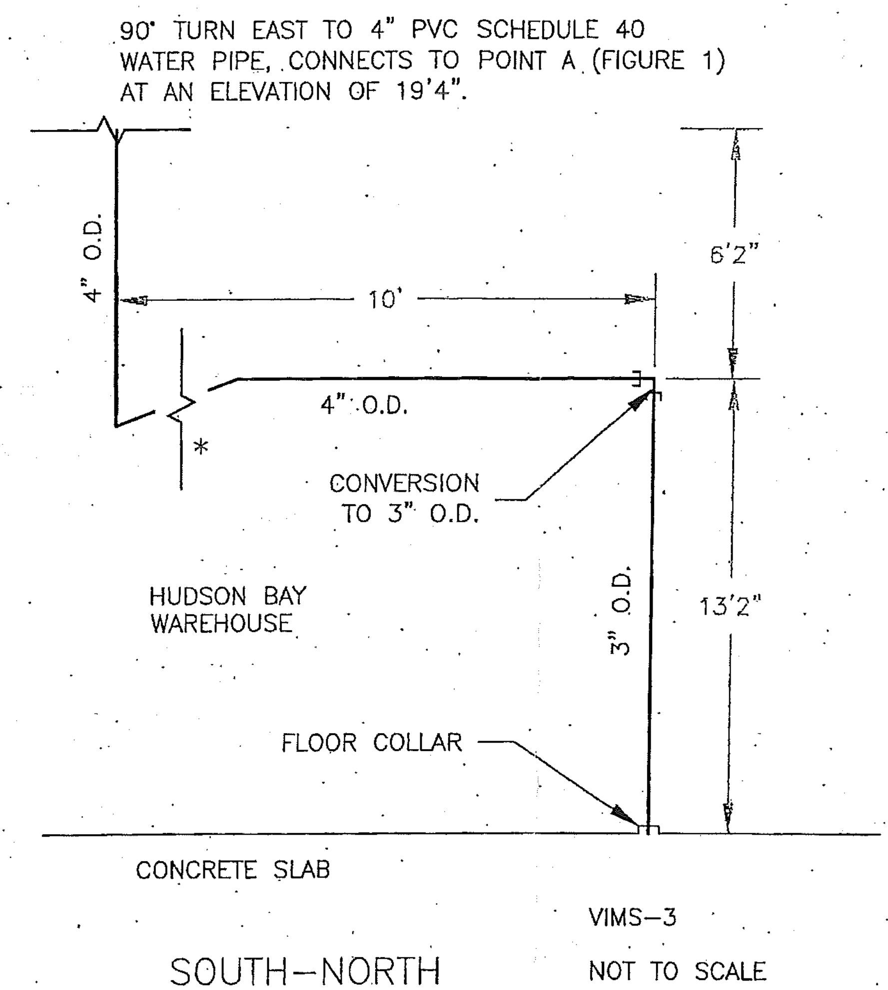
- PROPERTY LINE
- INTERIOR DUCT WORK
- ⊕ SUMP LOCATION
- BAY DOOR OPENING
- × APPROXIMATE TEST HOLE LOCATION

ENSR | AECOM

Merged with ENSR in 2007 RETEC

GE - S. DAWSON ST. 02978-415-750	SUB-SLAB DEPRESSURIZATION SYSTEM
DATE: 10/19/07 DRWN: E.M./UKN	FIGURE 1

File: H:\GE-S.Dawson\19314S144-D.dwg Layout: FIG 1 (11x17) User: emarshall Plotted: Oct 19, 2007 - 1:15pm Xref's:



NOTES:

1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.
8. PIPE SYSTEM RUNS APPROXIMATELY 4" FROM INTERNAL PLYWOOD WALL BETWEEN HUDSON BAY & MASON SUPPLY.

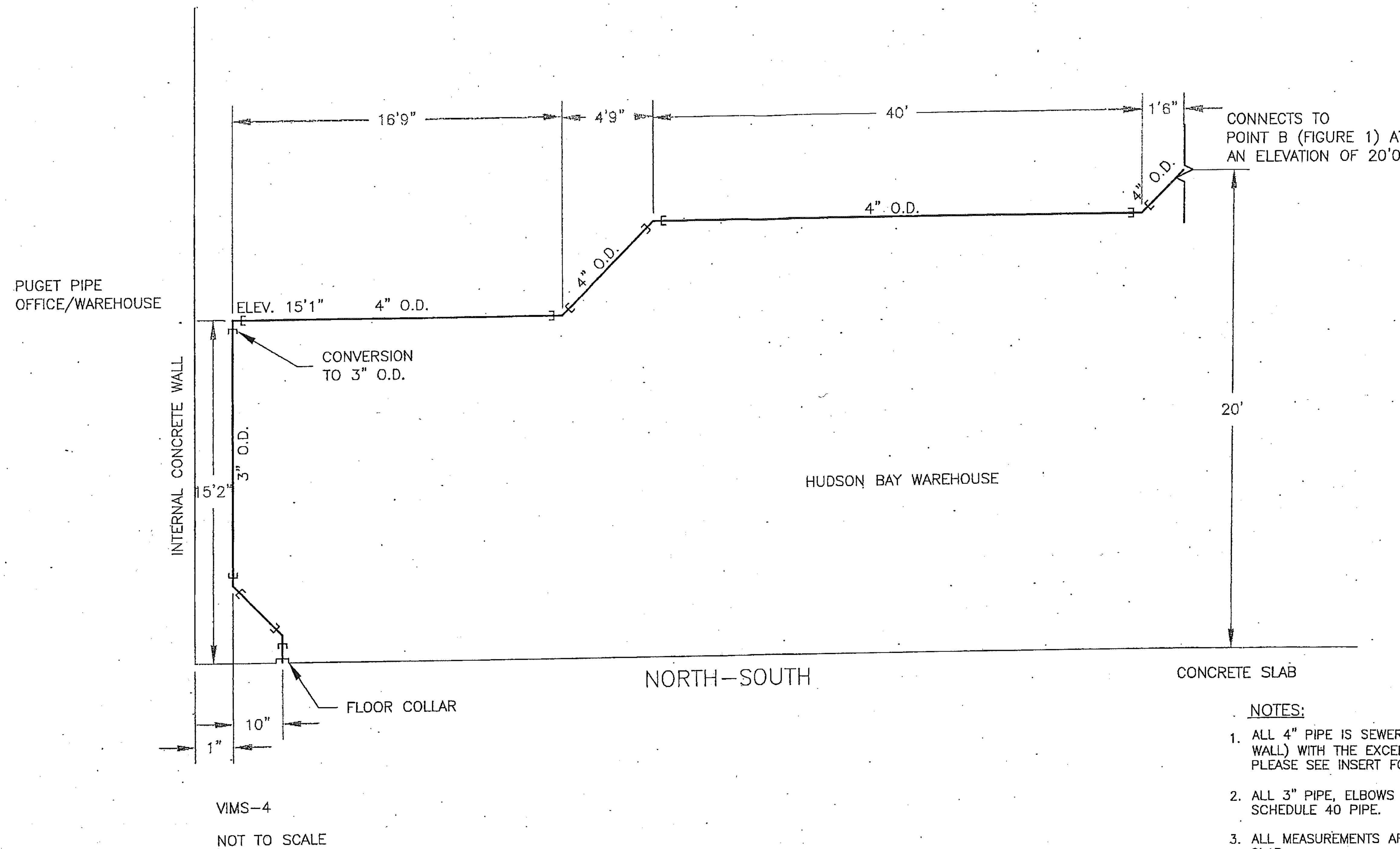
* PIPE SYSTEM CONSTRUCTED AROUND INTERNAL WALL AT THIS POINT AND IS 1'6" IN LENGTH.

File: H:\19314\19314-pipe-section-views(B).dwg Layout: FIG 2 User: emarshall Plotted: Aug 21, 2007 - 3:44pm Xref's:

ENSR | AECOM

Merged with ENSR in 2007 RETEC

GE - S. DAWSON ST. 02978-415-750		VIMS-3 SECTION DETAIL
DATE: 8/21/07	DRWN: E.M./SEA	FIGURE 2



NOTES:

1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.

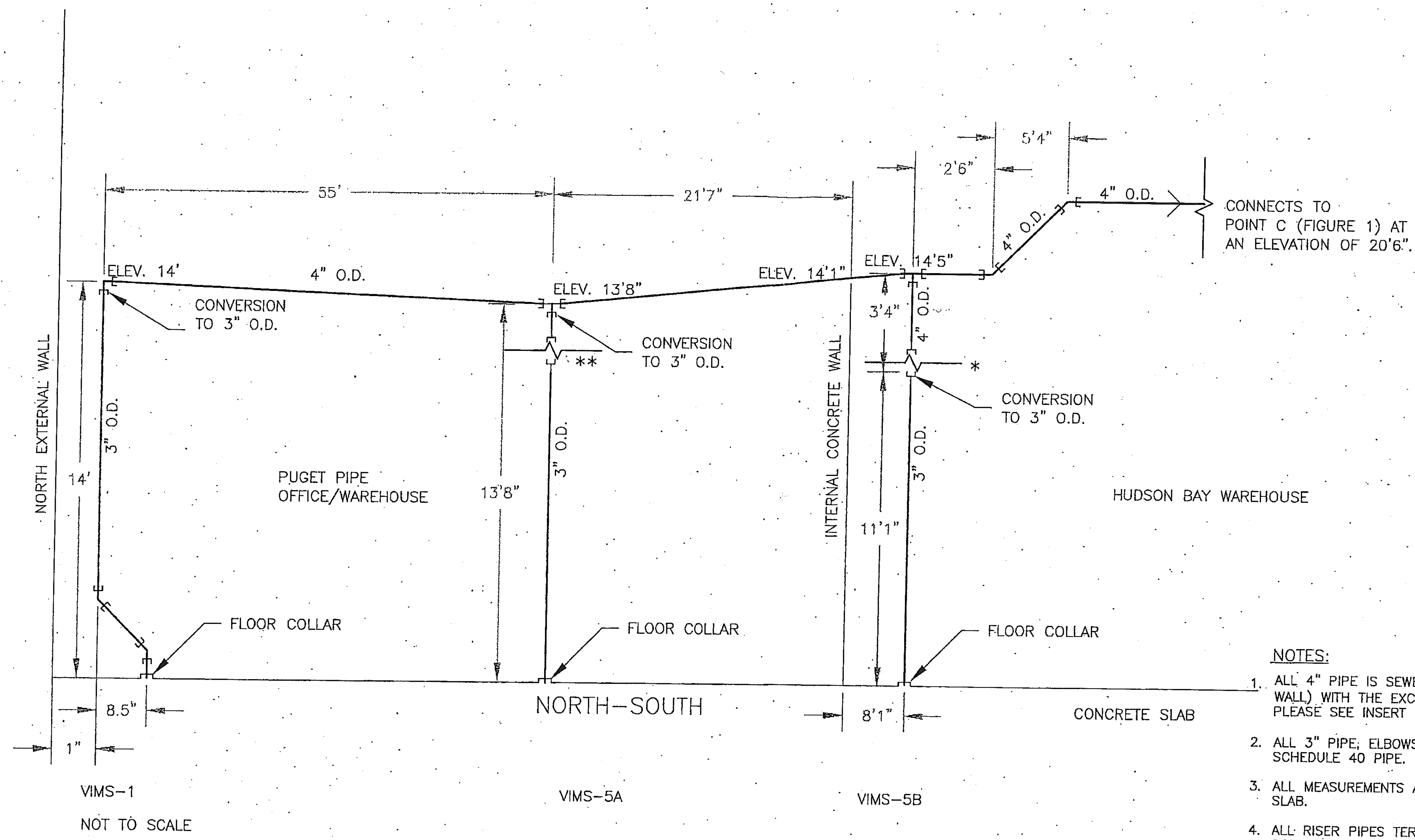
ENSR | AECOM

Merged with ENSR in 2007

RETEC

GE - S. DAWSON ST. 02978-415-750		VIMS-4 SECTION DETAIL
DATE: 8/15/07	DRWN: E.M./SEA	FIGURE 3

File: H:\19314\19314-pipe-section-views(B).dwg Layout: FIG 3 User: emarshall Plotted: Aug 21, 2007 - 3:25pm Xref's:



NOTES:

1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.

* PIPE EXTENDS 8" TO THE WEST.

** PIPE EXTENDS 11" TO THE EAST.

File: H:\19314\19314-pipe-section-views(B).dwg Layout: FIG 4 User: emarshall Plotted: Aug 21, 2007 - 3:33pm Xref's:

ENSR | AECOM

Merged with ENSR in 2007

RETEC

GE - S. DAWSON ST. 02978-415-750	VIMS-1, VIMS 5A, VIMS-5B SECTION DETAIL
DATE: 8/21/07 DRWN: E.M./SEA	FIGURE 4

Appendix A

Information Package

GE
Aviation

James W. Sumner, Manager
Group Environmental Programs

One Neumann Way, M/D T165
Cincinnati, OH 45215

T 513-672-3986, DC 8*892-3986
F 513 552-8918, DC 8*892-8918
jim.sumner@ge.com

August 24, 2007

Mr. Dean Yasuda
Washington Department of Ecology
Northwest Regional Office
3190 – 160th Avenue S.E.
Bellevue, Washington 98008-5452

Dear Mr. Yasuda:

As required by Agreed Order # DE 4258, Section VII, F. enclosed please find a copy of the Information Package sent to the following;

- Mr. Bill Teplicky, McKinstry – Building Owner
- Steve Weber, Puget Sound Pipe & Supply – Tenant
- Tom Merriman, Mason Supply Company – Tenant
- James King, Hudson Bay Insultation - Tenant

Should you have any questions please do not hesitate to call me at (513) 672-3986 or Jamie Stevens at (206) 624-9349.

Sincerely,

James W. Sumner

Attachment – Information Package

cc: Julie Selick, DOE
Jamie Stevens, Linda Baker – RETEC

ENSR | AECOM

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207, Seattle, WA 98134-1162
T 206.624.9349 F 206.624.2839 www.ensr.aecom.com

Memorandum

Date: August 22, 2007

To: Bill Teplicky - McKinstry

From: Jamie Stevens

Subject: Information Package for 220 S Dawson Street Building

Overview

As a part of the Agreed Order between GE and the Department of Ecology we are providing this information package to provide an overview of the recently installed Vapor Intrusion Mitigation System (VIMS).

What is a Sub-Surface Vapor Intrusion Mitigation System?

The purpose of VIMS is to minimize migration of vapors from below the building to inside the building. This is achieved by actively extracting air from one or more pits constructed below the slab through a piping network connected an inline centrifugal fan. Extracting the air not only removes vapors, but also decreases the pressure under the slab so that it is lower than inside the building. This negative pressure gradient reduces air flow upward through the slab. The air extracted by the fan discharges to the atmosphere.

Systems similar to this are used around the country at both commercial and residential sites for a wide variety of VOCs that migrate through soil largely by diffusion. Similar systems are also commonly used to control radon gas infiltration (common in Western Washington and the Northeast).

Details of the 220 South Dawson Street VIMS

VIMS construction was completed on August 6, 2007 by Advance Radon Technology (ART) with direct oversight from RETEC and Ecology. All work was completed as specified in the Work Plan[1], relevant letters from Ecology[2], and in accordance with all relevant standards and requirements.

[1] Sub-Surface Vapor Intrusion – Interim Measures Work Plan and Design, Revision 1. Prepared by The RETEC Group, Inc. January 29, 2007.

[2] February 23, 2007; May 29, 2007 (2 separate letters with the same date); May 31, 2007; June 5, 2007; and July 10, 2007

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207, Seattle, WA 98134-1162
T 206.624.9349 F 206.624.2839 www.ensr.aecom.com

The VIMS systems consists of five separate pits, each connected to a 3" schedule 40 PVC pipe riser which extends up from the concrete slab to the roof. Two risers are located in the northwest portion of the building and three are located in the southwest portion of the building. These locations were determined by Ecology and corresponded to sampling locations where elevated concentrations of TCE were detected in the sub-slab vapors and indoor air. Each riser is connected to piping routed to a single, roof-mounted centrifugal fan that extracts the air from under the building foundation. The extracted air is vented through a stack located on the southwest portion of the roof. No end of stack treatment is required; all potential concentrations are below permissible limits set by the local air regulator agency[3].

U-tube manometers were installed into the sides of riser pipes at all VIMS locations to verify system air flow. The manometers were installed approximately 4 feet above the floor (heights vary depending on location, please see Figure 1). In general, an observed difference in fluid height between the sides of the U-tube indicates that air is flowing and that VIMS system is working. The difference in the fluid level will be affected by changes in atmospheric pressure but the fluid level should always remain different between each side of the tube. Figures 1 through 4 (attached) depict the configuration and construction details of VIMS and related equipment, including the fan, manometers, and the electrical service box.

Verification of Performance

The U-tube manometers will be checked every week for the first six weeks starting the week of August 13 through the week of September 17, and every month thereafter by RETEC field staff. Documentation of the field inspection will be submitted to Ecology and copies will be provided to McKinstry representatives.

Upon notification by Ecology air sampling will be conducted similar to the sampling in the past. Results of this sampling will be submitted to Ecology, copies will be provided to McKinstry.

Stack testing will also be collected at the same time as the indoor and outdoor air sampling events. One sample will be collected from the exhaust piping connecting to the discharge fan. Results of this sampling will be submitted to Ecology; copies will be provided to McKinstry.

Performance Period

The VIMS is required to operate continuously until Ecology determines that the system may be terminated.

What to do if you have questions, an emergency, or need to change existing conditions at the site?

If representatives of McKinstry or any of the building tenants have any questions or concerns, or if unusual operation of the system is observed, please see the tables below for contact information.

---

[3] Puget Sound Clean Air Agency

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207, Seattle, WA 98134-1162
T **206.624.9349** F **206.624.2839** www.ensr.aecom.com

Contact	Company	Phone and Email	Mailing Address
Jamie Stevens – ENSR Project Manager	RETEC/ENSR	Phone: 206-624-9349 Email: jstevens@ensr.aecom.com	1011 S.W. Klickitat Way, Suite 207 Seattle WA 98134
James Sumner – GE Project Manager	GE Aviation	Phone: 513-672-3986 Email: jim.sumner@ge.com	One Neumann Way M\D T165 Cincinnati, Ohio 45215

Any questions to the Department of Ecology should be directed to:

Contact	Company	Phone and Email	Mailing Address
Dean Yasuda – Ecology Site Manager	Department of Ecology – Northwest Regional Office	Phone: 425-649-7262 Email: DYAS461@ECY.WA.GOV	3190 160th Ave SE Bellevue, WA 98008

System operation requires no action by the representatives of McKinstry; however, potential modifications to the building could affect the performance of the VIMS. GE requests that representatives of McKinstry contact GE (or any of the contacts listed above) and Ecology immediately if any of the following types of modifications are planned or occur at the building:

- Changes to the Heating/Venting systems (including additional roof units)
- Changes to the concrete slab, internal walls, or any penetrations to external walls
- Changes to the building foot print
- Changes to any electrical work which could affect the current electrical control box location for the fan.

Additionally, GE requests that representatives of McKinstry and building tenants contact RETEC/ENSR or any of the contacts listed above immediately if any of the following damages or potential defects to the VIMS are observed:

- Damage to any of the pipes associated with the VIMS network
- If at any time the fan is unusually noisy, excessive vibration, not operating or if a circuit breaker is tripped
- If any unusual sounds, such as knocking or water running, are heard emanating from inside the pipes
- If the manometers appear to be malfunctioning or are damaged (i.e. fluid level equal).

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207, Seattle, WA 98134-1162
T 206.624.9349 F 206.624.2839 www.ensr.aecom.com

The fan and the exhaust stack are located on the southeast portion of the roof, above the Hudson Supply Warehouse space (see Figure 1). The fan specifications are attached for your reference. The top of the stack is 6'1" above the roofline and is labeled with warning signs indicating that proper PPE may be required for working within the immediate vicinity of the unit. If work is required on the roof in close proximity to the fan and for extended duration, McKinstry can request that the fan be turned off for the duration of the work. This request should be submitted to and approved by Ecology. PPE can be worn to allow extended work time if concentrations of TCE are above the NIOSH and OSHA permissible limits (as determined by the air monitoring). The most current permissible levels can be found at the National Institute for Occupational Safety and Health website: http://www.cdc.gov/niosh/npg/

Summary

We appreciate the corporation of McKinstry through the installation process. We are happy to provide any additional support or information upon request.

Sincerely yours,

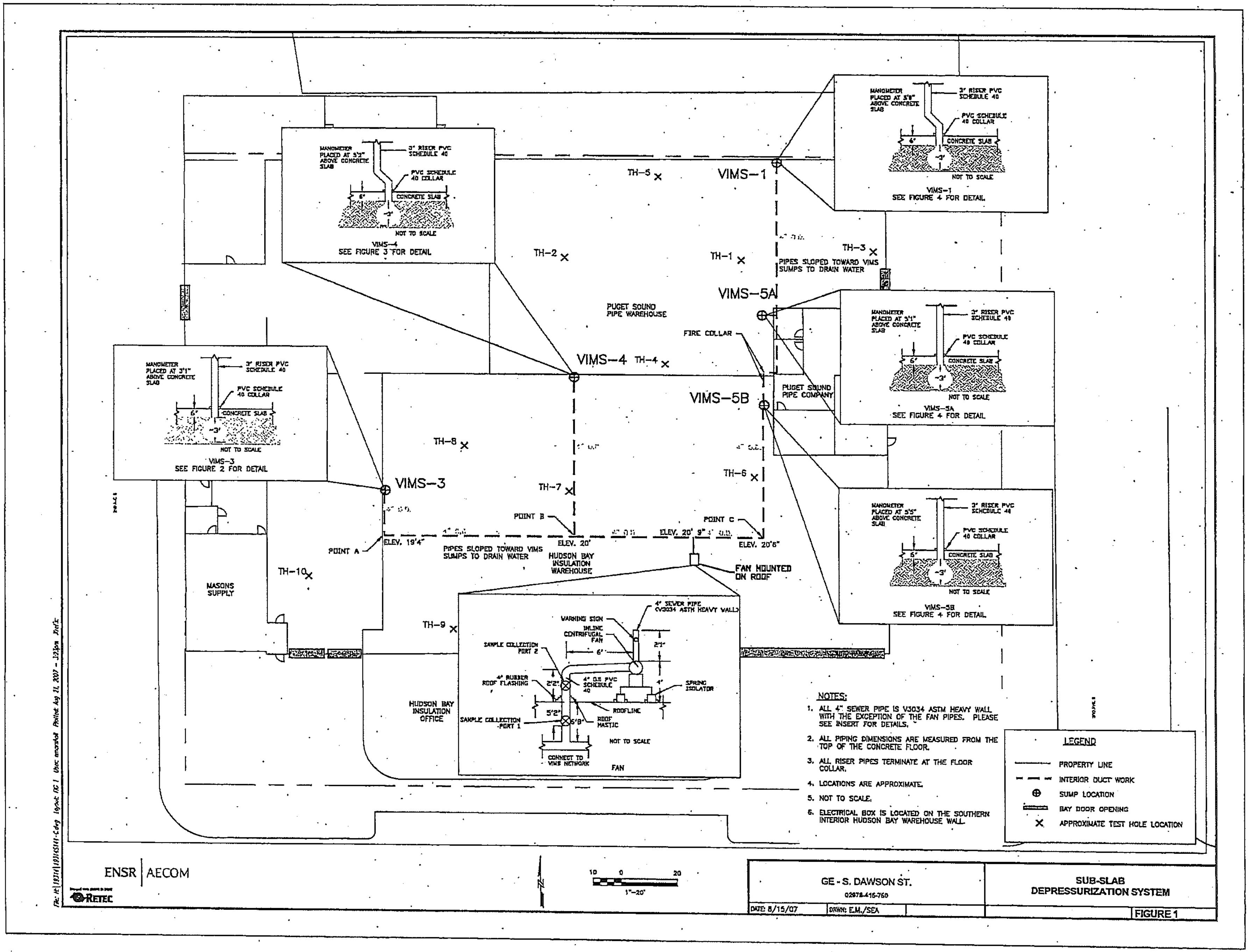
for

Jamie C. Stevens
Project Manager

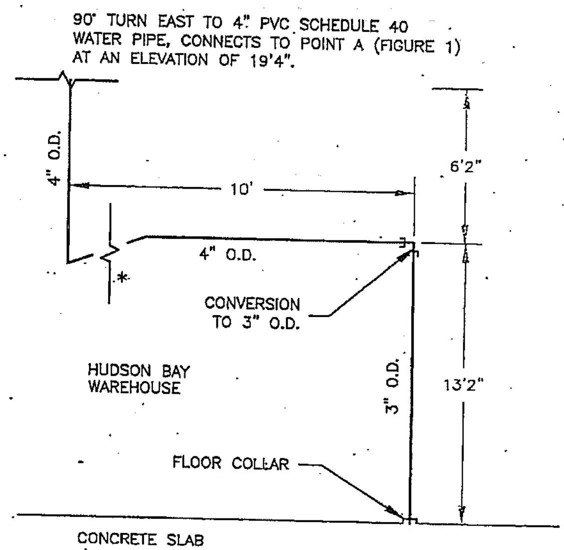
for

Mark Havighorst, P.E.
Sr. Project Engineer

Attachments: Figures 1 through 4
Fan Specifications



VIMS-1
VIMS-3
VIMS-4
VIMS-5A
VIMS-5B
TH-1
TH-2
TH-3
TH-4
TH-5
TH-6
TH-7
TH-8
TH-9
TH-10
MANOMETER PLACED AT 5'8" ABOVE CONCRETE SLAB
3" RISER PVC SCHEDULE 40
PVC SCHEDULE 40 COLLAR
CONCRETE SLAB
NOT TO SCALE
VIMS-1 SEE FIGURE 4 FOR DETAIL
VIMS-4 SEE FIGURE 3 FOR DETAIL
VIMS-3 SEE FIGURE 2 FOR DETAIL
VIMS-5A SEE FIGURE 4 FOR DETAIL
VIMS-5B SEE FIGURE 4 FOR DETAIL
PIPES SLOPED TOWARD VIMS SUMPS TO DRAIN WATER
PUGET SOUND PIPE WAREHOUSE
PUGET SOUND PIPE COMPANY
FIRE COLLAR
POINT A
POINT B
POINT C
ELEV. 19'4"
ELEV. 20'
ELEV. 20' 9"
ELEV. 20'6"
HUDSON BAY INSULATION WAREHOUSE
HUDSON BAY INSULATION OFFICE
MASONS SUPPLY
FAN MOUNTED ON ROOF
4" SEWER PIPE (V3034 ASTM HEAVY WALL)
WARNING SIGN
INLINE CENTRIFUGAL FAN
SAMPLE COLLECTION PORT 2
SAMPLE COLLECTION PORT 1
4" RUBBER ROOF FLASHING
4" OD PVC SCHEDULE 40
SPRING ISOLATOR
ROOFLINE
ROOF MASTIC
CONNECT TO VIMS NETWORK
FAN
NOTES:
1. ALL 4" SEWER PIPE IS V3034 ASTM HEAVY WALL WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL PIPING DIMENSIONS ARE MEASURED FROM THE TOP OF THE CONCRETE FLOOR.
3. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
4. LOCATIONS ARE APPROXIMATE.
5. NOT TO SCALE.
6. ELECTRICAL BOX IS LOCATED ON THE SOUTHERN INTERIOR HUDSON BAY WAREHOUSE WALL.
LEGEND
PROPERTY LINE
INTERIOR DUCT WORK
SUMP LOCATION
BAY DOOR OPENING
APPROXIMATE TEST HOLE LOCATION
ENSR | AECOM
RETEC
1"=20'
GE - S. DAWSON ST.
02878-416-760
DATE: 8/15/07
DRWN: E.M./SEA
SUB-SLAB DEPRESSURIZATION SYSTEM
FIGURE 1



SOUTH–NORTH

VIMS–3

NOT TO SCALE

NOTES:

1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.
8. PIPE SYSTEM RUNS APPROXIMATELY 4" FROM INTERNAL PLYWOOD WALL BETWEEN HUDSON BAY & MASON SUPPLY.

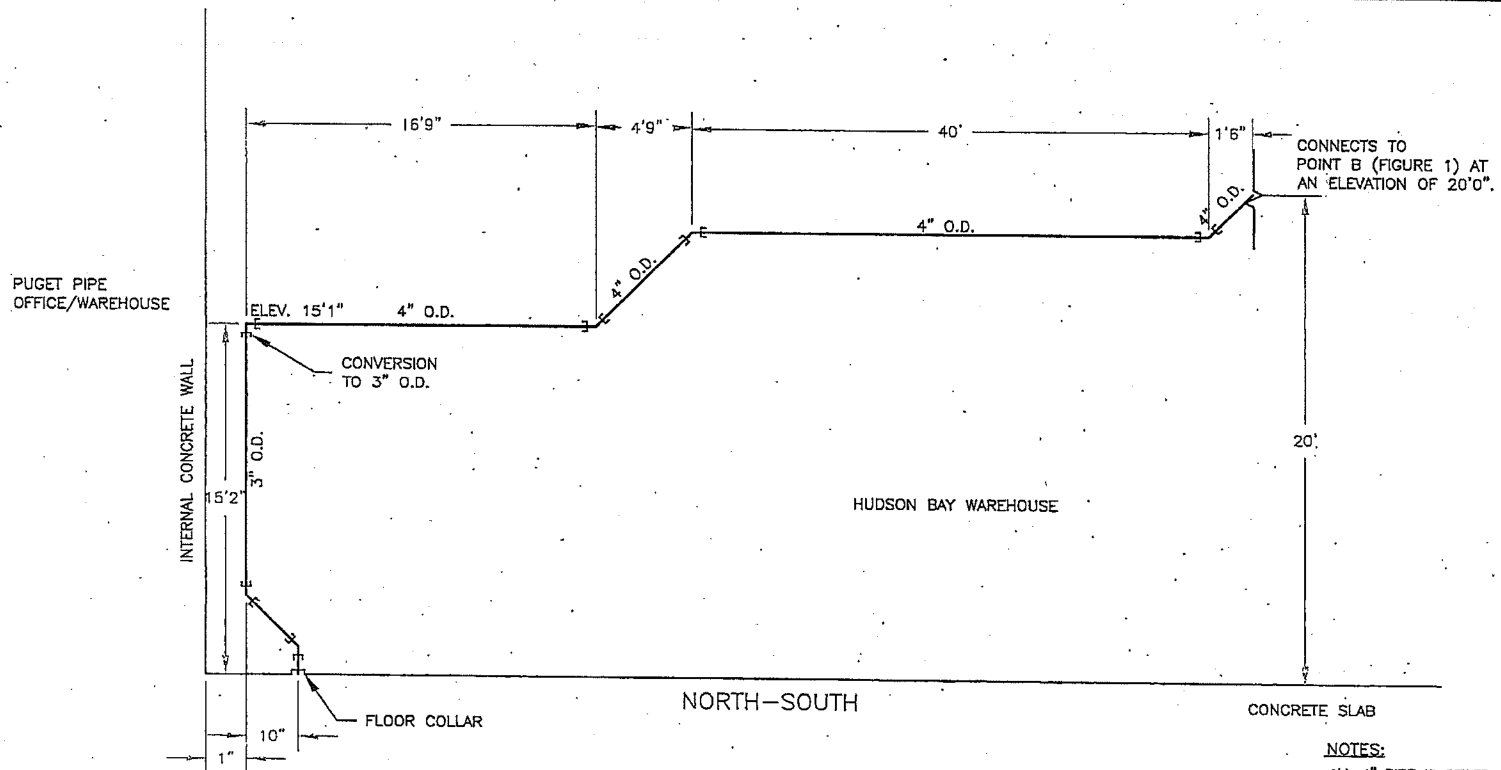
* PIPE SYSTEM CONSTRUCTED AROUND INTERNAL WALL AT THIS POINT AND IS 1'6" IN LENGTH.

ENSR | AECOM

RETEC

GE - S. DAWSON ST. 02978-415-750	VIMS-3 SECTION DETAIL
DATE: 8/21/07 DRWN: E.M./SEA	FIGURE 2

File: H:\19314\19314-pipe-section-views(B).dwg Layout: FIG 2 User: emarshall Plotted: Aug 21, 2007 - 3:44pm Xref's:



VIMS–4

NOT TO SCALE

NOTES:

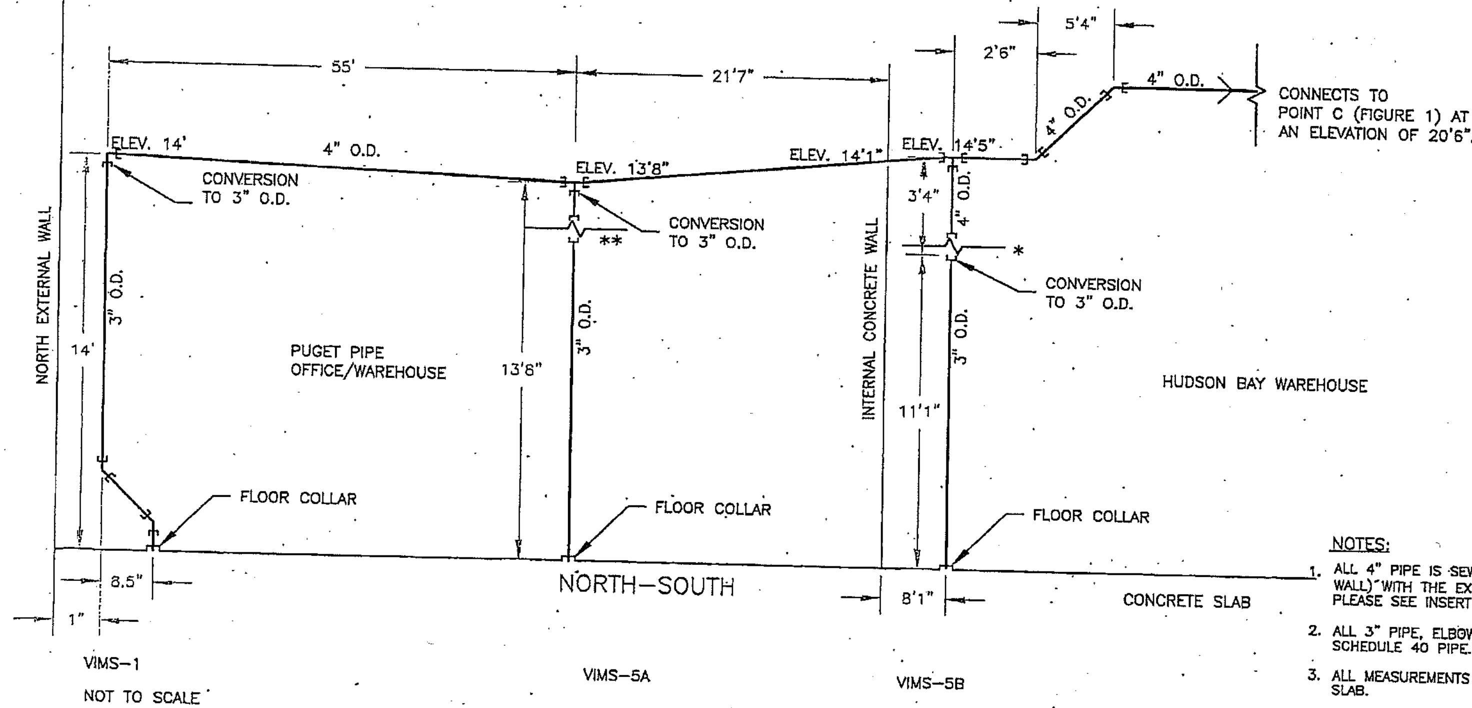
1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.

ENSR | AECOM

RETEC

GE - S. DAWSON ST. 02978-415-750	VIMS-4 SECTION DETAIL
DATE: 8/15/07 DRWN: E.M./SEA	FIGURE 3

File: H:\19314\19314-pipe-section-views(B).dwg Layout: FIG 3 User: emarshall Plotted: Aug 21, 2007 – 3:25pm Xref's:



NOTES:

1. ALL 4" PIPE IS SEWER PIPE (V3034 ASTM HEAVY WALL) WITH THE EXCEPTION OF THE FAN PIPES. PLEASE SEE INSERT FOR DETAILS.
2. ALL 3" PIPE, ELBOWS AND CONNECTORS ARE PVC SCHEDULE 40 PIPE.
3. ALL MEASUREMENTS ARE ABOVE THE CONCRETE SLAB.
4. ALL RISER PIPES TERMINATE AT THE FLOOR COLLAR.
5. LOCATIONS ARE APPROXIMATE.
6. PLEASE SEE FIGURE 1 FOR PIPE RUN.
7. SAMPLE PORTS AND MANOMETER LOCATIONS ARE SHOWN ON FIGURE 1.

* PIPE EXTENDS 8" TO THE WEST.

** PIPE EXTENDS 11" TO THE EAST.

ENSR | AECOM

RETEC

GE - S. DAWSON ST. 02978-415-750	VIMS-1, VIMS 5A, VIMS-5B SECTION DETAIL
DATE: 8/21/07 DRWN: E.M./SEA	FIGURE 4

File: H:\19314\19314-pipe-section-views(8).dwg Layout: FIG 4 User: emarshall Plotted: Aug 21, 2007 - 3:33pm Xref's:

cincinnati fan OEM and Industrial Air Handling Specialist

FAN SELECTION And PERFORMANCE

Friday, June 08, 2007

Job Name: NORTHWEST COMMERCIAL AIR, INC.
Reference: DOE Seattle Quote: 96373

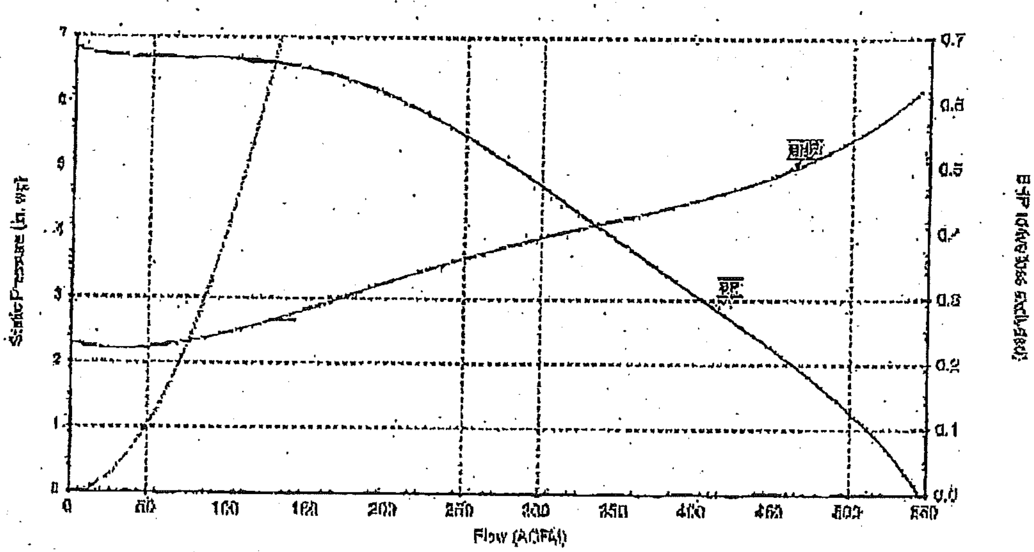
Operating Requirements

Volume, ACFM	125
Static Pressure, in. wg	6.5
Density, lb./ft.³	0.075
Operating Temperature, °F	70
AMCA Arrangement No.	4
Motor Frequency, Hz	60
Start-Up Temperature, °F	70

Fan Selection and Specifications

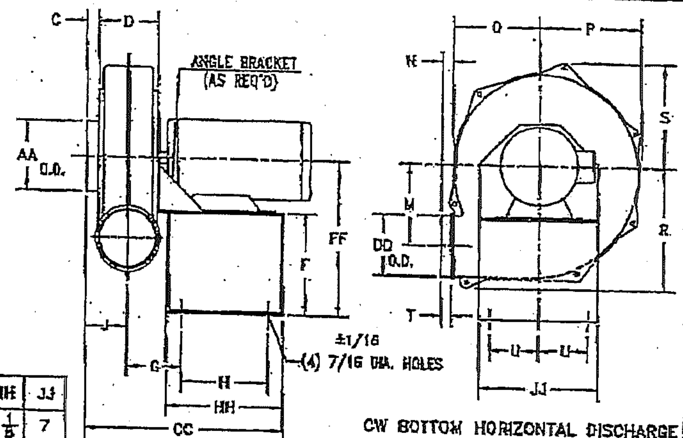
Model	PB-9
Fan RPM	3,450
Wheel Description	Cast Alum. 10-1/4 X 3 BC
Wheel Width, %	100%
Wheel Diameter, In.	10.25
Inlet Diameter, In.	5.00
Outlet Velocity, ft./min.	1,445
Fan BHP	0.27
Static Efficiency, %	49.6%
Cold Start BHP	0.27
Construction Class	N/A

Cincinnati Fan PB-9 Cast Alum. 10-1/4 X 3 BC Wheel (Full Width) @ 3,450 RPM
Rating Point- 125 ACFM @ 6.5 in. wg SP, 0.075 lb./ft.³ Density, 0.27 BHP, 5.0 in. Inlet



CFSWin Version: 7.2.2713.25601 Database Version: 7.21

A PB4



CW BOTTOM HORIZONTAL DISCHARGE SHOWN ABOVE

MODEL	FRAME	HOUSING C	D	J	M	N	O	P	R	S	T	AA	DD	F	G	H	U	CC	FF	HH	JJ
PB-8	56	1	3 3/4	2 7/8	4 1/8	1 1/8	4 5/8	5 5/8	7 3/16	4 7/8	1 1/8	4	4	5	3 3/16	5	2 3/4	12 1/8	8 9/16	7 1/8	7
PB-9	56	1 1/16	4 1/8	3 1/8	5 5/8	1 3/16	6 1/8	7 3/8	8 1/2	6 5/8	1	5	4	6 7/8	3 3/8	5 3/4	2 3/4	13 5/16	10 7/16	7 7/8	7
	143T-145T													8 1/4	4 3/16	5	3 3/4	13 15/16	11 7/8	8	9
PB-10A	56	1 1/4	4 1/4	3 3/8	6 9/16	1	6 7/8	9 7/16	10 3/16	7 13/16	1	6	5	6 7/8	3 7/16	5 3/4	2 3/4	13 11/16	10 7/16	7 7/8	7
	143T-145T													8 1/4	4 1/4	5	3 3/4	14 1/8	11 7/8	8	9
PB-12A	56	1 1/4	5	3 3/4	7 9/16	7/8	8	9 5/8	11 11/16	9 7/16	1	7	6	8 1/4	4 1/4	5	3 3/4	14 1/2	11 7/8	8	9
	143T-145T													8 1/4	4 5/8	5	3 3/4	14 7/8		8	9
	182T-184T													6 7/16	5	8 3/4	4 15/16	19		11 3/4	12
PB-14A	56	1 1/4	6	4 1/4	8 1/16	1	8 13/16	10 3/8	12 3/16	10 1/4	1	7	6	9 15/16	5 1/2	8 3/4	4 15/16	20	15 3/16	11 3/4	12
	143T-145T																				
	182T-213T																				
PB-15A	143T-145T	1 1/4	7 1/4	4 7/8	7 7/8	1	9 13/16	11 3/8	13	10 13/16	1	8	8	9 15/16	6 1/8	8 3/4	4 15/16	21 1/4	15 3/16	11 3/4	12
	182T-184T																				
	213T-215T																				
	254T-256T													8 15/16		13		25 1/2		16	16 1/2
PB-18	143T-145T	1 1/4	6 1/4	4 3/8	10 1/2	15/16	10 1/2	12 11/16	14 1/2	12 7/16	1	8	6	9 15/16	5 5/8	8 3/4	4 15/16	20 1/4	15 3/16	11 3/4	12
	182T-184T																				
	213T-215T																				
	254T-256T													8 15/16		13	-	24 1/2		16	16 1/2
PB-18WA	182T-184T	1 1/4	8 1/16	5 5/16	9 7/8	7/8	11	13 3/16	15 1/8	11 13/16	1	10	6	12 3/4	6 1/2	10 3/4	6 1/4	24 1/16	18	13 3/4	16 1/2
	213T-215T																				
	254T-256T													11 3/4		15 3/4		29 1/16		18 3/4	
	284T-286T													11							

OPTIONAL INLET SIZES

- ☐ 6" INLET AVAILABLE FOR PB-14A, PB-15A & PB-18
- ☐ 7" INLET AVAILABLE FOR PB-15A
- ☐ 8" INLET AVAILABLE FOR PB-14A & PB-18WA
- ☐ 10" INLET AVAILABLE FOR PB-15A & PB-18

NOTES:
1. HOUSINGS ARE ROTATABLE IN 45° INCREMENTS.
2. ALL MODELS: DISCHARGE FLANGE NOT AVAILABLE FOR DOWN BLAST DISCHARGE.

cincinnati fan
7697 SNIDER ROAD MASON, OHIO 45040

TOLERANCES:
ANGLES: ± 1°
FRACTIONS ±1/8

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED

SUPERSEDES:

CERTIFIED DRAWING

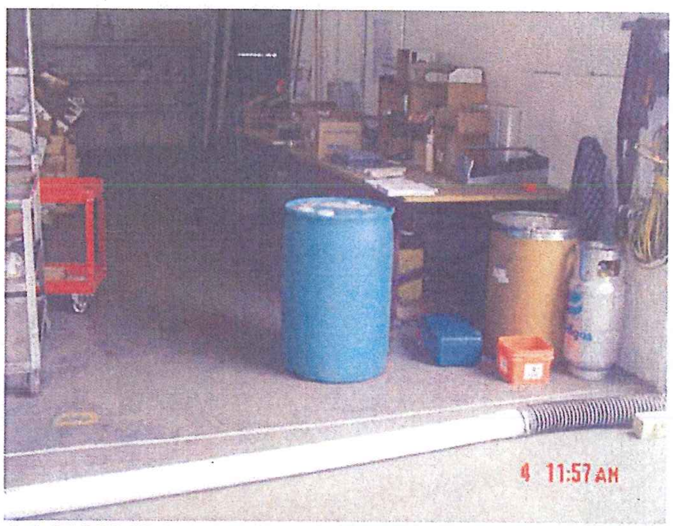
TITLE: PB BLOWERS — ARR. 4

A | DRAWING NO. PB4 | REV. 1

Appendix B

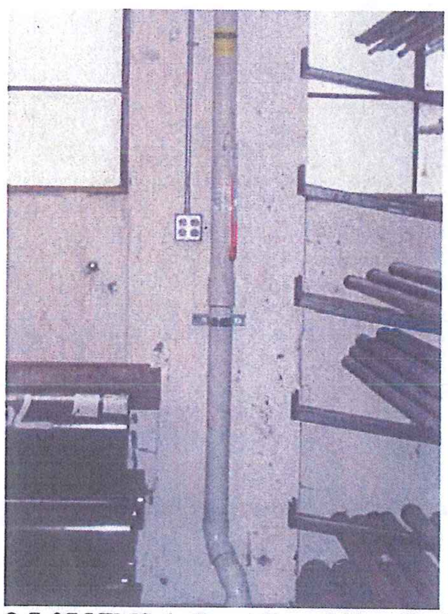
Photograph Log

6-7-07 VIMS-1 Puget Sound Pipe (Facing North) – Capped Riser after excavation of sump

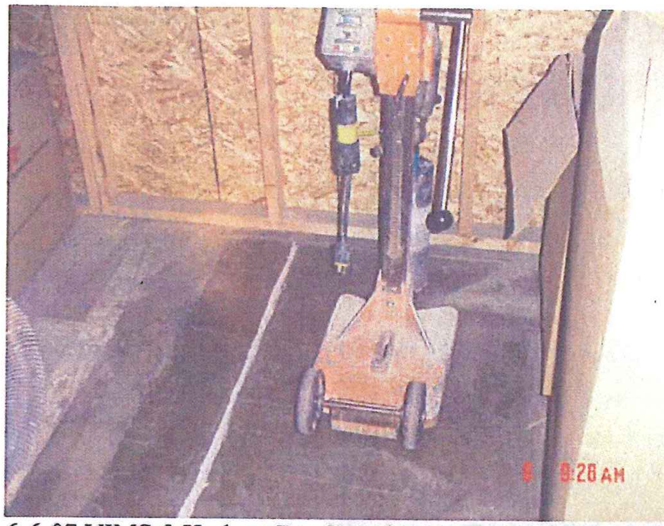


6-4-07 VIMS-1 Puget Sound Pipe Warehouse (Facing North) – Shows polyeurothane sealing and installation vent piping from vacuum blower.

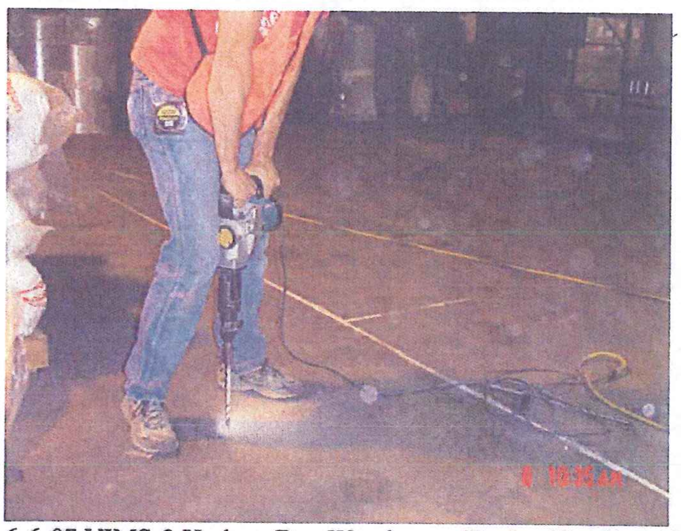
6-4-07 VIMS-1 Puget Sound Pipe Warehouse– Shows Digital Micromanometer recording the negative pressure differential over a test hole



8-7-07 VIMS-1 -Puget Sound Pipe (Facing North) - shows manometer and signs attached indicating contacts regarding the system

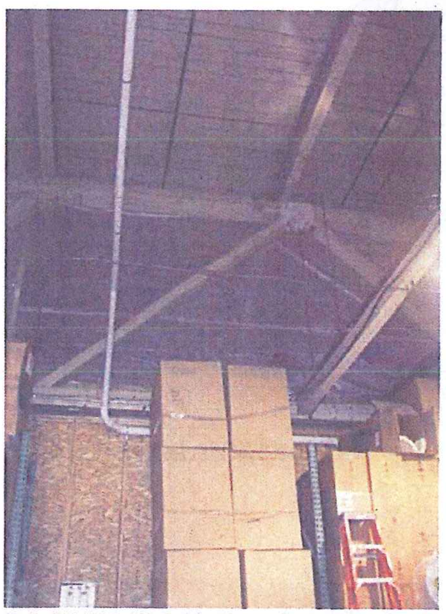


6-6-07 VIMS-3 Hudson Bay Warehouse (Facing West) - Drill set up to core out concrete

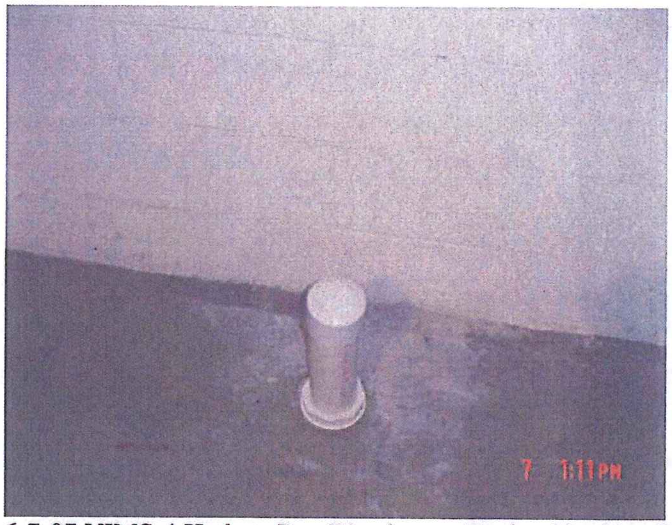


6-6-07 VIMS-3 Hudson Bay Warehouse (Facing North) – ART contractor drilling TH-8

6-6-07 VIMS-3 Hudson Bay Warehouse (Facing West) – Capped Riser after excavation of sump

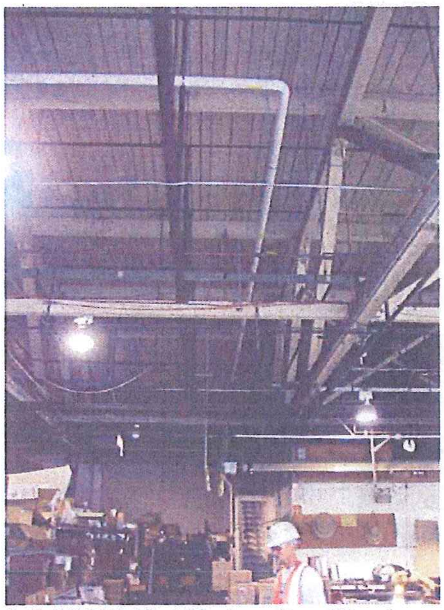


8-2-07 VIMS-3 Hudson Bay Warehouse (Facing West) - Piping from exhaust fan to VIMS-3



6-7-07 VIMS-4 Hudson Bay Warehouse (Facing North) – Capped Riser after excavation of sump

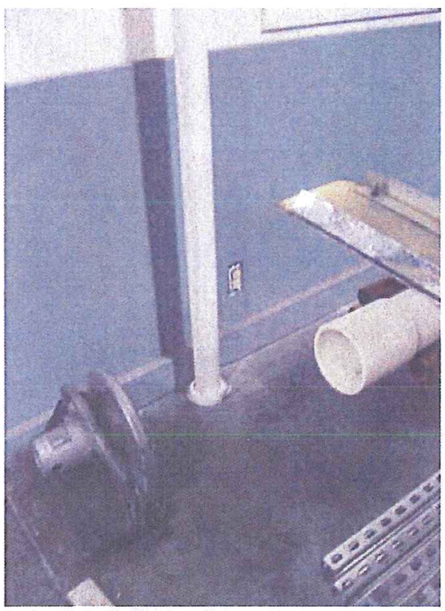
8-6-07 VIMS-4 Hudson Bay Warehouse (Facing West and up) – Piping connecting VIMS-3 and VIMS-4



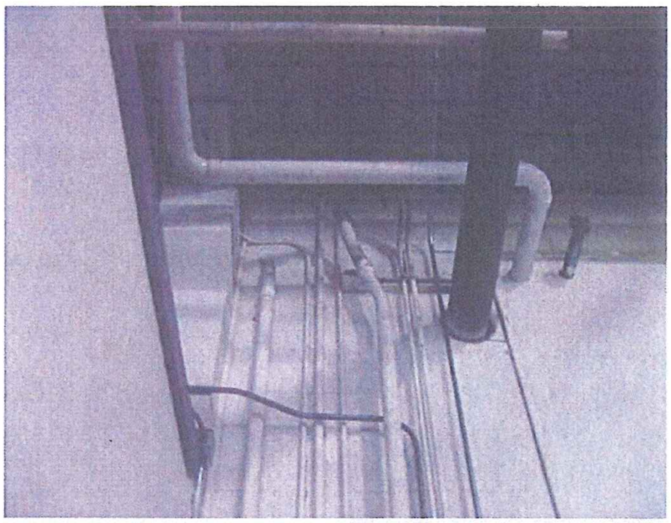
8-6-07 VIMS-4 Hudson Bay Warehouse (Facing North) – Piping network from exhaust fan to VIMS-5B

8-6-07 VIMS-4 Hudson Bay Warehouse (Facing Northwest) – Manometer installed

6-4-07 VIMS-5A Puget Sound Pipe (Facing South East) - Drilled concrete sump

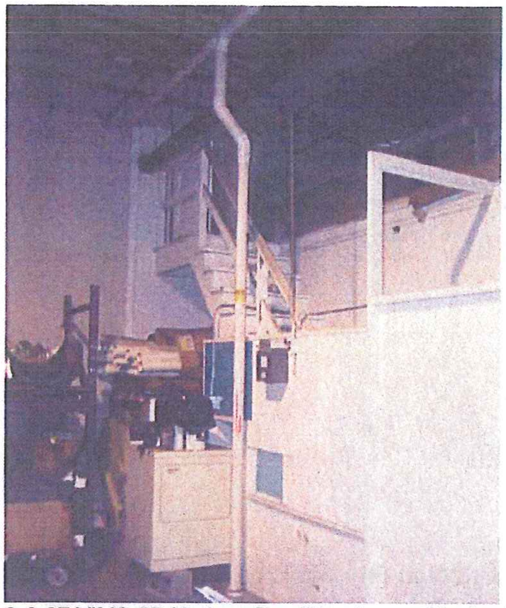


8-3-07 VIMS-5A Puget Sound Pipe (Facing South-East) – VIMS-5A Piping connecting to sump location

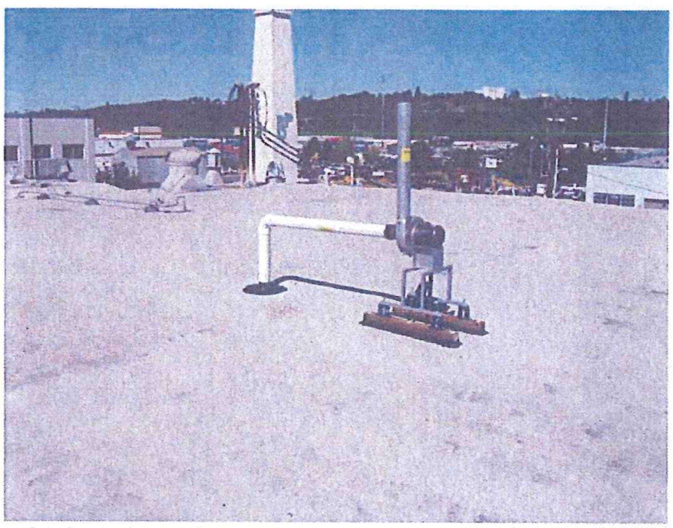


8-3-07 VIMS-5A Puget Sound Pipe (Facing South and Up) – Piping coming through Hudson Bay internal wall to Puget Sound Pipe.

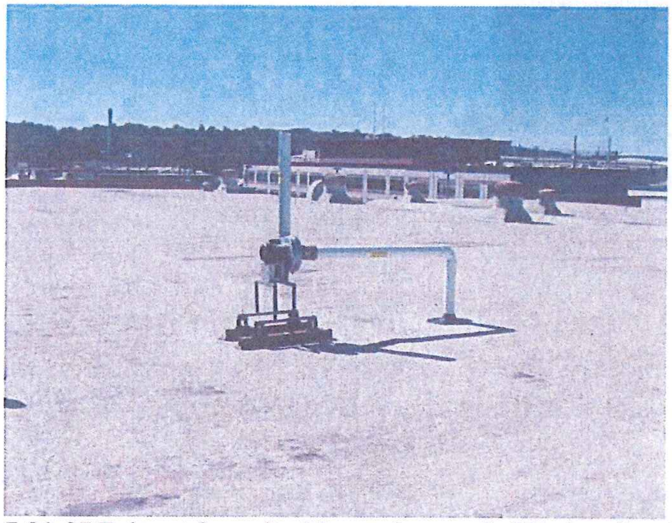
6-7-07 VIMS-5B Hudson Bay Warehouse (Facing Northeast) – Capped Riser after excavation of sump



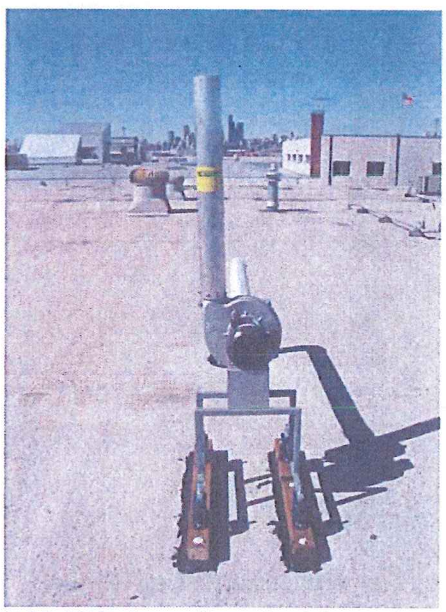
8-6-07 VIMS-5B Hudson Bay Warehouse (Facing North East) – Piping installed to the sump at VIMS-5B.



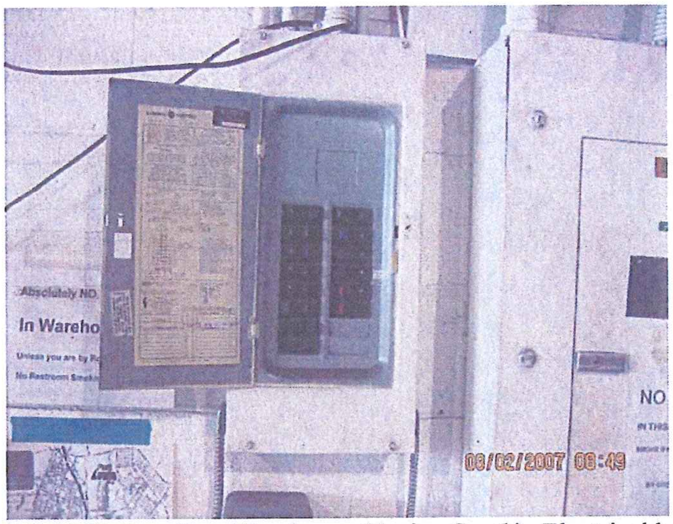
7-31-07 Exhaust fan unit - Mounted on roof of Hudson Bay Warehouse (Facing North-East)



7-31-07 Exhaust fan unit - Mounted on roof of Hudson Bay Warehouse (Facing North-West)



7-31-07 Exhaust fan unit - Mounted on roof of Hudson Bay Warehouse (Facing North)



8-2-07 Hudson Bay Warehouse (Facing South) -Electrical box for exhaust fan

8-6-07 Exhaust Fan– Sign placed on PVC exhaust pipe

Appendix C

Mechanical Permit Details

Permit Number:
6149569

CITY OF SEATTLE
Mechanical Permit

Department of Planning and Development
700 Fifth Ave., Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 684-8600

DISTRICT 3

APN #:

Site Address: 220 S DAWSON ST, SEATTLE, WA
Building ID:
Location:
Legal Description:
Records Filed At:

OWNER	CONTRACTOR		
MCKINSTRY 5005 3RD AVE SOUTH SEATTLE, WA 98134 Ph: (206) 762-3311		**Application Date:**	08/08/2007
		Issue Date:	09/20/2007
		Expiration Date:	03/20/2009
		Fees Paid:	$715.00
		As of Print Date:	09/20/2007

Description of Work: Installization of subslab depressuization system per plan

Permit Remarks: Contractor not selected at time of permit issuance. EEC

DPD Valuation: $14,500.00 **Special Inspections:** N

Land Use Conditions: N

Zoning/Overlays:

Residential Furnace/Appliance Information:

QTY	Appliance Type	Fuel Type	Action Type	Manufacturer	Model #	Output

A/P #	Related Cases/Permits
None	

Project Contacts	Name	Phone
Structural Reviewer	DOMINIC MARICICH	(206) 233-7175
Zoning Reviewer	JENNIFER HENRY	(206) 684-5223
Mechanical Reviewer	ROBERT POMADA	(206) 684-8440
Primary Applicant	DANIEL ARCIERI	(206) 624-2839

Applicant Signature: Daniel Arcieri **Date:** 9-20-07

Permitted work must not progress without prior inspection approval. When ready for inspection, make request with the Department of Planning and Development at (206) 684-8900 or on the internet at: www.seattle.gov/dpd/inspectionrequest. Provide the permit number, site address, and contact phone. Permission is given to do the above work at the site address shown, according to the conditions hereon and according to the specification pertaining thereto, subject to compliance with the Ordinances of the City of Seattle. Correct information is the responsibility of the applicant. Permits with incorrect information may be subject to additional fees.

THIS PERMIT MUST BE CONSPICUOUSLY POSTED AT THE WORK SITE

PERMIT # 6149569

City of Seattle
Department of Planning and Development
700 Fifth Ave., Suite 200

POST THIS SIDE OUT: THIS PERMIT MUST BE CONSPICUOUSLY POSTED AT THE WORK SITE

TO THE CONTRACTOR/OWNER,

Additional permits may be required for work occurring under this permit. This permit does not authorize Sewer, Public Right-of-Way Shoring, Drainage and Street Use, Fire Department, Boiler, Electrical, Elevator, Furnace, Gas Piping, Plumbing, or Sign permits. If other permits are required, they must be applied for separately from this permit. The requirements for all other permits related to this Permit, must be completed prior to the Final Inspection of this permit.

This Permits Final Inspection is required. The premises must not be occupied until the Final Inspection is provided and occupancy is authorized by the Seattle Department of Planning and Development.

ISSUED PERMIT STATUS:

You can check the status of issued permits on the internet at: www.seattle.gov/dpd

INSPECTION REQUESTS:

Please clarify which inspections your project requires before proceeding with your project.

You may request an inspection on the internet or by phone. Inspection requests received **before 7:00 AM** are scheduled for the same working day. Inspection requests received **after 7:00 AM** are scheduled for the next working day. Inspectors are available between the hours of 7:30 AM and 8:30 AM.

A) **Internet at:** www.seattle.gov/dpd/inspectionrequest Under ***Quick Links***, click ***Request an Inspection.***
B) **24 hour inspection request line at (206) 684-8900**, cell phones are discouraged due to frequent connection problems.
C) **Customer Service at (206) 684-8950** between the hours of 7:30 AM and 4:30 PM.

FIRST GROUND DISTURBANCE:

A) Before First Ground Disturbance, request an inspection of installed **Erosion Control Measures**.
B) When required, request a **Pre Construction Conference** to review project conditions and Special Inspections by calling (206) 684-8860.
C) If this permit requires a **Soil Bearing Capacity** special inspection by a Geotechnical Engineer, that approval is required **before** the foundation pour. The Building Inspector will accept the Geotechnical Engineer's approval signature below.
D) When **Special Inspections** are required, notify the Special Inspection Agency at least 24 hours in advance.

City of Seattle
Department of Planning and Development

BUILDING PERMIT FIELD INSPECTION REPORT

PERMIT # 6149569 **ADDRESS** 220 S Dawson St

BLDG ID # 450-0444

INSPECTION TYPE

☐ PRE CONSTRUCTION CONFERENCE	☐ FRAMING
☐ TEMPORARY EROSION AND SEDIMENT CONTROL	☐ SUB FLOOR ☐ WALLS ☐ CEILING GRID
☐ ADVISORY ONLY	☐ FIRE RESISTANCE – RATED ASSEMBLY
	☐ INSULATION
☐ SET BACK / LOCATION	☐ SLAB ☐ WALLS ☐ CEILING
☐ FOUNDATION	☐ FINAL
☐ FOOTINGS ☐ WALLS	
☐ STRUCTURAL	☐ SFD/DUPLEX FURNACE FINAL
☐ SHEAR WALLS – EXT. ☐ SHEAR WALLS – INT.	☐ MECHANICAL COVER
☐ HD'S / STRAPS ☐ DIAPHRAGM	☒ MECHANICAL FINAL

INSPECTION RESULT

☒ PASSED ☐ PARTIAL PASSED ☐ FAILED ☐ WAIVED

☐ Corrections Required ☐ Corrections Completed ☐ Permit Cancelled; Inspection Refund Approved

COMMENTS (FOR THE RECORD):

Ok Final

☐ **REINSPECTION FEE APPLIES:**
☐ APPROVED PLANS NOT ON SITE ☐ NOT READY FOR INSPECTION ☐ NO ONE ON JOBSITE ☐ CORRECTIONS INCOMPLETE

REQUIRED APPROVAL	DATE APPROVED	REQUIRED APPROVAL	DATE APPROVED
☐ SPECIAL INSPECTIONS		☐ BOILER	
☐ ELECTRICAL		☐ CONVEYANCE	
☐ PLUMBING		☐ REFRIGERATION	
☐ GAS PIPING		☐ SITE/SIDE SEWER	
☐ MECHANICAL		☐ SHOP DRAWINGS ON SITE	
☐ SDOT - STREET USE		☐ LANDSCAPING	
☐ SDOT - PRIVATE CONTRACT		☐ LAND USE CONDITIONS	
☐ SFD		☐ COUNCIL ORDINANCE	
☐ OTHER -		☐ OTHER -	

☐ OCCUPANCY APPROVED (NO CERTIFICATE REQUIRED). ☐ PTS PERMIT DO NOT CLEAR

☐ TEMPORARY OCCUPANCY APPROVED, TCO DURATION IN DAYS: ________.

TCO LIMITS: ________.

☐ OK TO ISSUE CERTIFICATE OF OCCUPANCY.

INSPECTOR: [signature] **DATE:** 10/4/07 **PHONE:**

Appendix D

Manufacturer Specifications and O&M Forms

cincinnati fan

Form: OMM-01-0207
Effective: 2/12/07
Part No.: 01218

Installation, Safety, Operation & Maintenance Instructions And Parts List
For Models PB, PBS, SPB, LM and LMF.
Arrangement 4 Blowers

BLOWER SPECIFICATIONS

BLOWER SERIAL NUMBER: 708393 **MFG. DATE:** 06/29/07

NOTE: The serial number above is a required reference for any assistance. It is stamped on the blower nameplate.

BLOWER SPECIFICATIONS:

Model: PB-9 **Arrangement:** 4 **Rotation:** CW **Discharge:** UB

Nominal Inlet Size: 5 (in Inches) **Wheel Size and Type:** 10-1/4 X 3 BC

BLOWER PERFORMANCE DATA: (If entered on order)

CFM: 125 **SP:** 6.5 (Inches of Water Gauge) **Motor BHP:** 0.265

Density: 0.075 **Altitude:** ______ (Ft. above S.L.) **Airstream Temperature:** 70 °F.

Fan RPM: 3450 **Maximum Safe Fan RPM:** ______ **DO NOT EXCEED THIS RPM**

MOTOR DATA: (This section is completed only if the motor was supplied by Cincinnati Fan)

HP: 1/3 **RPM:** 3450 **Voltage:** 115/208-230V **Phase:** 1

Hz: 60 **Frame Size:** 56C **Enclosure:** TEFC **Efficiency:** Std Eff

IF Motor is EXP, Class(es) & Group(s) are: ______

Manufacturers Model Number: 3336ES1BB56C **CFV Part Number:** 37107W

ATTENTION: RECEIVING DEPARTMENT

All Cincinnati Fan products are packaged to minimize any damage during shipment. The freight carrier is responsible for delivering all items in their original condition as received from Cincinnati Fan. The individual receiving this equipment is responsible for inspecting this unit for any obvious or concealed damage. If any damage is found, it should be noted on the bill of lading before the freight is accepted and the receiver must file a claim with the freight carrier.

LONG TERM STORAGE NOTICE

If this blower will NOT be installed and put into operation within 30 days, refer to the "Long Term Storage Instructions" on pages 12 and 13. Failure to follow all applicable long term storage instructions, will void your warranty. This blower should be stored in doors in a clean, dry location. If it must be stored outside, refer to the "Long Term Storage Instructions".

⚠ DANGER

Hazardous voltage can cause electrical shock and death.	High speed rotating equipment can cause severe personal injury.	Lock out/Tag out to prevent personal injury BEFORE starting ANY service or inspection.	Avoid injury. NEVER operate without ALL required safety guards in place.	Avoid injury. You MUST read and understand all instructions in this manual BEFORE installing.

TABLE OF CONTENTS

I. GENERAL
- A. Unpacking and Handling 2
- B. Safety Accessories & Instructions 2-3

II. INSTALLATION
- A. Vibration 3
- B. Mounting Methods 3-4
- C. Duct Work Connections 4
- D. Safety Guards 4
- E. Dampers and Valves 4
- F. Set Screw & Taper-lock Bushing Torque Values 5

III. ELECTRICAL
- A. Disconnect Switches 5
- B. Motors 5-6
- C. Maximum Blower Speed 6

IV. INITIAL UNIT STARTUP
- A. Pre-Startup & Post-Startup Checks 7
- B. Vibration 8-9

V. ROUTINE INSPECTION & MAINTENANCE 9
- A. Hardware 10
- B. Motor Bearing Lubrication 10
- C. Wheel Balance 10
- D. Vibration 10
- E. Dampers and Valves 10
- F. Safety Equipment or Accessories 10-11

VI. ORDERING PARTS 11

VII. TROUBLESHOOTING 11-12

VIII. LONG TERM STORAGE 12-13

IX. WARRANTY, LIABILITY & RETURNS 14

X. PARTS DRAWING 15

I. GENERAL

A. Unpacking:

Be careful not to damage or deform any parts of the blower when removing it from the packaging container. **All the packaging material should be kept in the event the blower needs to be returned.**

Handling:

Handling of the blower should be performed by trained personnel and be consistent with all safe handling practices. Verify that all lifting equipment is in good operating condition and has the proper lifting capacity. The blower should be lifted using well-padded chains, cables or lifting straps with spreader bars. Some blower models have lifting eye locations provided in the blower base. **NEVER lift the blower by an inlet or discharge flange, motor shaft, motor eye bolt, or any other part of the blower assembly that could cause distortion of the blower assembly.**

B. Safety Instructions & Accessories:

1. **Safety Instructions:**
   All installers, operators and maintenance personnel should read AMCA Publication 410-96, **"Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans"**. This manual is included with the blower. Additional copies can be requested by writing us at Cincinnati Fan, 7697 Snider Rd., Mason, OH 45040-9135
2. **Sound:**
   Some blowers can generate sound that could be hazardous to personnel. It is the responsibility of the user to measure the sound levels of the blower and/or system, determine the degree of personnel exposure, and comply with all applicable safety laws and requirements to protect personnel from excessive noise.

3. **Air Pressure and Suction:**

In addition to the normal dangers of rotating machinery, the blower can present additional hazards from the suction or pressure created at the blower inlet or discharge. Suction at the blower inlet can draw materials into the blower where they become high velocity projectiles at the discharge and cause severe personal injury or death. It can also be extremely dangerous to persons in close proximity to the inlet or discharge as the forces involved can overcome the strength of most individuals.

⚠ WARNING

NEVER OPERATE A BLOWER WITH A NON-DUCTED INLET AND/OR DISCHARGE. IF THE BLOWER INLET AND/OR DISCHARGE IS NON-DUCTED, IT IS THE USERS RESPONSIBILITY TO INSTALL AN INLET AND/OR DISCHARGE GUARD.

4. **Temperature:**

Many blowers, blower components and all motors operate at temperatures that could burn someone if they come in contact with them. If this potential hazard could exist in your installation, steps must be taken by the user to protect anyone from coming in contact with this equipment.

5. **Spark Resistance;** (Per AMCA Standard 99-0401-86 and ISO 13499)

⚠ DANGER

NO GUARANTEE OF ANY LEVEL OF SPARK RESISTANCE IS IMPLIED BY SPARK RESISTANT CONSTRUCTION. IT HAS BEEN DEMONSTRATED THAT ALUMINUM IMPELLERS RUBBING ON RUSTY STEEL CAN CAUSE HIGH INTENSITY SPARKS. AIR STREAM MATERIAL AND DEBRIS OR OTHER SYSTEM FACTORS CAN ALSO CAUSE SPARKS.

6. **Safety Accessories;**

Guards:

All moving parts must be guarded to protect personnel. Safety requirements can vary, so the number and types of guards required to meet company, local, state and OSHA regulations must be determined and specified by the actual user or operator of the equipment.

NEVER start any blower without having all required safety guards properly installed. All blowers should be checked on a regular schedule, for missing or damaged guards. If any required guards are found to be missing or defective, the power to the blower should be immediately turned off and locked out in accordance with OSHA regulations. Power to the blower should NOT be tuned back on until the required guards have been repaired or replaced.

This blower can become dangerous due to a potential "windmill" effect, even though all electrical power has been turned off or disconnected. The blower wheel should be carefully secured to prevent any rotational turning ***BEFORE*** working on any parts of the blower/motor assembly that could move.

7. **Access or Inspection Doors:**

⚠ DANGER

NEVER OPEN ANY ACCESS OR INSPECTION DOORS WHILE THE BLOWER IS OPERATING. SERIOUS INJURY OR DEATH COULD RESULT FROM THE AFFECTS OF AIR PRESSURE, AIR SUCTION OR MATERIAL THAT IS BEING CONVEYED. DISCONNECT OR LOCK OUT POWER TO THE BLOWER AND LET THE BLOWER WHEEL COME TO A COMPLETE STOP *BEFORE* OPENING ANY TYPE OF ACCESS OR INSPECTION DOOR.

II. INSTALLATION

A. Vibration:

Before any mounting method is selected, the user should be aware of the effects vibration will have on the blower, motor and other parts. Improper blower installation can cause excessive vibration causing premature wheel and/or motor bearing failure, that is not covered under warranty. Vibration eliminator pads, springs or bases should be properly installed to prevent any blower vibration from transmitting to the foundation, support structure or ducting.

⚠ WARNING

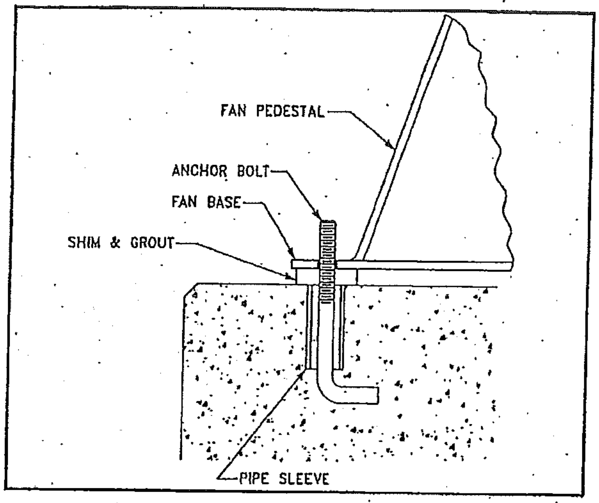
SHUT THE BLOWER DOWN IMMEDIATELY IF THERE IS ANY SUDDEN INCREASE IN VIBRATION.

B. Mounting Methods:

1. **Floor Mounted Units;**

Centrifugal blowers should be mounted on a flat, level, concrete foundation weighing 2-3 times the weight of the complete blower/motor assembly. It is recommended that the foundation be at least 6 inches larger than the base of the blower. The foundation should include anchor bolts such as shown in **Fig. 1** on page 4. Place the blower over the anchor bolts and shim under each bolt until the blower is level. After shimming, flat washers, lock washers and lock nuts should be tightened at each anchor bolt. Any gaps between the blower base and the foundation should be grouted. If the blower will be sitting on some type of vibration pads or mounts, follow the recommended mounting procedures supplied with the vibration elimination equipment.

Fig. 1



2. Elevated Units;

Improper mounting of elevated blowers can cause vibration problems. The structure that the blower/motor assembly will be mounted on must be strong enough to support at least 3 times the weight of the entire blower/motor assembly. **An insufficient support will cause excessive vibration and lead to premature wheel and/or motor bearing failure.** Bracing of the support structure must be sufficient enough to prevent any side sway. The entire structure should be welded at all connection joints to maintain constant alignment of the platform.

⚠ DANGER

THE IMPROPER DESIGN OF AN ELEVATED PLATFORM STRUCTURE COULD RESULT IN A RESONANT CONDITION, AND CONSEQUENTLY, CAUSE A LIFE THREATENING, CATASTROPHIC, STRUCTURAL FAILURE.

C. Duct Work Connections:

All duct connections to the blower should include flexible connectors between the ducting and the blower inlet and/or discharge. This will eliminate distortion, noise and vibration from transmitting to the duct and building. The connectors should be selected to handle the operating conditions for air volume and pressure that the blower will produce. **All ducting or accessories, added by the user, should be independently supported. DO NOT use the blower/motor assembly to support any additional weight.** Inlet and/or discharge duct elbows should be located a minimum of 2 blower wheel diameters from the blower. Any duct elbows located closer than 2 wheel diameters to the blower inlet or discharge **WILL** reduce the air performance and blower efficiency. Any duct elbows near the blower discharge should be in the **same rotational direction** as the **blower rotation.**

Non-Ducted Blower Inlet:

Any blower with no ducting on the inlet **must** have an inlet guard. The blower should be located so the blower inlet is, at least, 1 wheel diameter away from any wall or bulkhead to eliminate a reduction in air flow.

Non-Ducted Blower Discharge:

Any blower with no ducting on the discharge **must** have a discharge guard.

D. Safety Guards:

Cincinnati Fan offers guards, as optional, to keep your blower in compliance with OSHA safety regulations. These include inlet or discharge guards. Any blowers built with high temperature construction, a "heat slinger guard" is standard. It is the responsibility of the user to make sure this blower meets all local, state and OSHA safety regulations. If you have a specific guard requirement not covered by OSHA, please contact the local Cincinnati Fan sales office for assistance.

E. Dampers and Valves: (Airflow control devices)

If the blower is supplied with any type of air flow control device, it should be closed before initial start-up of the blower to minimize overloading of the motor. Any airflow control device, with bearings, should be maintained in accordance with the manufacturers instructions. Any air flow control device, with an automatic control mechanism, should be adjusted per the manufacturers recommendations.

F. Set Screw and Taper-lock Bushing Torque Values:

All blower wheel set screws are tightened to the proper torque prior to shipment. Some wheels may have taper-lock hubs and split, taper-lock bushings to secure the wheel to the motor shaft.

NOTE: Check all set screw or taper-lock bushing torques. Forces encountered during shipment, handling, rigging and temperature can affect factory settings. For correct torque values, see **Tables 1 and 2** below.

Table 1

SET SCREW TORQUE VALUES		
Diameter & Number of Treads/Inch	Hex Wrence Size (Across Flats)	Required Torque (Inch Pounds)
1/4-20	1/8"	65
5/16-18	5/32"	165
3/8-16	3/16"	228
7/16-14	7/32"	348
1/2-13	1/4"	504
5/8-11	5/16"	1104

Table 2

TORQUE VALUES FOR TAPER-LOCK BUSHINGS	
Taper-lock Bushing Size	Required Torque (Inch Pounds)
H	95
B	192
P	192
Q	350
R	350

⚠ CAUTION

Set screws should <u>NEVER</u> be used more than once. If the set screws are loosened, they MUST be replaced. Use only knurled, cup-point, set screws with a nylon locking patch.

III. ELECTRICAL

A. Disconnect Switches:

All blower motors should have an independent disconnect switch located in close visual proximity to turn off the electrical service to the blower motor. **Disconnects must be locked out in accordance with OSHA "lock out-tag out" procedures any time inspection or maintenance is being performed on the blower and/or motor assembly. The "lock out-tag out" procedure should be performed by a licensed electrician or authorized personnel.** All disconnects should be sized in accordance with the latest NEC codes (National Electric Codes) and any local codes and should be installed only by a licensed electrician. "Slow blow" or "time delay" fuses or breakers should be used since the initial start-up time for the blower motor, although rare, can be up to 10 seconds.

B. Motors:

⚠ DANGER

ALL WIRING CONNECTIONS, INSPECTION AND MAINTENANCE OF ANY MOTOR MUST BE PERFORMED BY A LICENSED ELECTRICIAN IN ACCORDANCE WITH THE MOTOR MANUFACTURERS RECOMMENDATIONS, ALL ELECTRICAL CODES AND OSHA REGULATIONS. FAILURE TO PROPERLY INSTALL, MAKE WIRING CONNECTIONS, INSPECT OR PERFORM ANY MAINTENANCE TO A MOTOR CAN RESULT IN MOTOR FAILURE, PROPERTY DAMAGE, EXPLOSION, ELECTRICAL SHOCK AND DEATH.

1. **<u>DO NOT</u> connect or operate a motor without reading the motor manufacturers instructions supplied with the blower.** The basic principle of motor maintenance is: **KEEP THE MOTOR CLEAN AND DRY.** This requires periodic inspections of the motor. The frequency of the inspections depends on the type of motor, the service and environment it will be subjected to and the motor manufacturers instructions.
2. **Cleaning:** Cleaning should be limited to exterior surfaces only. **Follow motor manufacturers cleaning instructions.**
3. **Lubrication:** Most small motors have sealed bearings that are permanently lubricated for the life of the motor. Some larger motors have grease plugs that should be replaced with grease fittings to perform re-lubrication. These motors, or any motor with grease fittings, should be lubricated in accordance with the motor manufacturers recommendations. Lubrication frequency depends on the motor horsepower, speed and service. **BE SURE** you use compatible grease and **DO NOT** over grease.
4. **Location:** If the motor will be outside and subjected to the weather, it is recommended that a weather cover be installed to keep rain and snow off of the motor. No motors are guaranteed to be "watertight". Be careful to allow enough openings between the motor and the motor cover to let the motor "breath". If the back end of the motor is covered, the cover should be no closer than 3" to the back of the motor for proper ventilation.

5. **Wiring Connections:** All wiring connections should be made for the proper voltage and phase as shown on the motor nameplate. Connections should follow the motor manufacturers recommendations as shown on the wiring schematic. This wiring diagram will be located on the outside of the motor, inside of the motor conduit box or on the motor nameplate. **Reversing some wires might be necessary to get the correct blower rotation.**
6. **Motors with Thermal Overload Protection:** If a motor is equipped with thermal overloads, the thermal overload must be wired per the wiring schematic to be operable. ***There are 3 types of thermal overloads:***
   - **a. Automatic:** These will automatically shut the motor down if the internal temperature exceeds the design limits.

⚠ DANGER

MAKE SURE YOU LOCK OUT THE POWER TO THE MOTOR BEFORE INSPECTING ANY MOTOR WITH AUTOMATIC THERMALS. WHEN THE THERMALS COOL DOWN, THEY WILL ALLOW THE MOTOR TO AUTOMATICALLY START UP AGAIN, UNLESS YOU HAVE LOCKED OUT THE POWER TO THE MOTOR.

   - **b. Manual:** These motors will have a button on them. If the motor overheats, it will shut down. After you have inspected the motor and eliminated the over heating problem, you will need to "reset" it by pushing the button. **You should still lock out the power BEFORE inspecting the motor.**
   - **c. Thermostats:** This type of thermal is a temperature sensing device **ONLY.** If the motor overheats, the thermostats will open or close (depending on the type) and send a **"signal"** to the electrical box. ***THEY WILL NOT TURN THE MOTOR OFF.*** **These are pilot circuit devices that must be connected to the magnetic starter circuit.**
7. **EXPLOSION PROOF Motors:** No motor is explosion proof. Explosion proof (EXP) motors are designed so if there is an explosion **WITHIN** the motor, the explosion will be **CONTAINED INSIDE** the motor and not allowed to get out to the atmosphere. All explosion proof motors must be selected based on the atmosphere and/or the environment the motor will be operating in. Explosion proof motors are designed, rated, and labeled for their operating conditions based on Classes, Groups and "T" Codes. **The Class, Group and "T" Code of an EXP motor MUST be selected based on the atmosphere and/or environmental conditions the motor will be operating in. Consult the NEC (National Electric Code) and the NFPA (National Fire Protection Association) for the proper EXP motor Class, Group and "T" Code required for your specific application and location.**

⚠ DANGER

IF AN EXPLOSION PROOF MOTOR IS USED IN AN AREA CONTAINING VOLITILE LIQUIDS, GASES, FUMES OR DUST FOR WHICH THE MOTOR WAS NOT DESIGNED TO OPERATE IN, AN EXPLOSION AND/OR FIRE CAN OCCUR.

NOTICE:
   - **a. All EXP motors have some type of thermal overload as required by UL (Underwriters Laboratories). Refer to all of Section 6 above.**
   - **b. All EXP motors are required to have the UL (Underwriters Laboratories) and CSA (Canadian Standards Association) listing numbers on the motor name plate or on a separate plate attached to the motor. The Class, Group and "T" Code the motor is designed for must also be listed.**

8. **Normal Motor Operating Temperatures:**
   Using your hand to test the normal running temperature of a motor can be a very painful experience;
   - **The normal operating temperature of a fully loaded, open type, electric motor operating in a 70°F. (21° C.) ambient temperature is 174°F. (79° C.)**

C. Maximum Blower Speed and Motor Speed Controllers:

If you will be using any type of motor speed controller with this blower, **DO NOT** exceed the **maximum safe blower speed.** Installing and using a speed control devise requires special training and certification as required by the speed control manufacturer. See the manufacturers instructions for proper use, installation and wiring connections for the maximum speed settings. It may also be necessary to "block out" some speeds to eliminate a resonant vibration problem. The maximum safe blower speed is shown on the data sheet shipped with the blower. If you have lost the data sheet, contact Cincinnati Fan or our sales office for your area. You must have the serial number from the blower name plate for us to determine the maximum safe blower speed. Cincinnati Fan will only extend the motor manufacturers warranty, when used with a speed controlling devise, if the motor has the words **"Inverter Duty"** marked on the motor name plate. If the motor does not have **"Inverter Duty"** marked on the motor name plate, and you have a motor failure, you will be required to contact the motor manufacturer for any service or warranty claims.

IV. INITIAL UNIT STARTUP

NOTICE: Failure to complete and document all the following pre-startup and both post-startup checks, listed in sections A (below) and B on page 8, could void all warranties.

A. Pre-Startup & Post-Startup Checks: (Check blocks as each step is completed. Retain this for your records.)

A1. Pre-Startup Checks Completed By: ______________________ **DATE:** __________

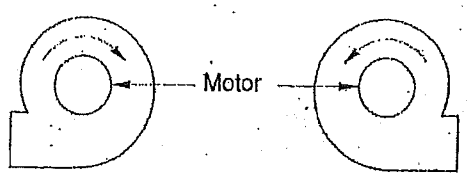
A2. 8 Hour, Post-Startup Checks Completed By: ______________________ **DATE:** __________

A3. 3 Day, Post-Startup Checks Completed By: ______________________ **DATE:** __________

MAKE SURE POWER TO THE MOTOR IS LOCKED OUT BEFORE STARTING PRE-STARTUP OR POST-STARTUP CHECKS.

1. ☐☐☐ If possible, *CAREFULLY* spin the blower wheel by hand to ensure it rotates freely and no rubbing or clicking noise is heard.
2. ☐☐☐ Check all blower, foundation and duct work hardware to make sure it is tight.
3. ☐☐☐ Check all blower wheel set screws to make sure they are tight per **Table 1** on page 5.
4. ☐☐☐ If the wheel has a taper-lock bushing, make sure the bolts are tightened per **Table 2** on page 5.
5. ☐☐☐ Make certain there is no foreign material in the blower or duct work that can become a projectile.
6. ☐☐☐ Make sure any inspection doors in the duct work are securely bolted or locked.
7. ☐☐☐ Ensure all electrical power components are properly sized and matched for your electrical system.
8. ☐☐☐ Check that all required guards are properly secured.
9. ☐☐☐ Any dampers should be fully opened and closed to make sure there is no binding or interference.
10. ☐☐☐ If your blower is mounted on an elevated support structure, make sure the structure is welded at all the joint connections and the structure is properly braced to prevent "side sway".
11. ☐☐☐ Close any dampers to minimize load on motor. Especially on blowers with high temperature construction. **Never** subject a "cold" blower to a "hot" gas stream. If the blower will be handling "hot gases" greater than 150°F (65°C) it is imperative that the blower be subjected to a gradual rate of temperature increase, not to exceed 15°F/minute (8°C/minute). The same temperature limits are also important when the blower is experiencing a drop in temperature until the temperature drops down to 150°F (65°C). Only, when the <u>entire</u> blower has reached an equilibrium temperature of 150°F (65°C), or less, should the power be turned off.
12. ☐☐☐ Make sure the power source connections to the blower motor are per the motor manufacturers instructions.
13. ☐☐☐ Make sure the blower wheel is stationary prior to startup. **Starting a blower with a wheel that is rotating backwards can cause wheel damage.**
14. ☐☐☐ Apply power to the blower motor momentarily (i.e. "bump start") to check for proper blower wheel rotation. If the blower is rotating in the wrong direction, reconnect the motor leads per the motor manufacturers wiring schematic. **Blower rotation is determined by viewing the blower from the <u>motor side</u> of the blower, NOT from the inlet side.** After reconnecting the leads, repeat this step. **See Fig. 2 below.**

Fig. 2



Clockwise (CW) Rotation **Counter-Clockwise (CCW) Rotation**

15. ☐☐☐ Apply power to the blower motor and let it come up to full speed. **Turn off the power.** Look and listen for any unusual noise or mechanical abnormality while the blower wheel is still spinning. If any are noticed, lock out the power, wait for the blower wheel to come to a complete stop, locate the cause and correct it.
16. ☐☐☐ Unlock power and start the blower.
17. ☐☐☐ Measure, record and keep the following motor data for future reference and comparison:
(Single phase motors will only have L1 and L2 leads)

Amperage draw on each motor lead: L1 _______ **L2** _______ **L3** _______
(<u>Running</u> amps **SHOULD NOT** exceed the motor nameplate amps for the voltage being operated on)

Voltage coming to motor leads: L1_______ **L2**_______ **L3**_______
(Should be <u>about</u> the same input voltage on <u>all</u> leads)

B. Vibration:

The blower was balanced at the factory to comply with ANSI/AMCA Standard 204-05, Category BV-2. However, rough handling in shipment and/or erection, weak and/or non-rigid foundations, and misalignment may cause a vibration problem after installation. After installation, the vibration levels should be checked by personnel experienced with vibration analysis and vibration analysis equipment.

NOTE:

The blower SHOULD NOT be operated if the vibration velocity of the fan exceeds 0.50 inches per second, filter out, if the blower is rigidly mounted. If the blower is mounted on isolators or on an isolator base, it SHOULD NOT be operated if the vibration velocity of the blower exceeds 0.75 inches per second, filter out.

Vibration readings for direct driven blowers should be taken on the motor at the top, sides and end as per **Fig. 3** below. After you have taken your vibration readings, write them down in the spaces below and keep for future comparison.

⚠ DANGER

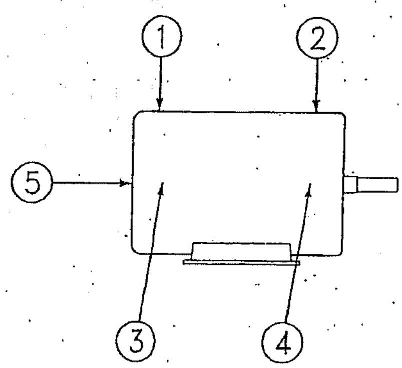
If the blower is going to be conveying material, it is the users responsibility to periodically turn the blower off and lock out the power. The blower wheel should then be checked for material build-up and/or erosion. If material has built up on any parts of the wheel, it MUST be removed and cleaned before it is put back into service. If any parts of the wheel have been eroded, the wheel MUST be replaced. Failure to perform this inspection can cause excessive vibration that will damage the blower and/or motor bearings. When vibration becomes excessive, it will lead to complete blower failure that could cause property damage, severe personal injury and death. The user must determine the frequency of this inspection based on the actual circumstances of their operation, BUT checking the vibration readings should NEVER exceed a 12 month period. For the AMCA/ANSI standard for vibration limits, see Fig. 4 on page 9.

Fig. 3

VIBRATION METER PROBE POSITIONS

For Arrangement 4 Blowers

	1	2	3	4	5
A					
B					
C					

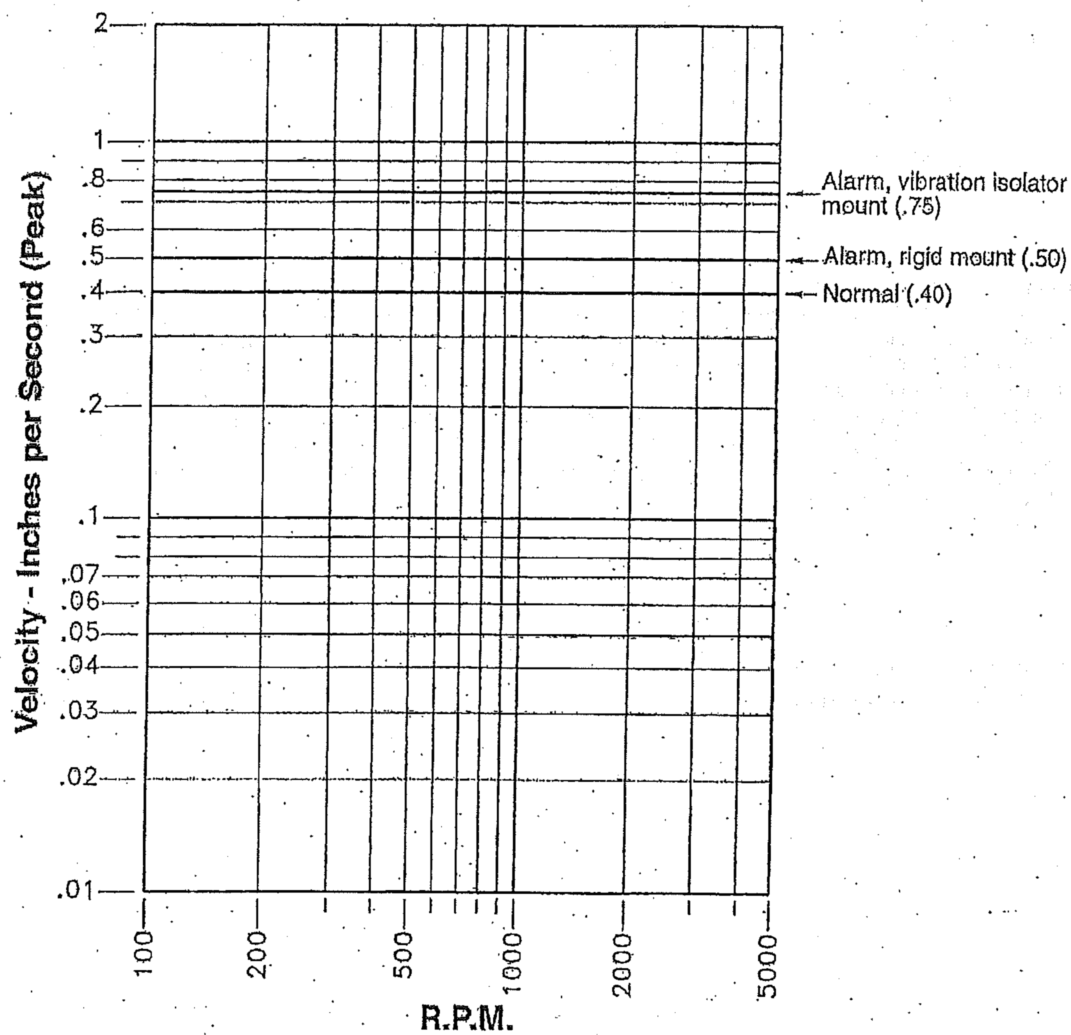


A Pre-Startup .... Readings taken by: ______________________ Date: ____________

B 8 Hour Post-Startup .... Readings taken by: ______________________ Date: ____________

C 3 Day Post-Startup .... Readings taken by: ______________________ Date: ____________

Fig. 4 Vibration Severity Chart



V. ROUTINE INSPECTION & MAINTENANCE

Periodic inspection of all the blower parts is the key to good maintenance and trouble-free operation. The frequency of inspections must be determined by the user and is dependent upon the severity of the application. **BUT**, it should **NEVER** exceed a 12 month period. The user should prepare an inspection and maintenance schedule and make sure it is adhered to.

⚠ WARNING

BEFORE STARTING ANY INSPECTION OR MAINTENANCE, BE SURE BLOWER IS TURNED OFF, POWER IS LOCKED OUT AND THE BLOWER WHEEL HAS BEEN CAREFULLY SECURED TO PREVENT WIND MILLING. IF THE OPERATING CONDITIONS OF THE BLOWER ARE TO BE CHANGED (SPEED, PRESSURE, TEMPERATURE, ETC.) CONSULT CINCINNATI FAN, OR OUR SALES OFFICE FOR YOUR TERRITORY, TO DETERMINE IF THE UNIT WILL OPERATE SAFELY AT THE NEW CONDITIONS.

A. Hardware:

All blower and foundation hardware should be checked to make sure it is tight. Wheel set screws or taper-lock bushings should be tightened to the torque values shown in **Tables 1 and 2** on page 5.

NOTE: If any set screws have come loose, they must be thrown away and replaced. <u>NEVER</u> use set screws more than once. **Replace with knurled, cup-point set screws with a nylon locking patch.**

B. Motor Bearing Lubrication:

1. Motor Bearings:

Most smaller motors have sealed bearings that never require re-lubrication for the life of the motor. For any motors <u>with</u> grease fittings, consult the motor manufacturers recommendations with reference to the lubrication frequency <u>and</u> the type of grease that should be used.

DO NOT over grease the motor bearings. Generally, 1-2 shots should be enough. Use a hand operated grease gun at no more than 40 PSI. ***IF POSSIBLE, <u>CAREFULLY</u>* lubricate the motor bearings while the motor is running.**

C. Wheel Balance:

All blower wheels are balanced at the factory. It is not uncommon that additional "trim balancing" is required after the blower is assembled. Trim balancing of the blower assembly, in the field, is typically <u>always</u> necessary for all replacement wheels. **After any wheel is installed, the final balance of the entire blower assembly should be checked.** Refer to Section B on page 8 and Fig. 4 on page 9. Air stream material or chemicals can cause abrasion or corrosion of the blower parts. This wear is generally uneven and, over time, will lead to the wheel becoming unbalanced, causing excessive vibration. When that happens, the wheel must be rebalanced or replaced. The other air stream components should also be inspected for wear or structural damage and cleaned or replaced if necessary. **After cleaning any blower wheel, it should be balanced and then "trim balanced" <u>on the motor shaft</u>.**

There are three ways to balance a blower wheel:

1. Add balancing weights for <u>fabricated</u> aluminum, steel or stainless steel wheels:
Balance weights should be rigidly attached to the wheel at a location that will not interfere with the blower housing nor disrupt air flow. They should (if at all possible) be welded to the wheel. When trim balancing the wheel, **on the blower,** be sure to ground the welder **directly** to the blower wheel. Otherwise, the welding current will likely pass through the motor and damage the motor bearings.

2. Grinding off material for <u>cast</u> aluminum wheels:
If you are grinding on the wheel to remove material, be very careful not to grind too much in one area. That could affect the structural integrity of the wheel.

3. Forward curved wheels, Model LM only (also known as squirrel cage or multivane wheels).
These wheels have balancing clips attached to individual blades around the wheel. That is the only proper way to balance this type of wheel.

<u>NOTE</u>:
Removing any forward curve wheel from the blower to clean it, requires special attention when reinstalling the wheel back into the blower housing. Make sure you reinstall the wheel so the proper wheel-to-inlet clearance is maintained. Failure to do this will affect the blowers airflow (CFM), static pressure (SP) capabilities and efficiency. Consult Cincinnati Fan or our local sales office for your area for assistance if necessary.

D. Vibration:

As mentioned previously in this manual, excessive vibration can cause premature motor bearing failure that could lead to catastrophic failure of the blower. After performing any routine maintenance, the vibration readings should be taken again. New readings should be taken (maximum every 12 months) and compared to the readings you recorded in Figure 3, on page 8, during the initial startup. **If any major differences are present, the cause should be determined and corrected before the blower is put back into operation.**

The most common causes of vibration problems are:

1. Wheel unbalance.
2. Mechanical looseness.
3. Poor blower inlet and/or discharge conditions.
4. Foundation stiffness.

E. Dampers and Valves: (Airflow control devices)

Turn off and lock out power to the blower motor. Any dampers or valves should be periodically inspected to make sure all parts are still operable within their full range and there is no interference with any other damper or blower components. Any bearings or seals should be checked for their proper function. The manufacturers maintenance instructions should be followed.

F. Safety Equipment & Accessories:

It is the users responsibility to make sure that all safety guards required by the company, local, state and OSHA regulations are properly attached and fully functional at all times. If any guards become defective or non-functional at any time, **the power to the blower <u>MUST</u> be turned off and locked out** until complete repairs and/or replacements have been made, installed and inspected by authorized personnel.

Any accessories used in conjunction with the blower should also be inspected to make sure they are functioning within their intended limits and design specifications. The manufacturers maintenance manuals should be referred to for correct maintenance procedures. These accessories include, but are not limited to, the following:
Shaft seals, inspection doors, vibration isolators or vibration bases, air flow or pressure measuring equipment, hoods, controls, special coatings, silencers, expansion joints, valves, flexible connectors and filters.

VI. ORDERING REPLACEMENT PARTS:

Under normal conditions, you should not need any spare or replacement parts for at least 24 months after shipment from Cincinnati Fan. That does not include any wear due to abrasion, corrosion, excessive temperatures, abuse, misuse, accident or any severe conditions the fan was not designed for.

NOTICE:

1. **If this blower is vital to any process that could cost you lost revenue, we strongly recommend that you keep a replacement blower wheel and motor at your location.**
2. **If this blower is vital for the safety of any people and/or animals, we strongly recommend that you keep a complete blower/motor assembly, as originally ordered, at your location.**

To order any parts or complete units, contact us for the name of our sales office for your area. Or you can find them on our website at: **www.cincinnatifan.com**

WE MUST HAVE THE BLOWER SERIAL NUMBER FROM THE BLOWER NAME PLATE TO IDENTIFY PARTS CORRECTLY.

VII. TROUBLESHOOTING

⚠ DANGER

Troubleshooting should only be performed by trained personnel. Any potential electrical problems should only be checked by a licensed electrician. All safety rules, regulations and procedures MUST be followed. Failure to follow proper procedures can cause property damage, severe bodily injury and death.

Potential problems and causes listed below are in no order of importance or priority. The causes are only a list of the most common items to check to correct a problem. If you find the cause of a problem, **DO NOT** assume it is the **ONLY** cause of that problem. Different problems can have the same causes.

PROBLEM	CAUSE
Excessive Vibration	1. Loose mounting bolts, wheel set screws, taper-lock hubs. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Bent motor shaft. 5. Worn motor bearings. 6. Motor out of balance. 7. Inadequate structural support. 8. Support structure not sufficiently cross braced. 9. Weak or resonant foundation. 10. Foundation not flat and level.
Airflow (CFM) Too Low	1. Blower wheel turning in wrong direction (**rotation**). 2. Actual system static pressure (**SP**) is higher than expected. 3. Motor speed (**RPM**) too low. 4. Dampers or valves not adjusted properly. 5. Leaks or obstructions in duct work. 6. Filters dirty. 7. Inlet and/or discharge guards are clogged. 8. Duct elbow too close to blower inlet and/or discharge. 9. Improperly designed duct work 10. Blower wheel not properly located relative to the inlet bell (LM Model only).
Airflow (CFM) Too High	1. Actual system static pressure (SP) is lower than expected. 2. Motor speed (RPM) too high. 3. Filter not in place. 4. Dampers or valves not adjusted properly.

PROBLEM	CAUSE
Motor Overheating	**NOTE: A normal motor will operate at 174°F. See B-8 on page 6.** 1. Actual system static pressure (**SP**) is lower than expected. 2. Voltage supplied to motor is too high or too low. 3. Motor speed (**RPM**) too high or defective motor. 4. Air density higher than expected. 5. Motor wired incorrectly or loose wiring connections. 6. Cooling fan cover on back of motor is clogged. (Fan cooled motors only.)
Excessive Noise	1. Wheel rubbing inside of housing. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Loose mounting bolts, wheel set screws, or taper-lock hubs. 5. Bent motor shaft. 6. Worn motor bearings. 7. Motor out of balance. 8. Motor bearings need lubrication. 9. Vibration originating elsewhere in system. 10. System resonance or pulsation. 11. Inadequate or faulty design of blower support structure. 12. Blower operating near "stall" condition due to incorrect system design or installation.
Fan Doesn't Operate	1. Motor wired incorrectly. 2. Incorrect voltage supply. 3. Defective fuses or circuit breakers. 4. Power turned off elsewhere. 5. Motor wired incorrectly or loose wiring connections. 6. Defective motor.

VIII. LONG TERM STORAGE INSTRUCTIONS: (Storage exceeding 30 days after receipt of equipment)

NOTE: Failure to adhere to these instructions voids all warranties in their entirety.

1. Storage site selection:
   a. Level, well-drained, firm surface, in clean, dry and warm location. Minimum temperature of 50°F (10°C).
   b. Isolated from possibility of physical damage from construction vehicles, erection equipment, etc.
   c. Accessible for periodical inspection and maintenance.
2. The blower should be supported under each corner of its base to allow it to "breath". Supports (2 x 4's, timbers, or railroad ties) should be placed diagonally under each corner.
3. If the equipment is to be stored for more than three (3) months, the entire blower assembly must be loosely covered with plastic, **but not tightly wrapped.**
4. Storage Maintenance:

   A periodic inspection and maintenance log, by date and action taken, must be developed and maintained for each blower. See example below. Each item must be checked monthly.

EXAMPLE:

Storage / Maintenance Schedule Log

ITEM	ACTION	DATES CHECKED
1	Re-inspect units to insure any protective devices used are functioning properly. Check for scratches in the finish which will allow corrosion or rust to form.	
2	Rotate wheel a minimum of 10 full revolutions to keep the motor bearing grease from separating and drying out. *This is a critical step.*	

Long Term Storage instructions continued on page 13.

5. General Motor Procedure:

If the motor is not put into service immediately, the motor must be stored in a clean, dry, warm location. Minimum temperature of 50°F. (10°C,). Several precautionary steps must be performed to avoid motor damage during storage.

a. Use a "Megger" each month to ensure that integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
b. **DO NOT** lubricate the motor bearings during storage. Motor bearings are packed with grease at the factory.
c. If the storage location is damp or humid, the motor windings **must** be protected from moisture. This can be done by applying power to the motor's space heaters, (IF AVAILABLE) while the motor is in storage. If the motor does not have space heaters, storing it in a damp or humid location will, very quickly, cause internal corrosion and motor failure which is not warranted.

NOTE:

For specific storage instructions, for the <u>actual</u> motor and any accessory parts that were supplied, refer to the manufacturer's instructions for the motor and other accessory items that were shipped with the blower.

IX. LIMITED WARRANTY:

Cincinnati Fan & Ventilator Company (Seller) warrants products of its own manufacture, against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation, whichever occurs first. This warranty does not apply to any of Seller's products or any part thereof which has been subject to extraordinary wear and tear, improper installation, accident, abuse, misuse, overloading, negligence or alteration. This warranty does not cover systems or materials not of Seller's manufacture. On products furnished by Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller received from the manufacturer thereof. Expenses incurred by Purchaser's in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of the Seller under this warranty shall be limited to repairing or replacing F.O.B. the Seller's plant, or allowing credit at Seller's option. **THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EITHER EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF THE SELLER. THE PURCHASER ACKNOWLEDGES THAT NO OTHER REPRESENTATIONS WERE MADE TO PURCHASER OR RELIED UPON BY PURCHASER WITH RESPECT TO THE QUALITY OR FUNCTION OF THE PRODUCTS HEREIN SOLD.**

Removal of the Sellers nameplate or any generic fan nameplate containing the fan serial number voids all warranties, either written or implied. Failure to complete and document all the pre-startup and post startup checks and perform the suggested routine maintenance checks voids all warranties, either written or implied.

LIMITATION OF LIABILITY:

Notice of any claim, including a claim for defect in material or workmanship, must be given to Seller in writing within 30 days after receipt of the equipment or other products. Seller reserves the right to inspect any alleged defect at Purchaser's facility before any claim can be allowed and before adjustment, credit, allowance replacement or return will be authorized. See **RETURNS** below. Seller's liability with respect to such defects will be limited to the replacement, free of charge, of parts returned at Purchaser's expense F.O.B. Seller's plant and found to be defective by the Seller.

IN NO EVENT WILL SELLER BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, INCLUDING WITHOUT LIMITATION DAMAGES FOR INJURY TO PERSONS OR PROPERTY, LOST PROFITS OR REVENUE, LOST SALES OR LOSS OF USE OF ANY PRODUCT SOLD HEREUNDER. PURCHASER'S SOLE AND EXCLUSIVE REMEDY AGAINST SELLER WILL BE THE REPLACEMENT OF DEFECTIVE PARTS AS PROVIDED HEREIN OR REFUND OF THE PURCHASE PRICE FOR DEFECTIVE PRODUCTS, AT SELLER'S SOLE OPTION. SELLER'S LIABILITY ON ANY CLAIM, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, FOR ANY LOSS OR DAMAGE ARISING OUT OF OR IN CONNECTION WITH PURCHASER'S ORDER OR THE PRODUCTS OR EQUIPMENT PURCHASED HEREUNDER, SHALL IN NO CASE EXCEED THE PURCHASE PRICE OF THE EQUIPMENT GIVING RISE TO THE CLAIM.

RESPONSIBILITY:

It is the understanding of the Seller that Purchaser and/or User will use this equipment in conjunction with additional equipment or accessories to comply with all Federal, State and local regulations. The Seller assumes no responsibility for the Purchaser's or Users compliance with any Federal, State and local regulations.

RETURNS:

Cincinnati Fan & Ventilator Company assumes no responsibility for any material returned to our plant without our permission. An RMA (Return Material Authorization) number must be obtained and clearly shown on the outside of the carton or crate and on a packing slip. Any items returned must be shipped freight prepaid. Failure to comply will result in refusal of the shipment at our receiving department.

DISCLAIMER

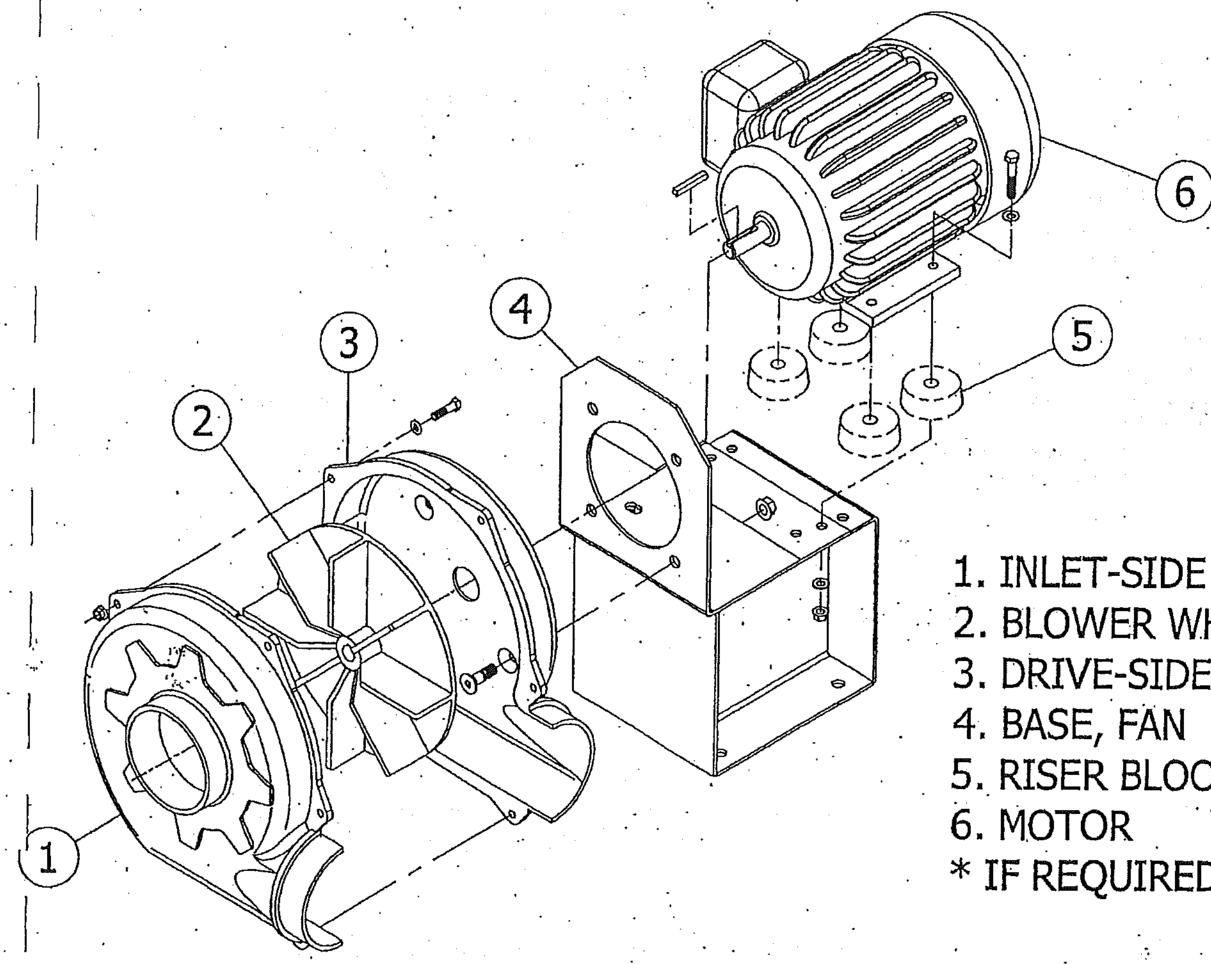
This manual, and all its content herein, is based on all applicable known material at the time this manual was created. Any parts of **this manual are subject to change at any time and without notice.**

If any statements, diagrams and/or instructions contained herein, **for components not manufactured by the Seller,** conflict with instructions in the manufacturer's manual (i.e.: motors, dampers, etc.), the instructions in the manufacturer's manual, for that component take precedent.

Should you want the latest version of this manual, please contact us or our sales office for your area. Or, you can print a current version by going to our website at: **www.cincinnatifan.com**

cincinnati fan

7697 Snider Road, Mason, OH 45040-9135
Phone: (513) 573-0600 Fax: (513) 573-0640
E-Mail: sales@cincinnatifan.com



1. INLET-SIDE HOUSING
2. BLOWER WHEEL
3. DRIVE-SIDE HOUSING
4. BASE, FAN
5. RISER BLOCKS*
6. MOTOR

* IF REQUIRED

PB 2-PIECE ARRANGEMENT 4 ASSEMBLY
(PB-8 TO PB-12A)

The drawing shown above is a representation of the basic model blower or fan purchased on the serial number shown on page 1. It does not include any optional or accessory parts or any special construction features that might have been supplied with the original order.

cincinnati fan OEM and Industrial Air Handling Specialist

FAN SELECTION And PERFORMANCE

Friday, June 08, 2007

Job Name: NORTHWEST COMMERCIAL AIR, INC.
Reference: DOE Seattle Quote: 96373

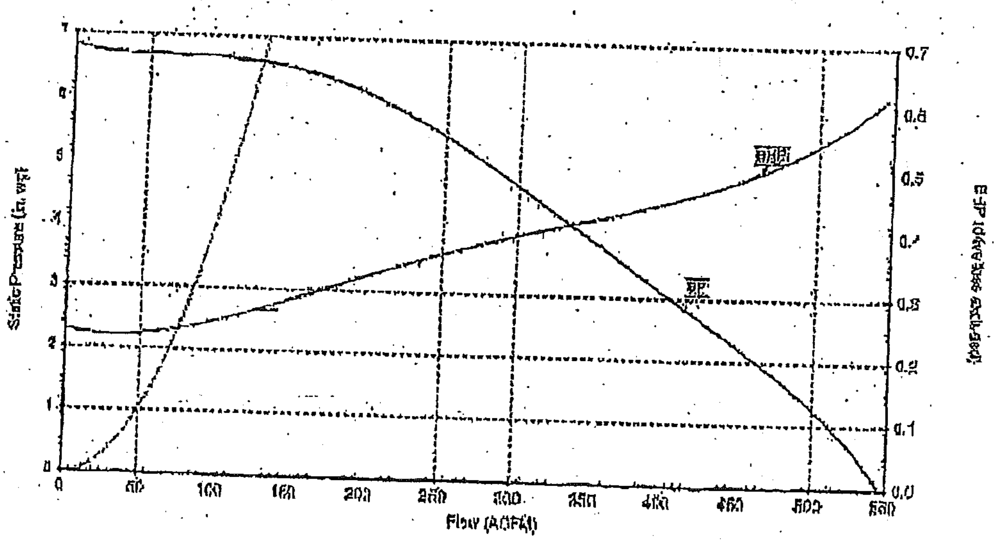
Operating Requirements

Volume, ACFM	125
Static Pressure, in. wg	6.5
Density, lb./ft.³	0.075
Operating Temperature, °F	70
AMCA Arrangement No.	4
Motor Frequency, Hz	60
Start-Up Temperature, °F	70

Fan Selection and Specifications

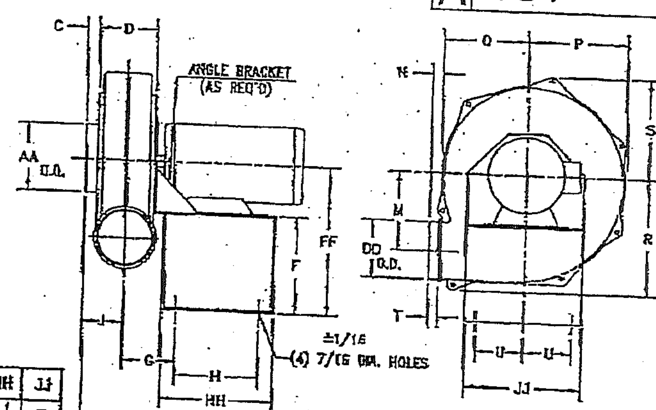
Model	PB-9
Fan RPM	3,450
Wheel Description	Cast Alum, 10-1/4 X 3 BC
Wheel Width, %	100%
Wheel Diameter, in.	10.25
Inlet Diameter, in.	5.00
Outlet Velocity, ft./min.	1,446
Fan BHP	0.27
Static Efficiency, %	49.6%
Cold Start BHP	0.27
Construction Class	N/A

Cincinnati Fan PB-9 Cast Alum. 10-1/4 X 3 BC Wheel (Full Width) @ 3,450 RPM
Rating Point - 125 ACFM @ 6.5 in. wg SP, 0.075 lb./ft.³ Density, 0.27 BHP, 5.0 in. Inlet



CFSWin Version: 7.2.3713.25601
Database Version: 7.2.1

A PB4



CW BOTTOM HORIZONTAL DISCHARGE SHOWN ABOVE

MODEL	FRAME	HOUSING C	D	J	M	N	O	P	R	S	T	AA	DD	F	G	H	U	CC	FF	HH	JJ
PB-8	56	1	3 3/4	2 7/8	4 1/8	1 1/8	4 5/8	5 5/8	7 3/16	4 7/8	1 1/8	4	4	5	3 3/16	5	2 3/4	12 1/8	8 9/16	7 1/8	7
PB-9	56	1 1/16	4 1/8	3 1/8	5 5/8	1 3/16	6 1/8	7 3/8	8 1/2	6 5/8	1	5	4	6 7/8	3 3/8	5 3/4	2 3/4	13 5/16	10 7/16	7 7/8	7
	143T–145T													8 1/4	4 3/16	5	3 1/4	13 15/16	11 7/8	8	9
PB-10A	56	1 1/4	4 1/4	3 3/8	6 9/16	1	6 7/8	9 7/16	10 3/16	7 13/16	1	6	5	6 7/8	3 7/16	5 3/4	2 3/4	13 11/16	10 7/16	7 7/8	7
	143T–145T													8 1/4	4 1/4	5	3 3/4	14 1/8	11 7/8	8	9
PB-12A	56	1 1/4	5	3 3/4	7 9/16	7/8	8	9 5/8	11 11/16	9 7/16	1	7	6	8 1/4	4 1/4	5	3 3/4	14 1/2	11 7/8	8	9
	143T–145T													8 1/4	4 5/8	5	3 3/4	14 7/8		8	9
	182T–184T													6 7/16	5	8 3/4	4 15/16	19		11 3/4	12
PB-14A	56	1 1/4	6	4 1/4	8 1/16	1	8 13/16	10 3/8	12 3/16	10 1/4	1	7	6	8 15/16	5 1/2	8 3/4	4 15/16	20	15 3/16	11 3/4	12
	143T–145T																				
	182T–213T																				
PB-15A	143T–145T	1 1/4	7 1/4	4 7/8	7 7/8	1	9 13/16	11 3/8	13	10 13/16	1	8	8	9 15/16	6 1/8	8 3/4	4 15/16	21 1/4	15 3/16	11 3/4	12
	182T–184T																				
	213T–215T																				
	254T–256T													8 15/16		13		25 1/2		16	16 1/2
PB-18	143T–145T	1 1/4	6 1/4	4 3/8	10 1/2	15/16	10 1/2	12 11/16	14 1/2	12 7/16	1	8	6	9 15/16	5 5/8	8 3/4	4 15/16	20 1/4	15 3/16	11 3/4	12
	182T–184T																				
	213T–215T																				
	254T–256T													8 15/16		13		24 1/2		16	15 1/2
PB-18WA	182T–184T	1 1/4	8 1/16	5 5/16	9 7/8	7/8	11	13 3/16	15 1/8	11 13/16	1	10	6	12 3/4	6 1/2	10 3/4	6 1/4	24 1/16	18	13 3/4	16 1/2
	213T–215T																				
	254T–256T													11 3/4		15 3/4				18 3/4	
	284T–286T													11				29 1/16			

OPTIONAL INLET SIZES

- ☐ 6" INLET AVAILABLE FOR PB-14A, PB-15A & PB-18
- ☐ 7" INLET AVAILABLE FOR PB-15A
- ☐ 8" INLET AVAILABLE FOR PB-14A & PB-18WA
- ☐ 10" INLET AVAILABLE FOR PB-15A & PB-18

NOTES:
1. HOUSINGS ARE ROTATABLE IN 45° INCREMENTS.
2. ALL MODELS: DISCHARGE FLANGE NOT AVAILABLE FOR DOWN BLAST DISCHARGE.

cincinnati fan
7697 SNIDER ROAD MASON, OHIO 45040

TOLERANCES:
ANGLES: ± 1°
FRACTIONS ±1/8

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED

SUPERSEDES:

CERTIFIED DRAWING

TITLE: PB BLOWERS – ARR. 4

A DRAWING NO. PB4

REV. 1

Dwyer®

Flex-Tube® Manometer

Installation & Operating Instructions

1220/1230 Series
U-Tube and Well-Type Manometers

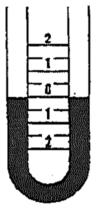


Fig. 1

Vith both ends of the tube pen, the liquid is at the same eight in each leg.

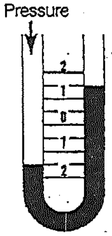


Fig. 2

The difference in height, "h", which is the sum of the readings above and below zero, indicates pressure.

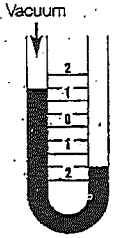


Fig. 3

The difference in height, "h", which is the sum of the readings above and below zero, indicates the amount of vacuum.

Measuring Pressure, Vacuum and Differential Pressure with Dwyer Manometers

Dwyer manometers are available in two different styles. The W/M models use either water for readings in inches of water or mercury for readings in inches of mercury. The D models use Dwyer .826 specific gravity red gage oil for readings in inches of water. The scales on the two styles have different lengths, so it is important to use the correct fluid.

Mounting Dwyer U-Tube Manometers

1221 – Mount to a vertical surface through holes in the scale.

1222 – Attach magnets to steel surface or remove magnets and mount through holes in scale.

1223 – Attach magnets to steel surface or through the hole in safety trap housing.

1227 – Because of angled connections, 1227 must be filled with indicating tube at an angle. After filling, check zero in vertical position.

Note: Read vertical range on the right leg with the manometer vertical. Incline the manometer to zero for low range reading.

Mounting Dwyer Well Manometers

1230 – Mount to a vertical surface with flat-head screws through the holes in the scale.

1235 – Mount behind panel cutout to show only the tube and scale. Attach by drilling holes through the manometer's back-plate and panels. Make the panel cutout for the length and width of the tube and scale.

Filling U-Tube Manometers 1221 – 1222

Open both fittings to atmosphere. Slide scale to mid-point of travel. Add liquid to zero on scale.

Filling 1223 – 1230 and 1235 Manometers

Remove large fitting from well using a 3/4″ open-end wrench. Also remove cork, disc, and O-ring. Be sure the other side is vented to atmosphere. Adjust zero to middle of travel. Add fluid to well up to the zero on scale. Replace cork, disc, and O-ring before replacing fitting. To order red gage oil, order part # A-101 (3/4 oz.) To order fluorescein green color concentrate, order part # A-126 (3/4 oz.)

Operation of 1221, 1222 and 1223 Manometers

Connect either side to pressure or vacuum, leaving the other side open to atmosphere. Add together the readings above and below zero.

It is normal for the two sides to have different readings and has no effect on accuracy. For differential pressure, connect both the high and low fittings. Add the readings above and below zero on the scale.

Operation of 1230 and1235 Manometers

Positive Pressure: Connect the well reservoir fitting to the pressure source, leaving the other side open to atmosphere.

Negative Pressure: Connect the top fitting to vacuum source, leaving well side open to atmosphere.

Differential Pressure: Connect higher pressure to well reservoir fitting and lower pressure to upper fitting.

Note: When finished, close fitting to prevent spilling or evaporation.

Maintenance

With proper care, Dwyer Flex-Tube® Manometers will continue to give accurate readings. If cleaning is needed, remove fittings, drain fluid, and rinse with mild soap and water. A cleaning brush (part #A-366) may be used to remove oxidation.

Avoid harsh soaps and solvents which may damage manometer and void warranty.

When replacing O-rings, apply a thin coat of petroleum jelly to assure a good seal. Do not coat O-ring used in the overpressure safety trap.

Avoid using fluids other than those specified. Corrosive fluids may damage the manometer.

Printed in U.S.A. 6/01 FR# 44-440475-00 Rev. 4

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri ______________ Date: ______________

Piping Check

	Yes	No
System suction points are sealed?	____	____
Piping system is properly supported?	____	____
Excessive noise is heard in piping joints?	____	____
Valves & manometers installed?	____	____
Vacuum > 0.1" observed at all manometers?	____	____
Correct labels applied in proper location?	____	____

Electrical Check

	Yes	No
Is fan in operation?	____	____
Excessive noise heard when fan is running?	____	____
Electrical junction box all closed?	____	____
Electrical conduit properly supported?	____	____
Correct labels applied in proper location?	____	____

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint	____	____
Heating/Ventilating Systems	____	____
Drains, Sumps, Floor Cracks	____	____
Wall Penetrations, Cracks	____	____

Manometer readings:

	Pressure (inches of H20)		
	Left side	**Right side**	**Total**
VIMS-1	____	____	____
VIMS-3	____	____	____
VIMS-4	____	____	____
VIMS-5A	____	____	____
VIMS-5B	____	____	____

Comments:

____
____
____
____
____

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Appendix E

RETEC Weekly Reports

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri   Date: 8-10-07

Piping Check	**Yes**	**No**
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check		
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?		
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20) Left side	Right side	Total
VIMS-1	2.6	2.6	5.2
VIMS-3	2.7	2.8	5.5
VIMS-4	2.6	2.6	5.2
VIMS-5A	2.8	2.7	5.5
VIMS-5B	2.85	2.9	5.75

Comments:

VAPOR SYSTEM INSPECTION FORM
Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri   Date: 8-14-07

Piping Check	**Yes**	**No**
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check		
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?		
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20)		
	Left side	Right side	Total
VIMS-1	2.65	2.60	5.25
VIMS-3	2.65	2.8	5.45
VIMS-4	2.6	2.6	5.2
VIMS-5A	2.8	2.65	5.45
VIMS-5B	2.85	2.9	5.75

Comments:

VAPOR SYSTEM INSPECTION FORM
Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri

Date: 8-24-07

Piping Check

	Yes	No
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check

	Yes	No
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	[illegible]
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20)		
	Left side	Right side	Total
VIMS-1	2.6	2.6	5.2
VIMS-3	2.7	2.8	5.5
VIMS-4	2.65	2.65	5.3
VIMS-5A	2.8	2.65	5.45
VIMS-5B	2.9	2.95	5.85

Comments:

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri   Date: 8-27-07

Piping Check

	Yes	No
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check

	Yes	No
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20) Left side	Right side	Total
VIMS-1	2.65	2.65	5.3
VIMS-3	2.65	2.75	5.4
VIMS-4	2.7	2.7	5.4
VIMS-5A	2.7	2.7	5.4
VIMS-5B	2.85	2.95	5.8

Comments:

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri   Date: 7-6-07

Piping Check

	Yes	No
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check

	Yes	No
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

Pressure (inches of H20)

	Left side	Right side	Total
VIMS-1	2.65	2.65	5.3
VIMS-3	2.8	2.9	5.7
VIMS-4	2.7	2.7	5.4
VIMS-5A	2.75	2.75	5.5
VIMS-5B	2.9	2.95	5.8

Comments:

VAPOR SYSTEM INSPECTION FORM
Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri　　　　Date: 9-10

Piping Check

	Yes	No
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check

	Yes	No
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20)		
	Left side	Right side	Total
VIMS-1	2.55	2.6	5.15
VIMS-3	2.7	2.8	5.5
VIMS-4	2.6	2.65	5.25
VIMS-5A	2.8	2.75	5.55
VIMS-5B	2.8	2.85	5.65

Comments:

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri Date: 9-21-05

Piping Check

	Yes	No
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check

	Yes	No
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?

	Yes	No
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20) Left side	Right side	Total
VIMS-1	2.65	2.65	5.3
VIMS-3	2.7	2.75	5.45
VIMS-4	2.6	2.65	5.25
VIMS-5A	2.8	2.7	5.5
VIMS-5B	2.85	2.95	5.8

Comments:

VAPOR SYSTEM INSPECTION FORM
Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VAPOR SYSTEM INSPECTION FORM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Performed by: Daniel Arcieri

Date: 10-5-07

Piping Check	**Yes**	**No**
System suction points are sealed?	X	
Piping system is properly supported?	X	
Excessive noise is heard in piping joints?		X
Valves & manometers installed?	X	
Vacuum > 0.1" observed at all manometers?	X	
Correct labels applied in proper location?	X	

Electrical Check		
Is fan in operation?	X	
Excessive noise heard when fan is running?		X
Electrical junction box all closed?	X	
Electrical conduit properly supported?	X	
Correct labels applied in proper location?	X	

Have the following items changed since the last visit?		
Building support structures or footprint		X
Heating/Ventilating Systems		X
Drains, Sumps, Floor Cracks		X
Wall Penetrations, Cracks		X

Manometer readings:

	Pressure (inches of H20) Left side	Right side	Total
VIMS-1	2.6	2.7	5.3
VIMS-3	2.7	2.7	5.4
VIMS-4	2.55	2.65	5.2
VIMS-5A	2.8	2.65	5.45
VIMS-5B	2.85	2.95	5.8

Comments:

VAPOR SYSTEM INSPECTION FORM
Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

Appendix F

ART Certification of Completion

ADVANCED RADON TECHNOLOGIES INC.

ADVANCED RADON TECHNOLOGIES, INC.

RADON MITIGATION & TESTING
WA ST. CONTR LIC# ADVANRT06402

2801 N. Monroe Street, Suite "A" Spokane, WA 99205 Phone: (509) 326-5127 Fax: (509) 328-2927

Certificate of Completion

October 11, 2007

ENSR Corporation (RETEC)
Jamie Stevens
1011 SW Klickitat Way # 207
Seattle, WA 98134

Jamie:

The Radon system was installed at 220 S Dawson Street per the original design pending the remodel by the current owner.

Thank you,

Mark S Gerard

Mark S Gerard , Owner
Advanced Radon Technologies, Inc.
2801 N Monroe
Spokane, WA 99205

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Performed by: ____________________ Date: __________ Time: __________

Performed by: ____________________

Piping Check – VIMS-1/5A/5B[i]	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-4	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-3	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

____

____

____

____

____

Other Comments:

____

____

____

____

____

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Electrical Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Electrical Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Roof Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Fan in operation?			
Excessive noise heard when fan is running?			
System suction points are sealed?			
Are all anchors/supports correctly installed?			
Piping system is properly supported?			
Correct labels applied in proper location?			

Roof Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Fan in operation?			
Excessive noise heard when fan is running?			
System suction points are sealed?			
Are all anchors/supports correctly installed?			
Piping system is properly supported?			
Correct labels applied in proper location?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

Other Comments

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Tenant Interview

Name: ______________________ Contact Information: ______________________

	Yes	No
Any problems with conducting business with the VIMS running?	____	____
VIMS problems noticed?	____	____
Damage to any part of the VIMS?	____	____
VIMS accessible?	____	____
Have the following items changed since the last monthly visit?		
• Building support structures or footprint	____	____
• Heating/Ventilating Systems	____	____
• Drains, Sumps, Floor Cracks, Concrete Joint Seals	____	____
• Wall Penetrations, Cracks	____	____

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

____

____

____

____

____

____

____

Other Comments

____

____

____

____

____

____

____

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Manometer Readings

	Pressure (inches of water)			Variation ≥ 1.0 inch of water Compared to Previous Month?	
	Left Side	**Right Side**	**Total**	**Yes***	**No**
VIMS-1/5A/5B[i]					
VIMS-4					
VIMS-3					

* If yes, please complete the following.

Previous Month's Manometer Readings

	Pressure (inches of water)		
	Left Side	**Right Side**	**Total**
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Was repair made within 7 days?	**NA**	**Yes**	**No***
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Please provide the corrective actions made, or recommended repair or modification needed.

* If no, notification to Ecology by phone and email is required within 7 calendar days after the observation is made.

Other Comments

AECOM

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Performed by: ______________________ Date: __________ Time: __________

Performed by: ______________________

Piping Check – VIMS-1/5A/5B[i]	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-4	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-3	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

____

____

____

____

____

Other Comments:

____

____

____

____

____

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Electrical Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Electrical Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Tenant Interview

Name: ______________________ Contact Information: ______________________

	Yes	**No**
Any problems with conducting business with the VIMS running?		
VIMS problems noticed?		
Damage to any part of the VIMS?		
VIMS accessible?		
Have the following items changed since the last monthly visit?		
• Building support structures or footprint		
• Heating/Ventilating Systems		
• Drains, Sumps, Floor Cracks, Concrete Joint Seals		
• Wall Penetrations, Cracks		

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

Other Comments

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Manometer Readings

	Pressure (inches of water)			Variation ≥ 1.0 inch of water Compared to Previous Month?	
	Left Side	**Right Side**	**Total**	**Yes***	**No**
VIMS-1/5A/5B[i]					
VIMS-4					
VIMS-3					

* If yes, please complete the following.

Previous Month's Manometer Readings

	Pressure (inches of water)		
	Left Side	**Right Side**	**Total**
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Was repair made within 7 days?	**NA**	**Yes**	**No***
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Please provide the corrective actions made, or recommended repair or modification needed.

* If no, notification to Ecology by phone and email is required within 7 calendar days after the observation is made.

Other Comments

[i] VIMS-1/5A/5B represents the combined piping associated with each of these locations. Individual manometers are not installed on VIMS-1, VIMS-5A, and VIMS-5B.

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Performed by: ______________________ Date: __________ Time: __________

Performed by: ______________________

Piping Check – VIMS-1/5A/5B[i]	Yes	No	Not Accessible
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-4	Yes	No	Not Accessible
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-3	Yes	No	Not Accessible
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

____

____

____

____

____

Other Comments:

____

____

____

____

____

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Electrical Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Electrical Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Roof Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Fan in operation?			
Excessive noise heard when fan is running?			
System suction points are sealed?			
Are all anchors/supports correctly installed?			
Piping system is properly supported?			
Correct labels applied in proper location?			

Roof Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Fan in operation?			
Excessive noise heard when fan is running?			
System suction points are sealed?			
Are all anchors/supports correctly installed?			
Piping system is properly supported?			
Correct labels applied in proper location?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

Other Comments

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Tenant Interview

Name: ______________________ Contact Information: ______________________

	Yes	No
Any problems with conducting business with the VIMS running?	______	______
VIMS problems noticed?	______	______
Damage to any part of the VIMS?	______	______
VIMS accessible?	______	______
Have the following items changed since the last monthly visit?		
• Building support structures or footprint	______	______
• Heating/Ventilating Systems	______	______
• Drains, Sumps, Floor Cracks, Concrete Joint Seals	______	______
• Wall Penetrations, Cracks	______	______

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

____

____

____

____

____

____

____

Other Comments

____

____

____

____

____

____

____

VAPOR SYSTEM INSPECTION FORM
ANNUAL INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Manometer Readings

	Pressure (inches of water)			Variation ≥ 1.0 inch of water Compared to Previous Month?	
	Left Side	Right Side	Total	Yes*	No
VIMS-1/5A/5B[i]					
VIMS-4					
VIMS-3					

* If yes, please complete the following.

Previous Month's Manometer Readings

	Pressure (inches of water)		
	Left Side	Right Side	Total
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Was repair made within 7 days?	NA	Yes	No*
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Please provide the corrective actions made, or recommended repair or modification needed.

* If no, notification to Ecology by phone and email is required within 7 calendar days after the observation is made.

Other Comments

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Performed by: ____________________ Date: __________ Time: __________

Performed by: ____________________

Piping Check – VIMS-1/5A/5B[i]	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-4	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

Piping Check – VIMS-3	**Yes**	**No**	**Not Accessible**
System suction points are sealed?			
Piping system is properly supported?			
Audible or visual evidence of pipe leaks?			
Excessive noise is heard in piping joints?			
Valve(s) & manometer(s) installed properly?			
Correct labels applied in proper location?			
If accessible, concrete joint seals worn or cracked?			

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

Other Comments:

AECOM

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Electrical Check – VIMS-1/5A/5B, VIMS-4	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Electrical Check – VIMS-3	**Yes**	**No**	**Not Accessible**
Excessive noise heard when fan is running?			
Electrical junction box all closed?			
Electrical conduit properly supported?			
Correct labels applied in proper location?			

Tenant Interview

Name: ____________________ Contact Information: ____________________

	Yes	**No**
Any problems with conducting business with the VIMS running?		
VIMS problems noticed?		
Damage to any part of the VIMS?		
VIMS accessible?		
Have the following items changed since the last monthly visit?		
• Building support structures or footprint		
• Heating/Ventilating Systems		
• Drains, Sumps, Floor Cracks, Concrete Joint Seals		
• Wall Penetrations, Cracks		

If modifications/corrective actions were needed, please provide the observations made, the corrective actions/modifications made or recommended repair or modifications needed.

Other Comments

VAPOR SYSTEM INSPECTION FORM
MONTHLY INSPECTION

AECOM

Sub-Slab Soil Vapor Depressurization System
220 South Dawson Street, Seattle, Washington

VIMS-1, VIMS-3, VIMS-4, VIMS-5A, VIMS-5B

Manometer Readings

	Pressure (inches of water)			Variation ≥ 1.0 inch of water Compared to Previous Month?	
	Left Side	**Right Side**	**Total**	**Yes***	**No**
VIMS-1/5A/5B[i]					
VIMS-4					
VIMS-3					

* If yes, please complete the following.

Previous Month's Manometer Readings

	Pressure (inches of water)		
	Left Side	**Right Side**	**Total**
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Was repair made within 7 days?

	NA	**Yes**	**No***
VIMS-1/5A/5B[i]			
VIMS-4			
VIMS-3			

Please provide the corrective actions made, or recommended repair or modification needed.

* If no, notification to Ecology by phone and email is required within 7 calendar days after the observation is made.

Other Comments

[i] VIMS-1/5A/5B represents the combined piping associated with each of these locations. Individual manometers are not installed on VIMS-1, VIMS-5A, and VIMS-5B.

EXHIBIT H

Groundwater Sampling and Analysis Plan, Revision 1,
dated January 2008 and
Quality Assurance Project Plan, dated January 2008

General Electric
WA0009278706
ENSR | AECOM
HZW 4.4.3

Prepared for:
General Electric Aircraft Engines
1 Neumann Way, Mail Drop T165
Cincinnati, Ohio 45215

Sampling and Analysis Plan- Revision 1

The RETEC Group, Inc.
February 2008
Document No.: 02978-415-735

Merged with ENSR in 2007
RETEC

ENSR | AECOM

Prepared for:
General Electric Aircraft Engines
1 Neumann Way, Mail Drop T165
Cincinnati, Ohio 45215

Sampling and Analysis Plan- Revision 1

Jamie Stevens FOR:
Prepared By Aaron Huntington
Staff Engineer

Jamie Stevens FOR:
Reviewed By Jamie Stevens, P.E.
Project Manager

Jamie Stevens FOR:
Reviewed By Linda Baker, R. G.
Program Manager

The RETEC Group, Inc.
February 2008
Document No.: 02978-415-735

Merged with ENSR in 2007
RETEC

Contents

1.0 Introduction 1-1

2.0 Project Organization 2-1

2.1 Program and Project Manager Responsibilities 2-1

2.2 Office and Site Health and Safety Officer Responsibilities 2-1

2.3 Project Engineer, Scientist and Geologist Responsibilities 2-2

2.4 Sampling Technician 2-2

2.5 Quality Assurance Officer Responsibilities 2-3

2.6 Data Validator 2-3

3.0 Sampling Procedures 3-1

3.1 Site Access 3-1

3.2 Water Level Measurement 3-1

3.3 Sample Collection Using Low Flow Methods 3-2

3.3.1 Purging 3-2

3.3.2 Sample Collection 3-2

3.3.3 Health and Safety Plan 3-3

3.3.4 Documentation 3-3

3.4 Decontamination 3-3

3.5 Groundwater Well Development 3-4

4.0 Sample Custody and Packaging 4-1

4.1 Chain-of-Custody 4-1

4.1.1 Packing for Shipment 4-1

4.2 Sample Log-in 4-2

5.0 Reporting 5-1

6.0 References 6-1

List of Tables

Table 3-1 Site Monitoring Well Contact Information

Table 3-2 MW Construction Details and Pump Setting Information

Table 3-3 Summary of Groundwater Analytical Methods

Table 3-4 Summary of Groundwater Analytical Methods - Additional Parameters

List of Figures

Figure 1 Site Location Map

List of Appendices

Appendix A Quality Assurance Project Plan

Appendix B ENSR SOPs

Appendix C Boring Logs

1.0 Introduction

This Sampling and Analysis Plan (SAP) presents the project organization, objectives and procedures associated with the collection of environmental samples at the former GE facility in Seattle, Washington. All quality assurance and quality control procedures related to this SAP are included in the Quality Assurance Project Plan (QAPP) found in Appendix A. This SAP meets the requirements of the Model Toxics Control Act (MTCA) (WAC 173-340-820) and is developed in accordance with applicable professional technical standards, Washington Department of Ecology guidelines (Ecology, 1991, 1995), and project-specific goals.

The SAP and QAPP describe the procedures that are implemented to ensure that the precision, accuracy, representativeness, and completeness of the project data are sufficient to satisfy the project objectives.

2.0 Project Organization

The organizational structure for the project consists of a Program Manager, Project Manager, Regional and Site Health and Safety Officer, Project Engineer/Scientist/Geologist, Sampling Technician, Quality Assurance (QA) Officer, and Data Validator.

2.1 Program and Project Manager Responsibilities

The Program Manager's primary responsibility is technical accuracy, completeness, and overall project management.

The Project Manager (PM) is the primary point of contact and is responsible for technical, financial, and scheduling matters. The PM's responsibilities include:

- Assignment of duties to the project staff and orientation of the staff to the needs and requirements of the project
- Supervision of the performance of project team members
- Monitoring all aspects of the project to verify that all work is completed in accordance with this SAP and attached QAPP
- Budget and schedule control
- Establishment of a project record-keeping system
- Coordination of all major project deliverables for technical accuracy and completeness
- Ecology contact.

2.2 Office and Site Health and Safety Officer Responsibilities

The Office Health and Safety Officer (HSO) has the following responsibilities:

- Interface with the Project Manager as required in matters of health and safety
- Approve the site-specific Health and Safety Plan (HASP) for the project and require amendment as site conditions warrant
- Appoint or approve a Site Safety Officer (SSO) to assist in implementing the HASP
- Monitor compliance with the HASP
- Assist the Project Manager in ensuring that proper health and safety equipment is available for the project
- Approve personnel to work on the site with regard to medical examinations and health and safety training.

The Site Safety Officer (SSO) is responsible for verifying that project personnel and visitors adhere to the site safety requirements outlined in the HASP. These responsibilities include:

- Conducting the health and safety training for project personnel as appropriate
- Modifying health and safety equipment or procedure requirements based on data gathered during the site work

- Determining the posting locations and routes to medical facilities, including poison-control centers, and arranging for emergency transportation to medical facilities
- Posting the telephone numbers of local public emergency services and facilities
- Performing site audits to verify adherence to the requirements of the HASP.

The SSO has authority to stop any operation that threatens the health or safety of the work team, visitors or surrounding populace. The daily health and safety activities may be conducted by the SSO or a designated replacement.

2.3 Project Engineer, Scientist and Geologist Responsibilities

The Project Engineer/Scientist/Geologist has the following responsibilities:

- Coordinating directly with property owners to confirm site access prior to sampling events
- Reviewing subcontractors' work and approve all subcontractor invoices
- Working with the subcontractors and analytical laboratories to ensure that all field activities are conducted appropriately and that field activities are properly documented
- Coordinating the sampling operations to verify that the sampling team members adhere to this SAP and all referenced reports/plans
- Providing daily schedules for field personnel including subcontractors
- Maintaining a field log for all work completed on site
- Preparing the field investigation data and information for reports.

Note that it is not necessary for the Project Engineer/Scientist/Geologist to be present on-site during all sampling activities or field operations. Coordination and communication with the Sampling Technician will ensure compliance with this SAP and QAPP.

The Project Geologist is also be responsible for over seeing any monitoring well installation, generating monitoring well boring logs, and generating site wide groundwater contour maps.

2.4 Sampling Technician

The primary responsibility of the Sampling Technician is the collection of site samples with proper documentation of all sampling activities, and following all sampling standard operating procedures (SOPs). The Sampling Technician reports to the Project Engineer/Geologist. The Sampling Technician has the following responsibilities:

- Following sampling procedures outlined in the SOPs and any site specific requirements
- Providing documentation of all activities during the sampling event
- Following the QAPP and the Site Health and Safety Plan
- Packing and shipping of all samples directly to the laboratory.

2.5 Quality Assurance Officer Responsibilities

The Quality Assurance (QA) Officer is responsible for audits and monitoring adherence to the project QA objectives and the QAPP. The QA Officer reports directly to the Project Manager. The QA Officer has the following responsibilities:

- Reviewing laboratory analytical data
- Coordinating QA/QC operation with the laboratory coordinator
- Providing the Data Validator with the laboratory analytical data and sampling field notes
- Collaborating with the Project Engineer/Geologist in establishing sampling and analysis programs
- Serving as liaison between the laboratory and Project Engineer or Sampling Technician
- Serving as the "focal point" for laboratory activities
- Coordinating laboratory and data activities by the analytical services staff
- Notifying the laboratory of specific laboratory nonconformances and changes
- Maintaining a complete set of laboratory data
- Releasing testing data and results to the Project Engineer.

2.6 Data Validator

Responsibilities of the Data Validator include:

- Identifying data to be classified as questionable or qualitative
- Comparing actual sampling and laboratory procedures to those outlined in this plan
- Reporting the validation results to the Project Engineer and QA Officer.

3.0 Sampling Procedures

The following sections describe the groundwater monitoring well sampling procedures that are followed at the site to ensure that quality data is collected. Figure 1 includes a site map showing the locations of all existing monitoring wells. The QAPP is included in Appendix A, Appendix B includes SOPs, and monitoring well boring logs are included in Appendix C.

3.1 Site Access

The former GE facility is currently owned by Keymac, LLC and is maintained by McKinstry Company. Select downgradient wells are on Merlano Construction property and in the City of Seattle right of way. The following table summarizes the locations of existing monitoring wells on site and the designated representative who should be notified when the wells are scheduled to be accessed.

Table 3-1: Site Monitoring Well Contact Information

Well ID	Point of Contact
MW-1 through MW-9, MW-13	Keymac/McKinstry (Alex Cordas) phone: 206-762-3311
MW-10 through MW-12, MW-14M/D, MW-19M, MW-20M, EPI-MW-1S/D through EPI-MW-4S/D	Merlano Construction (Heidi Kludt) phone: 206-762-9125.
MW-15M/D through MW-18M/D, MW-21S	City of Seattle Right of Way - Street Use Permit may be required contact: (206) 684-5283 http://www.seattle.gov/transportation/stuse_permits_online.htm

Note:

Wells located along the side walk may be subject to a street use permit depending on the scope of work

GW gauging/sampling does not require a street use permit

3.2 Water Level Measurement

Water-level data are used to indicate the directions of groundwater flow and areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relations. Measurements of the static-water level are also needed to estimate the amount of water to be purged from a well prior to sample collection, when purge volumes are based on well volumes, rather than stabilization of parameters (i.e., for samples collected by bailing, rather than using low flow techniques). Water level measurements are conducted in accordance with ENSR SOP 7101.

Upon arrival at a monitoring well, the surface seal and well protective casing is examined for any evidence of frost heaving, cracking, or vandalism. All observations are recorded in the fluid-level monitoring log or the project field book.

All the water-level measuring points are marked by the surveyor on the well casing itself, or are collected from the north side of the well casing. Water-level measurements are made using an electronic or mechanical device. Many types of electrical instruments are available for water-level measurement; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Electrodes are generally contained in a weighted probe that keeps the tape taut while providing some shielding of the electrodes against false indications as the probe is being lowered into the well. Before lowering the probe in the well, the circuitry can be checked by dipping the probe in water and observing the indicator (a light, sound, and/or meter).

To reduce any potential effects of pressure build up inside the monitoring wells, all monitoring wells are vented prior to collecting water level measurements. This is accomplished by releasing the well caps and allowing the wells to vent for at least 15 minutes.

To obtain a water-level measurement, the decontaminated water level probe is slowly lower into the monitoring well until the indicator (light, sound, and/or meter) shows water contact. At this time the precise measurement is determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement.

The water-level measurement device is decontaminated immediately after use following the procedures described in Section 3.3.

3.3 Sample Collection Using Low Flow Methods

Groundwater samples will be collected via EPA-Approved Low Flow Groundwater Sampling Procedures and will following the procedures listed in SOP 7130 (Attachment B). Twenty-seven of the wells onsite have dedicated submersible bladder pumps and dedicated tubing. Five wells, located on the Merlano Construction property (also know as the Liberty Ridge Property) do not have dedicated pumps. All purging and samples are collected using the dedicated pumps or a single stainless steel bladder pump. Groundwater is collected from the five monitoring wells on the Liberty Ridge Property using a QED stainless steel bladder pump. The bladder pump is decontaminated prior to sampling and after each monitoring well is sampled (see Section 3.4 for decontamination details). The polyethylene bladder and all sampling and airline tubing is replaced after sampling at each monitoring well.

3.3.1 Purging

The pump inlet is placed at approximately the midway point between the lowest measured groundwater level and the bottom of the screen, for monitoring wells that screen the water table. Gauging data from the each event is compared to the historical low water level, and the pump is adjusted accordingly. For wells where the screen does not intercept the water table, the pump inlet is placed midway along the screen interval. Table 3-2 includes both depths and elevations of the pump inlets and the elevation of the top and bottom of each monitoring well screen based on the current historic low water level.

After adjustment of the pump inlet to the required elevation, monitoring well purging is initiated at a rate of less than 300 milliliters per minute. As required with the low-flow sampling technique, turbidity, dissolved oxygen, and oxidation-reduction potential in the groundwater is monitored during purging of each well. The pH, specific conductance, and temperature are also monitored. Purge volumes are based on obtaining stability, as determined by having consecutive measurements at least three minutes apart being within ten percent of the previous measurement, except for conductivity which is within three percent of the previous measurement. Field parameters are collected in accordance with ENSR SOPs 7320 and 7125 (see Appendix B).

3.3.2 Sample Collection

Upon stabilization of parameters, the purge rate is reduced to approximately 200 milliliters per minute to collect samples. Samples are collected from the discharge tube of the pump directly into appropriate sample containers. Analytical methods and requirements are summarized in Table 3-3. Analytical methods listed in Table 3-3 represent a routine GW monitoring event.

Table 3-4 provides analytical methods for additional constituents required by Ecology at this time. The sampling frequency for these additional constituents will be determined in a separate correspondence. Any other additional parameters may be called for in specific reports/correspondence; in such cases, the reports/correspondence will detail any additional handling and preservation requirements.

3.3.3 Health and Safety Plan

The potential human health risk associated with inhalation and/or contact with the constituents of concern (COCs) at the site is discussed in the site Health and Safety Plan. All sampling activities are conducted in accordance with the site Health and Safety Plan.

3.3.4 Documentation

Various documents are completed and maintained as a part of groundwater sample collection. These documents will provide a summary of the sample collection procedures and conditions, shipment method, analyses requested, and the custody history. These documents may include:

- Field book
- Groundwater sampling forms
- Sample labels
- Chain-of-custody
- Shipping receipts.

All documentation is stored in the project files.

3.4 Decontamination

Decontamination is performed as a quality assurance measure and as a safety precaution. It prevents cross-contamination between samples and also helps maintain a clean working environment. Equipment requiring decontamination may include hand tools, sample collection equipment, monitoring and testing equipment, personal protective equipment, or heavy equipment (e.g., loaders, backhoes, drill rigs, etc.).

All sampling equipment is decontaminated prior to use and between each sample collection point, in accordance with ENSR SOP 7600 (Appendix B). Waste products produced by the decontamination procedures such as rinse liquids, solids, rags, gloves, etc. are collected and disposed of properly based on the nature of site impact and site protocols. Any materials and equipment that are reused will be decontaminated or properly protected before being taken off-site.

The following summarizes the decontamination procedures:

- Remove gross visible solids from the equipment by brushing and then rinsing with tap water
- Wash with detergent or soap solution (e.g., Alconox and tap water)
- Rinse with tap or distilled water
- Repeat entire procedure or any parts of the procedure as necessary
- Rinse with distilled water
- After decontamination procedure is completed, avoid placing equipment directly on ground surface.

3.5 Groundwater Well Development

Well development is the process of cleaning the face of the borehole and the formation around the outside of the well screen to permit groundwater to flow easily into the monitoring well. Monitoring wells are developed for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole to permit the water to flow into the screen easily
- To remove the clay, silt, and other fines from the formation so that during subsequent sampling the water will not be turbid or contain suspended matter which can easily interfere with chemical analysis
- To remove any formation damage that may have occurred as a result of well drilling.

Well development is necessary for all newly completed wells and may be required for existing site wells (including recovery wells) that have been left dormant for some time or have accumulated significant quantities of sediment or biological fouling in the well, gravel pack, or surrounding formation. If groundwater well development is required, all monitoring well development will be performed in accordance with ENSR SOP 7221 (Appendix B).

Well development is accomplished by causing the natural formation water inside the well to move vigorously in and out through the screen. The suspended sediment is then removed from the well by bailing or pumping. Several techniques may be employed in developing a well. To be effective, all require reversals or surges in flow to avoid bridging by particles. These surges can be created by using surge blocks, air lifts, bailers, or pumps (described in detailed in ENSR SOP 7221). The use of water other than the natural formation water is not recommended during well development.

Copies of all well development or redevelopment field forms will be submitted to Ecology.

Well Development for Newly Completed Wells

Before developing the well, water depth, and well depth will be measured using an electronic or mechanical device. Approximately 10 well volumes (calculated from the length of the water column and the well casing diameter) are removed from the well during development. The discharge from the well is continuously monitored and development is continued until a particulate free discharge is apparent and the field parameters (pH, conductivity, and temperature) have stabilized within 10 percent of the previous reading. Field parameters are recorded on the well development record after each volume is removed. All materials and equipment used in conjunction with development will be decontaminated prior to use and all provisions made to prevent cross-contamination during development. Well depths are measured following development to determine whether sand or silt has accumulated in the well.

Regardless of the method employed, any discharges from the wells are properly disposed of depending on the nature of the liquid removed from the well. Additionally, all materials and equipment placed into the well in conjunction with development is decontaminated prior to use.

Well Development for Existing Wells

Indicators that trigger well development in existing wells include: a substantial increase in turbidity, decrease in well yield, or if, during pump maintenance, sediment accumulation (of within 1 inches of the groundwater sampling pump intake and 3 inches of the recovery pumps intake) is measured in the well. The total well depth can be measured and compared to the installed total well depth to identify if silt is accumulating at the bottom of the well. Measuring the total well depth is complicated at the site because of the dedicated pumping and tubing in all wells, with the exception of the Liberty Ridge EPI wells. Raising and lower groundwater pumps increases the potential for contamination from surface contacts. To minimize this risk an initial evaluation of turbidity, a decrease in well yield, and/or silt accumulation measured during pump maintenance will trigger measuring the total well depth.

A turbidity and well yield are measured during the routine groundwater sampling events. During these events, turbidity, drawdown rates, and purge rates will be compared to the pervious sampling event. If a change in any of these parameters is measured, the total well depth will be gauged to determine if silt has accumulated. If silt has not accumulated in the wells, a further evaluation of the pumps, tubing, and all associated equipment will be conducted to troubleshoot the reason for the observed change.

If well redevelopment is required, the procedures outlined above and detailed ENSR SOP 7221 (Appendix B) will be followed. Copies of all well redevelopment logs and documentation will be provided to Ecology in the groundwater monitoring report (Section 5).

4.0 Sample Custody and Packaging

Chain-of-custody procedures are intended to document sample possession from the time of collection to disposal. Packing and shipping is essential to provide a high degree of certainty that environmental samples arrive at their destination intact. Chain-of-custody procedures and packing and shipping are summarized below and described in detail in ENSR SOP 7510 and 7007 (Appendix B).

4.1 Chain-of-Custody

A sample is considered to be under custody if it is in one's possession, view, or in a designated secure area. Transfers of sample custody are documented by chain-of-custody forms. The chain-of-custody record will include, at a minimum, the following information:

- Client or project name, or unique identifier, if confidential
- Sample collector's name
- Company's (ENSR) mailing address and telephone number
- Designated recipient of data (name and telephone number)
- Analytical laboratory's name and city
- Description of each sample (i.e., unique identifier and matrix)
- Date and time of collection
- Quantity of each sample or number of containers
- Type of analysis required
- Date and method of shipment.

Additional information may include type of sample containers, shipping identification air bill numbers, etc.

When transferring custody, both the individual(s) relinquishing custody of samples and the individual(s) receiving custody of samples will sign, date, and note the time on the form. If samples are to leave the collector's possession for shipment to the laboratory, the subsequent packaging procedures are followed.

4.1.1 Packing for Shipment

To prepare a cooler for shipment, the sample bottles are inventoried and logged on the chain-of-custody form. All sample bottles are labeled. At least one layer of protective material is placed in the bottom of the container. As each sample bottle is logged on the chain-of-custody form, it is wrapped with protective material (e.g., bubble wrap, matting, plastic gridding, or similar material) to prevent breakage. Each sample bottle is placed upright in the shipping container. Each sample bottle cap is checked during wrapping and tightened if needed. Avoid over-tightening, which may cause bottle cap to crack and allow leakage. Additional packaging material such as bubble wrap or Styrofoam pellets is spread throughout the voids between the sample bottles.

Most samples require refrigeration as a minimum preservative. Ice placed in heavy duty zip-lock type bags is distributed over the top of the samples. A minimum of two bags of ice will be placed in each cooler. Additional packing material should then be placed to fill the balance of the cooler or container.

Place the original completed chain-of-custody record in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container. Alternatively, the bag may be taped to the underside of the container lid. Retain a copy of the chain-of-custody record with the field records.

Close the top or lid of the cooler or shipping container and rotate/shake the container to verify that the contents are packed so that they do not move. Add additional packaging if needed and re-close. Place signed and dated chain-of-custody seal at two different locations (front and back) on the cooler or container lid and overlap with transparent packaging tape. The chain-of-custody tape is placed on the container in such a way that opening the container will destroy the tape. Packaging tape should encircle each end of the cooler at the hinges.

Sample shipment is sent via courier or an overnight express service that can guarantee 24-hour delivery. Retain copies of all shipment records as provided by the shipper.

4.2 Sample Log-in

Upon receipt of samples (accompanied by a completed chain-of-custody record detailing requested analyses), the Quality Assurance Officer(s) or his/her delegate will:

- Verify all paperwork, chain-of-custody records, and similar documentation
- Log-in samples, assign unique laboratory sample numbers, and attach the numbers to the sample container(s)
- Store samples in a refrigerated sample bank.

5.0 Reporting

Quarterly groundwater monitoring reports are submitted to Ecology within 60 calendar days following the sampling event. Quarterly groundwater monitoring reports submitted comply with WAC 173-340-820, WAC 173-340-830, WAC 173-340-840. Reports include the following information:

- A narrative summary of sampling methods, sampling analytical results, and plans for the next sampling event.
- Tabulated COC concentrations and water table elevation data from the last sampled event as well as historical COC concentrations for all previous sampling events. Tables will include MTCA Method B groundwater, A (unrestricted) groundwater, and B surface water cleanup levels, and other State and Federal applicable ARARs, for reference.
- A narrative evaluation of the results of the data validation results and a description of all data qualified or rejected.
- Site wide groundwater level contour maps.
- Iso-concentration maps for the primary COCs of concern including: TCE, PCE, and 11-DCE.
- Groundwater pump inlet locations during sampling, with respect to well screen elevations and water levels.
- Copies of all laboratory analytical data sheets and chain of custody forms.
- Copies of field activity logs and groundwater stabilization data (including any well development or redevelopment logs).

6.0 References

Ecology, 1991. *Guidance and Specifications for Preparing Quality Assurance Project Plans.* Washington State Department of Ecology.

Ecology, 1995. *Guidance on Sampling and Data Analysis Methods.* Washington State Department of Ecology Toxics Cleanup Program.

Washington State Department of Ecology Toxics Cleanup Program, 2001b. *Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC.* Publication No. 94-06. February.

Tables

Table 3-2 MW Construction Details and Pump Setting Information

	TOC Elevation[1]	Depth of Low GW (feet - TOC PVC)	Elevation of Low GW (feet)	Total Well Depth (feet - TOC PVC)[2]	Elevation of Well Depth (feet)	Elevation to Top of Screen (feet)	Elevation to Bottom of Screen (feet)	Screen Length (feet)	Pump Tubing Length (feet)	Required Pump Inlet Depth (feet TOC PVC)[3]	Required Pump Inlet Elevation (feet)	Quarterly Pump Adjustment Required for Groundwater Sampling since previous Quarter (feet upward)
MW-1	18.38	9.98	8.40	15.5	2.9	12.9	2.9	10	13.6	12.7	5.6	0.00
MW-2	18.22	10.02	8.20	15.3	2.9	12.9	2.9	10	13.7	12.7	5.6	0.00
MW-3	16.87	9.06	7.81	15.5	1.4	11.4	1.4	10	13.7	12.3	4.6	0.00
MW-4	19.54	11.82	7.72	16.6	2.9	12.9	2.9	10	14.7	14.2	5.3	0.00
MW-5	17.92	9.98	7.94	18.6	-0.7	14.3	-0.7	15	16.4	14.3	3.6	0.00
MW-6	17.74	10.24	7.50	18.4	-0.7	14.3	-0.7	15	16.7	14.3	3.4	0.00
MW-7	20.38	12.75	7.63	18.7	1.7	16.7	1.7	15	16.7	15.7	4.7	0.00
MW-8S[4]	17.58	10.23	7.35	18.9	-1.3	13.7	-1.3	15	16.7	14.6	3.0	0.00
MW-8M	17.14	9.18	7.96	30.0	-12.9	-2.9	-12.9	10	25.5	25.5	-8.4	NA
MW-9	16.56	8.86	7.70	18.8	-2.2	12.8	-2.2	15	16.7	13.8	2.7	0.00
MW-10	17.44	10.09	7.35	14.6 [2]	2.8	12.8	2.8	10	12.7	12.3	5.1	0.00
MW-11	17.485	10.26	7.23	18.9	-1.4	13.6	-1.4	15	16.6	14.6	2.9	0.00
MW-12	17.75	10.58	7.17	19.0	-1.3	13.8	-1.3	15	17.1	14.8	3.0	0.00
MW-13	18.38	9.38	9.00	19.0	-0.6	14.4	-0.6	15	17.7	14.2	4.2	0.00
MW-14M[4]	17.38	9.22	8.16	29.6	-12.2	-2.2	-12.2	10	24.6	24.6	-7.2	NA
MW-14D	16.9	8.78	8.12	54.7	-37.8	-27.8	-37.8	10	49.7	49.7	-32.8	NA
MW-15M[4]	16.95	9.13	7.82	29.7	-12.8	-2.8	-12.8	10	24.7	24.7	-7.8	NA
MW-15D	16.62	8.81	7.81	54.7	-38.1	-28.1	-38.1	10	49.7	49.7	-33.1	NA
MW-16M[4]	16.68	9.17	7.51	29.7	-13.0	-3.0	-13.0	10	24.7	24.7	-8.0	NA
MW-16D	16.545	8.99	7.56	54.6	-38.1	-28.1	-38.1	10	49.6	49.6	-33.1	NA
MW-17M	17.735	9.41	8.33	29.9	-12.2	-2.2	-12.2	10	24.5	24.9	-7.2	NA
MW-17D	17.795	9.52	8.28	54.8	-37.0	-27.0	-37.0	10	50.0	49.8	-32.0	NA
MW-18M	15.755	7.54	8.22	29.8	-14.0	-4.0	-14.0	10	24.5	24.8	-9.0	NA
MW-18D	15.545	7.32	8.23	54.9	-39.4	-29.4	-39.4	10	50.0	49.9	-34.4	NA
MW-19M	17.645	8.98	8.67	29.1	-11.5	-1.5	-11.5	10	24.5	24.1	-6.5	NA
MW-20M	17.625	8.96	8.67	29.6	-11.9	-1.9	-11.9	10	24.5	24.6	-6.9	NA
MW-21S	17.09	9.19	7.90	16.0	1.1	-2.9	1.1	10	6.0	6.0	11.1	0.00

Notes:

1 Survey elevations based on Mean Lower Low Water NAVD 88 DATUM.
2 Total well depths as measured.
3 Required pump inlet depth based on placing pump inlet midway between the low water level and the bottom of the well (as measured).
4 MW -8, MW-14S, MW-15S, and MW-16S have been renamed MW-8S, MW-14M, MW-15M, and MW-16M to denote well screen placement.
NA – Not applicable, wells with submerged screens are not affected by changes in water level.

Table 3-3 Summary of Groundwater Analytical Methods

Chemical	Method	Reporting Limit (µg/L)	Bottles	Preservative	Holding Times
Volatile Organic Compounds					
Tetrachloroethene	SW8260-SIM	0.02	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Trichloroethene	SW8260-SIM	0.02	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Vinyl Chloride	SW8260-SIM	0.02	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1,1,2-Tetrachloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1,1-Trichloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1,2,2-Tetrachloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1,2-Trichloro-1,2,2-trifluoroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1,2-Trichloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1-Dichloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1-Dichloroethene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,1-Dichloropropene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2,3-Trichlorobenzene	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2,3-Trichloropropane	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2,4-Trichlorobenzene	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2,4-Trimethylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2-Dibromo-3-chloropropane	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2-Dibromoethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2-Dichlorobenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2-Dichloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,2-Dichloropropane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,3,5-Trimethylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,3-Dichlorobenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,3-Dichloropropane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
1,4-Dichlorobenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
2,2-Dichloropropane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
2-Butanone	SW8260B	1	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
2-Chloroethylvinylether	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
2-Chlorotoluene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
2-Hexanone	SW8260B	3	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
4-Chlorotoluene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days

Table 3-3 Summary of Groundwater Analytical Methods

Chemical	Method	Reporting Limit (µg/L)	Bottles	Preservative	Holding Times
Volatile Organic Compounds					
4-Isopropyltoluene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
4-Methyl-2-Pentanone (MIBK)	SW8260B	1	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Acetone	SW8260B	3	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Acrolein	SW8260B	5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Acrylonitrile	SW8260B	1	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Benzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromobenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromochloromethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromodichloromethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromoethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromoform	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Bromomethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Carbon Disulfide	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Carbon Tetrachloride	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Chlorobenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Chloroethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Chloroform	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Chloromethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
cis-1,2-Dichloroethene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
cis-1,3-Dichloropropene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Dibromochloromethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Dibromomethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Ethylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Hexachlorobutadiene	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Isopropylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
m,p-Xylenes	SW8260B	0.4	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Methyl Iodide	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Methylene Chloride	SW8260B	0.3	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Naphthalene	SW8260B	0.5	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
n-Butylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
n-Propylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days

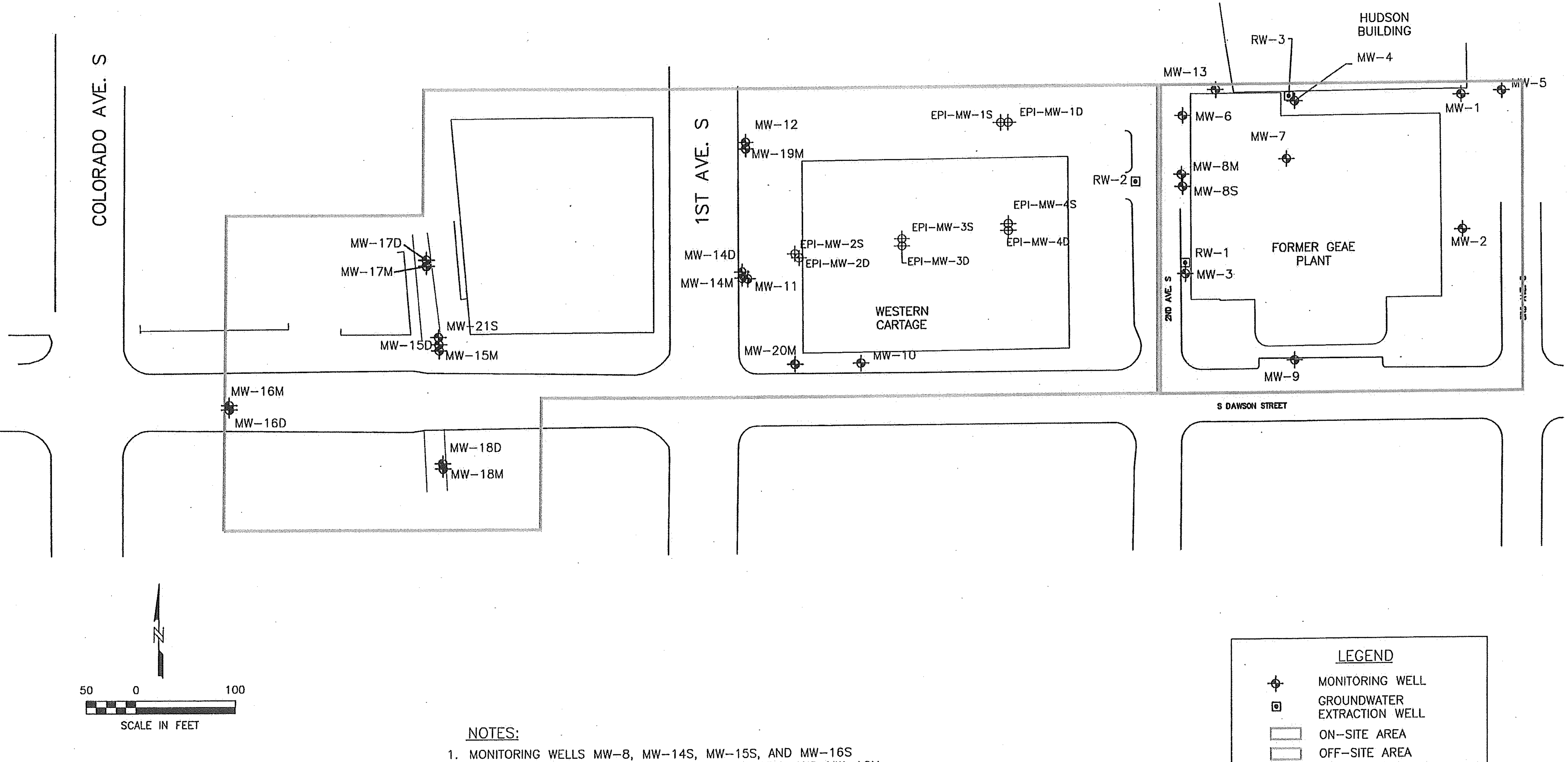
Table 3-3 Summary of Groundwater Analytical Methods

Chemical	Method	Reporting Limit (µg/L)	Bottles	Preservative	Holding Times
Volatile Organic Compounds					
o-Xylene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
sec-Butylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Styrene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
tert-Butylbenzene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Toluene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
trans-1,2-Dichloroethene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
trans-1,3-Dichloropropene	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
trans-1,4-Dichloro-2-butene	SW8260B	1	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Trichlorofluoromethane	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Vinyl Acetate	SW8260B	0.2	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days

Table 3-4 Summary of Groundwater Analytical Methods - Additional Parameters

Chemical	Method	Reporting Limit	Bottles	Preservative	Holding Times
1,4 Dioxane	SW8260-SIM	1.0 ug/L	40ml VOA containers	HCL, Cool to 4° C, Zero Headspace	14 Days
Total, Arsenic	SW846-6010B	0.001 mg/L	500-ml Poly	HCL, Cool, 4° C	30 days
Dissolved, Arsenic	SW846-6010B	0.001 mg/L	500-ml Poly	Field Filter, HCL, Cool, 4° C	30 days

Figures



NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.

ENSR | AECOM

Merged with ENSR in 2007 RETEC

GEAE - S. DAWSON STREET GE001-19314-735	SITE LOCATION MAP
DATE: 06/04/07 DRWN: E.M./SEA	FIGURE 1-1

File: H:\19314\19314S125.dwg Layout: FIGURE 1-1 User: emarshall Plotted: Jun 04, 2007 - 11:22am Xref's:

Appendix A

Quality Assurance Project Plan

ENSR | AECOM

Prepared for:
General Electric Aircraft Engines
1 Neumann Way, Mail Drop T165
Cincinnati, Ohio 45215

Quality Assurance Project Plan-Revision 1

The RETEC Group, Inc.
February 2008
Document No.: 02978-415-735

Merged with ENSR in 2007
RETEC

ENSR | AECOM

Prepared for:
General Electric Aircraft Engines
1 Neumann Way, Mail Drop T165
Cincinnati, Ohio 45215

Quality Assurance Project Plan – Revision 1

Jamie Stevens FOR

Prepared by Aaron Huntington
Staff Engineer

Jamie Stevens

Reviewed by Jamie Stevens, P.E.
Project Manager

Jamie Stevens FOR

Reviewed by Linda Baker, R. G.
Program Manager

The RETEC Group, Inc.
February 2008
Document No.: 02978-415-735

Merged with ENSR in 2007
RETEC

Contents

1.0 Introduction 1-1

2.0 Quality Assurance Procedures 2-1
- 2.1 Quality Control of Sample Collection 2-1
- 2.2 Sample Custody 2-1
- 2.3 Quality Control Parameters 2-1
  - 2.3.1 Detection Limits 2-1
  - 2.3.2 Precision 2-2
  - 2.3.3 Accuracy 2-2
  - 2.3.4 Representativeness 2-3
  - 2.3.5 Comparability and Completeness 2-3
- 2.4 Calibration Procedures and Frequency 2-3
  - 2.4.1 General Calibration Procedures 2-3
  - 2.4.2 Calibration Failures 2-4
  - 2.4.3 Calibration Records and Maintenance 2-4

3.0 Analytical Procedures 3-1
- 3.1 Analytical Laboratories 3-1
- 3.2 General Requirements 3-1
- 3.3 Analytical Data Review and Reporting 3-1
- 3.4 Analytical Data 3-2
- 3.5 Final Reporting and Archiving of Documents 3-2

4.0 Data Management and Assessment 4-1
- 4.1 Data Management 4-1
  - 4.1.1 Reporting 4-1
  - 4.1.2 Representativeness 4-1
  - 4.1.3 Data Review 4-1
- 4.2 Data Assessment 4-2
  - 4.2.1 Field Procedures 4-2
  - 4.2.2 Laboratory Procedures 4-2
  - 4.2.3 Accuracy 4-2
  - 4.2.4 Precision 4-2
- 4.3 Data Validation 4-3

5.0 References 5-1

1.0 Introduction

This Quality Assurance Project Plan (QAPP) details the quality assurance and quality control measures that will be taken during sample collection, shipment and analysis at the former General Electric facility located at 220 S. Dawson Street, Seattle WA (Site). The objective of this document is to ensure the procedures outlined in the Sampling and Analysis Plan (SAP) provide high quality data that can be used to accurately determine current site conditions. This document was prepared in accordance with Washington Department of Ecology Preparing Quality Assurance Project Plans for Environmental Studies, Publication No. 04-03-030 (Ecology, 2004).

Please refer to the SAP for project organization and detailed sampling procedures. A complete description of the project background can be found in the Interim Action Completion Report (RETEC, 2007).

2.0 Quality Assurance Procedures

2.1 Quality Control of Sample Collection

Samples collected for volatile analysis will be placed in two 40-ml volatile organic analyte (VOA) vials with zero headspace. Agitation will be minimized during sampling to reduce potential losses of volatile constituents. Table 3-3 of the SAP summaries sample handling, sample preservation requirements, and laboratory reporting limits for routine groundwater samples collected at the site. Additional parameters may be called for in specific reports/correspondence; in such cases, the reports/correspondence will detail any additional handling and preservation requirements.

At least one duplicate sample shall be collected for each 10 investigation samples. Trip blanks will be carried each day that more than one well is sampled for volatile constituents. Trip blanks will be prepared by the laboratory by filling representative glassware with known deionized water. These samples will be transported with the sample collection glassware and analyzed for evidence of systematic contamination from sample transport, glassware cleaning, and laboratory storage. Trip blanks will be sent with each day's samples shipped, one trip blank per cooler At least one matrix spike/matrix spike duplicate (MS/MSD) will be collected per 20 investigation samples.

2.2 Sample Custody

All Chain-of-custody procedures, packaging of samples, and sampling log-in will be done in accordance with the procedures out lined in Section 4 of the SAP and in ENSR SOP 7510 (Appendix B of the SAP).

2.3 Quality Control Parameters

Groundwater will be collected for laboratory analysis as described in Section 3 of the SAP. To achieve the project data quality requirements, the following quality-control parameters will be evaluated throughout the course of this project:

- Detection limits
- Data precision
- Data accuracy
- Representativeness
- Comparability and completeness.

These quality-assessment parameters are described in greater detail in the subsequent paragraphs.

2.3.1 Detection Limits

The method detection limit for a given parameter is determined by procedures specified in the method. Table 3-2 of the SAP summarizes the detection limits, and methods used for volatiles organic carbons. These detection limits will be observed for all laboratory analyses performed during this project, except where matrix interferences and high concentrations of target and non-target compounds increase the reporting detection limits.

2.3.2 Precision

Precision will be determined for field duplicate samples by examining sample results for degree of variance and determining if sampling error has occurred. Precision is a measure of agreement among individual measurements of the same parameter, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. The relative percent difference (RPD) parameter will be calculated to define the precision between duplicate analyses.

The RPD for each component is calculated using the following equation:

$$\% \text{RPD} = \frac{(X_2 - X_1)}{[(X_1 + X_2)/2]} \times 100$$

where:

X_1 = first duplicate sample value

X_2 = second duplicate sample value

The laboratory objective for precision is to generate RPD values that fall within the established control limits for the method employed. The field objective for precision is to generate RPD values that are between 0 and 50 percent for soil samples and 0 to 30 percent for groundwater samples. If the criteria are not met, the Data Validator will examine other quality-control criteria to determine the need for some qualification of the data.

2.3.3 Accuracy

Accuracy is defined as the degree of agreement between a measurement and an accepted reference of true concentration. Accuracy is determined by spiking samples with a known concentration of standard compounds and comparing the analytical results with the known value. Data accuracy will be assessed by determining the percent recovery of a spiked compound. Percent recovery (%R) is determined by the equation:

$$\% \text{R} = \frac{(C_1 - C_0)}{C_S} \times 100$$

where:

C_1 = measured concentration in the spiked sample

C_o = measured concentration in the unspiked sample

C_s = concentration at which the sample was spiked

The concentration at which the sample was spiked (Cs) is calculated, using the following equation:

$$C_S = \frac{(C_{spike} \times V_{spike})}{V_{sample} + V_{spike}}$$

where:

C_s = concentration at which the sample was spiked

C_{spike} = spike concentration

V_{spike} = volume of spike

V_{sample} = volume of sample

The laboratory objective for accuracy is to generate %Rs that fall within established control limits for the method employed.

Surrogate and matrix spiking compounds and sample selection for spiking are determined by current SW-846 methodologies. Percent recoveries indicate the actual performance of the analytical method on real world samples. Surrogate spikes, matrix spikes, matrix spike duplicates, and QC spikes will be conducted using standard laboratory methods.

2.3.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic population, a process control, or an environmental condition. Appropriate sampling procedures (i.e., those sampling procedures presented in the attached SOPs) will be implemented so that the samples are representative of the environmental matrices from which they were obtained.

2.3.5 Comparability and Completeness

Comparability is achieved through the use of the same analytical methods that were used previously, through use of trained personnel and through following procedures in the SOPs. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The completeness goal will be at least 90 percent.

2.4 Calibration Procedures and Frequency

This section establishes the procedures for maintaining the accuracy of instruments and measuring equipment to conduct field measurements and tests.

The Sampling Technician is responsible for the calibration of field equipment (see ENSR SOPs in Appendix B of the SAP). The responsibility for the calibration of laboratory equipment lies with the Analytical Laboratory internal project manager.

2.4.1 General Calibration Procedures

Field testing equipment used for analytical determinations falls into two categories: those calibrated prior to each use and those calibrated on a scheduled periodic basis. Frequency of calibration will be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, the intended use and experience. The table below presents the calibration frequency of the field sampling equipment. Calibration procedures and quality assurance/quality control methods will conform to the SOP 7320, 7125, 7101, and 7315; summarized below.

Instrument	Calibration Procedure	Calibration Frequency
pH meter	Two-point calibration with pH buffers 7 and 4, or 10, as appropriate; see ENSR SOP 7320	Daily
Conductivity meter	See ENSR SOP 7320	Daily
DO meter	Two-point calibration; see ENSR SOP 7320	Daily
Redox meter	See ENSR SOP 7320	Daily
Thermometer	Check with ohm meter or standard thermometer; see ENSR SOP 7320	Annually
Photoionization detector	Isobutylene gas standard; see ENSR SOP 7315	Daily
Electric water-level probe	Test probe in tap water; check tape against known length see ENSR SOP 7101	Probe; as needed if malfunctions; tape

		length: annually
Turbidity Meter	3-point calibration; see ENSR SOP 7125	Daily

Equipment will be calibrated using reference standards (i.e., National Bureau of Standards (NBS), manufacturer's standards, or accepted values of natural physical constants). If national standards do not exist, the basis for calibration will be documented in the daily field activity log. Field equipment calibration will be performed as described by the equipment manufacturer.

2.4.2 Calibration Failures

Scheduled periodic calibration of testing equipment will not relieve field personnel of the responsibility to verify that equipment is functioning properly. If an individual suspects an equipment malfunction, she/he will remove the device from service, tag it so that it is not inadvertently used, and see that recalibration is performed or substitute equipment is obtained. Instruments past due for calibration will be immediately removed from service either physically or, if this is impractical, by tagging, sealing, labeling, or other means.

Results of activities performed using equipment that has failed recalibration will be evaluated by the Project Engineer/Geologist. If the activity results are adversely affected, the results of the evaluation will be documented, and the appropriate personnel notified. If water level measurements are found to be in error due to recalibration failure of the water level probe, the appropriate modifications will be made to the measurement according to the recalibration data and recorded in the data logbook. If pH, conductivity, or temperature meters fail recalibration, the data will be reviewed to determine whether alternate parameter data are sufficient to accept the groundwater sampling results. For instance, if the conductivity meter fails recalibration, pH and temperature readings will be used to verify that the purge water has stabilized. Since these parameters are calibrated prior to each use, it is unlikely that the data will be unacceptable.

2.4.3 Calibration Records and Maintenance

The Sampling Technician will document all calibration dates and methods on the calibration log or on the daily field log. Calibrated equipment will be uniquely identified by using the manufacturer's serial number or other means. Copies of all calibration records will be included in any summary reports generated for the field activities.

3.0 Analytical Procedures

The laboratories utilized for analysis of samples collected under the SAP shall perform all analysis according to EPA-accepted methods. Accepted EPA methods consist of those methods which are documented in the "*Contract Lab Program Statement of Work for Organic Analysis*" or any alternative method that has been approved by EPA for use during this project. The specific analytical methods to be used during the investigation will be specified in work plans. The analytical method procedures are detailed in the laboratory QA manual, available upon request from the laboratory.

3.1 Analytical Laboratories

Analytical Resources, Incorporated (ARI) of Seattle, Washington will perform analysis on all water samples collected as described in Section 3 of this SAP. The Laboratory Coordinator is Mark Harris.

3.2 General Requirements

In general, ARI will adhere to those recommendations as promulgated in 21 CFR Part 58, "Good Laboratory Practices," criteria described in Methods for Chemical Analysis of Water and Wastes, 1979 (EPA-600/4-79-020); procedures described in SW-846 Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, Third Edition, 1994; and those criteria presented in 40 CFR 136, "Guidelines Establishing Test Procedures for Analysis of Pollutants Under the Clean Water Act."

3.3 Analytical Data Review and Reporting

Data quality and utility depends on many factors, including sampling methods, sample preparation, analytical methods, quality control, and documentation. Physical and chemical data have been divided into five categories (EPA Region V Model Quality Assurance Project Plan, 1991), as follows:

- **Level V B Nonstandard Methods.** Analyses by nonstandard protocols, such as ultra-low detection limits or analysis of an unusual chemical compound. These analyses often require method modification and/or development. CLP (Contract Laboratory Program) Special Analytical Services (SAS) projects are considered Level V.
- **Level IV B CLP Routine Analytical Services (RAS).** This level is characterized by rigorous QA/QC protocols and documentation, and it provides qualitative and quantitative analytical data. Some EPA regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
- **Level III B Laboratory Analysis Using Methods Other than the CLP RAS.** This level is used primarily in support of engineering studies, using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS, without the CLP document requirements.
- **Level II B Field Analysis.** This level is characterized by the use of portable analytical instruments which can be used on-site or in mobile laboratories stationed near a site (close-support labs). Depending upon the types of impacts, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.
- **Level I B Field Screening.** This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. The types of data included are those generated on site through the use of PID, pH, conductivity, or other real-time monitoring equipment. Data can be generated regarding the presence or absence of certain materials (especially volatiles) at sampling locations.

The data generated in this project will be prepared and reviewed for Level III validation. ARI will use EPA methods to identify analytical values that do not meet the required ranges for surrogate recoveries and matrix spike recoveries. If such values are identified, then the analysis must be repeated. If the re-analyzed values are within required limits and holding times, they will be reported as true values. If, in the repeated analysis, the values are still outside required limits, the data are considered to be invalid, and matrix effects are considered to have caused the values to be outside of the acceptable recovery limits (Table 3-3 of the SAP).

3.4 Analytical Data

ARI will submit results which are supported by sufficient backup data and QA/QC results to enable the quality of the data to be determined conclusively. Prior to release of data, the ARI Laboratory Coordinator(s) will: review the data package for reasonableness; review QC data results; verify that calculation checks were properly performed; review chain-of-custody record(s), sample preservation, and holding-time requirements; and write a project narrative. Data that are not acceptable will be held until the problems are resolved. Section 2 of this QAPP describes the procedures that are employed to evaluate the precision, accuracy, representativeness, and completeness of the analytical test data generated during this project. It is the responsibility of the QA Officer to review these parameters. Validity of all data will be determined based on the criteria described in Section 2.

3.5 Final Reporting and Archiving of Documents

Upon successful completion of the data validation process, all data generated at the site will be tabulated and stored in an electronic data base file. Data summaries and results will be submitted in final report form. This report will consist of all pertinent sample and project information. It will also identify analytical procedures.

Copies of all analytical data and/or final reports will be retained in the laboratory files, and at the discretion of the Laboratory Coordinator(s), the data will be stored for a minimum of 1 year. After 1 year, or whenever the data become inactive, the files will be transferred to archives in accordance with standard laboratory procedure. Data may be retrieved from archives upon request.

4.0 Data Management and Assessment

The data collected and validated as part of the monitoring program will be combined with the extensive data already compiled for the Site. This section discusses the management of data generated as part the field effort.

4.1 Data Management

4.1.1 Reporting

After receipt of the analytical results, the QA Officer will review all raw data, including QA/QC data from the sample analyses.

Periodic reports will include a summary of data reduction results and a discussion of any inconsistencies that exist from a data-use standpoint. All field data sheets will be included as an appendix in the reports. All raw data will be appropriately identified in reports and included in a separate appendix of the report.

4.1.2 Representativeness

The determination of the representativeness of the data will be performed by:

- Comparing actual sampling procedures to those delineated in this plan;
- Examining the results of QC blanks for evidence of external or cross-contamination; such evidence may be cause for invalidations or qualification of the affected samples;
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative. Only representative data will be used in subsequent data reduction, validation activities, and facility characterization.

The analytical results of the equipment blank samples (cross-contamination) and trip blank samples (external contamination) will be compared to the results of the field samples to determine if the level of impact is significant. The rule of 5x will be used when chemicals are measured in a blank sample. This rule states that if a sample concentration is less than five times (5x) the blank, the sample should be qualified as non-detectable (EPA, 1988).

4.1.3 Data Review

The objective of the data review is to identify any qualitative, unreliable, or invalid laboratory measurements. Data review entails a review of the laboratory-provided QC data to verify that the laboratory is properly performing the QC program and is operating within the required control limits. As a result, it will be possible to determine which samples, if any, are related to out-of-control laboratory QC samples. Laboratory data will be screened for inclusion of and frequency of the necessary QC supporting information, such as detection limit verification, duplicates, spikes, and method blanks. QC supporting information will be screened to determine whether any data are outside established control limits. Any out-of-control data without appropriate corrective action will be cause to qualify the affected measurement data. Missing or infrequent QC information will be cause to contact the laboratory concerning affected measurement data and to request additional QC supporting information for re-analysis.

4.2 Data Assessment

4.2.1 Field Procedures

Quality control procedures for field instruments will be limited to periodic instrument calibration as described in Section 5.

4.2.2 Laboratory Procedures

Following the assessment of laboratory data for the inclusion of required QC data, the QC data will be analyzed for accuracy and precision. If quality control audits result in the detection of unacceptable data, the QA Officer will be responsible for initiating corrective action, which may include:

- Re-analyzing samples if holding-time criteria permit;
- Re-sampling and analyzing;
- Evaluating and amending sampling and analytical procedures;
- Accepting data and acknowledging the level of uncertainty.

4.2.3 Accuracy

The accuracy of the data will be determined as follows:

- Computing percent recoveries for spiked samples;
- Calculating the standard deviation in the overall average recovery value;
- Determining the range of uncertainty at a given level of confidence.

The accuracy of the data will be used to determine any bias in the analytical methods. The field sample results will not be adjusted for bias, but the bias will be considered in the interpretation of the data.

4.2.4 Precision

The determination of the precision of the data will be performed by examining duplicate samples for degree of variance and by determining if sampling error has occurred by the variance of duplicates. The precision values calculated from the field duplicates will be used in the data interpretations to determine how sensitive the site characterizations are to the variances in the data.

Specific precision targets cannot be formulated without baseline precision data. However, the precision data will be summarized into the following categories. For each compound or element, the number of field duplicates with variance in the following ranges will be evaluated:

- Less than 10 percent
- 10 to 25 percent
- 25 to 50 percent
- Greater than 50 percent.

This will provide qualitative information to the individuals interpreting the data as to the range of variances and will also allow the proper planning for QC samples in future sampling episodes.

4.3 Data Validation

After reviewing the laboratory analytical data, the QA officer will provide the Data Validator with the data and field notes from the applicable sampling activities. The Data Validator will compare the actual sampling and laboratory procedures to those explained in this plan, identify any questionable or qualitative data, and report the validation results to the QA Officer.

5.0 References

Ecology, 2004. Preparing Quality Assurance Project Plans for Environmental Studies, Publication No. 04-03-030. Washington Department of Ecology, July 2004.

ENSR, 2008. Sampling Analysis Plan. ENSR, January 23, 2008.

EPA, 1979. 21 CFR, Part 58 -- Good laboratory practices. In: *Methods for Chemical Analysis of Water and Wastes*. U.S. Environmental Protection Agency, EPA-600/4-79-020.

EPA, 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses*. U.S. Environmental Protection Agency, Region I.

EPA, 1991. *EPA Region V Model Quality Assurance Project Plan*. U.S. Environmental Protection Agency, Region V, Office of Superfund.

EPA, 1994. *Test Methods for Evaluating Solid Waste -- Physical/Chemical Methods*. Third Edition. U.S. Environmental Protection Agency. SW-846.

Guidelines establishing test procedures for analysis of pollutants under the Clean Water Act. In: 40 CFR, Part 136.

RETEC, 2007. *Interim Action Completion Report*. The RETEC Group, Inc. March 2007.

Appendix B

ENSR SOPs

ENSR | AECOM

Chain-of-Custody Procedures

SOP Number 7007

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

Chain-of-Custody Procedures

CONTENTS

1.0 SCOPE AND APPLICABILITY 3
2.0 SUMMARY OF METHOD 3
3.0 HEALTH AND SAFETY WARNINGS 3
4.0 INTERFERENCES 3
5.0 PERSONNEL QUALIFICATIONS 3
6.0 EQUIPMENT AND SUPPLIES 3
7.0 METHODS 4
7.1 Field Custody 4
7.2 Laboratory Sample Receipt and Inspection 5
8.0 DATA AND RECORDS MANAGEMENT 6
9.0 QUALITY CONTROL AND QUALITY ASSURANCE 6
10.0 REFERENCES 6
FIGURE 1 EXAMPLE CHAIN OF CUSTODY FORM 7
FIGURE 2 EXAMPLE CHAIN OF CUSTODY TAPE 8

LIST OF ACRONYMS

COC	Chain-of-Custody
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes chain-of-custody (COC) procedures applicable to ENSR sampling and analysis programs.

2.0 SUMMARY OF METHOD

The National Enforcement Investigations Center of the U.S. Environmental Protection Agency (USEPA) defines custody of evidence in the following manner:

- It is in your actual possession;
- It is in your view, after being in your physical possession;
- It was in your possession and then you locked or sealed it up to prevent tampering; or
- It is in a secure area.

Samples are physical evidence and should be handled according to certain procedural safeguards described in of this SOP.

3.0 HEALTH AND SAFETY WARNINGS

Not applicable.

4.0 INTERFERENCES

Not applicable.

5.0 PERSONNEL QUALIFICATIONS

Individuals responsible for completing COC documentation must be personnel working on the specific field program, have read this SOP, and have worked under the oversight of experienced personnel.

6.0 EQUIPMENT AND SUPPLIES

General field supplies include the following items:

- Sample Labels

- COC Form (Figure 1)
- COC Tape (Figure 2)
- Field project logbook/pen

7.0 METHODS

7.1 Field Custody

7.1.1 The field personnel is required to complete the following information on the COC form (Figure 1):

- Project Number (not project name)
- Project Location
- Field Sample Identification Number
- Date and Time of Sample Collection
- Sample Matrix
- Preservative
- Analysis Requested
- Sampler's Signature
- Signature of Person Relinquishing Sample Custody
- Date and Time Relinquished
- Sampler Remarks
- COC Tape Number

7.1.2 The COC must be filled out completely and legibly in ink. Corrections will be made, if necessary, by drawing a single line through and initialing and dating the error. The correct information is then recorded with indelible ink. All transfers from field personnel to laboratory personnel are recorded on the COC form in the "Relinquished By" and "Received By" sections.

7.1.3 If samples are to be shipped by overnight commercial courier (e.g., Federal Express), the field personnel must complete a COC form for each package (e.g., cooler) of samples and place a copy of each completed form inside the associated package before the package is sealed. Each completed COC form must accurately list the sample identification numbers of the samples with which it is packaged, and must contain the identification number of the COC tape on the package. It is not necessary for the shipping company to sign the COC.

Sample packaging will be conducted in accordance with ENSR SOP No. 7510 – Packaging and Shipment of Environmental Samples.

7.1.4 If samples are hand carried to a laboratory, the person hand carrying the samples is the sample custodian. If the carrier is a different person than the one who filled out the COC form and packaged the samples, then that person must transfer custody to the carrier by signing and dating each form in the "Relinquished By" section. The carrier must then sign and date each form in the adjacent "Received By" section. When the carrier transfers the samples to the laboratory, he or she must sign and date each form in the next "Relinquished By" section, and the laboratory sample custodian must sign and date each form in the adjacent "Received By" section.

7.2 Laboratory Sample Receipt and Inspection

7.2.1 Upon sample receipt, the coolers or packages are inspected for general condition and the condition of the COC tape. The coolers or boxes are then opened and each sample is inspected for damage.

7.2.2 Sample containers are removed from packing material and sample label field identification numbers are verified against the COC form.

7.2.3 The following information is recorded in the laboratory's records:

- Airbill Number
- Presence/absence of COC forms and COC tape
- Condition of samples
- Discrepancies noted
- Holding time and preservatives
- Sample storage location

7.2.4 The COC form is completed by signing and recording the date and time of receipt.

7.2.5 The ENSR Project Manager or designate must be notified of any breakage, temperature exceedances, or discrepencies between the COC paperwork and the samples.

8.0 DATA AND RECORDS MANAGEMENT

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion, and in the files of the laboratories that have performed the sample analyses.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

The records generated in this procedure are subject to review during data validation, in accordance with the Quality Assurance Project Plan (QAPP).

10.0 REFERENCES

ENSR SOP No. 7510 - Packaging and Shipment of Environmental Samples.

FIGURE 1 EXAMPLE CHAIN OF CUSTODY FORM

M901878

ENSR CHAIN OF CUSTODY RECORD Page ___ of ___

Client/Project Name:	Project Location:	Analysis Requested
Project Number:	Field Logbook No.:	
Sampler: (Print Name) (Affiliation)	Chain of Custody Tape No.:	
Signature:	Send Results/Report to:	

Field Sample No./Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination): ENSR 4303 W. LaPorte Ave. Fort Collins, CO 80521 (970) 416-0916
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No.

FIGURE 2 EXAMPLE CHAIN OF CUSTODY TAPE

ENSR | AECOM

Water Level Measurements

SOP Number 7101

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

Water Level Measurements

CONTENTS

1.0 SCOPE AND APPLICABILITY 3
2.0 SUMMARY OF METHOD 3
3.0 HEALTH AND SAFETY WARNINGS 3
4.0 INTERFERENCES 4
5.0 PERSONNEL QUALIFICATIONS 4
6.0 EQUIPMENT AND SUPPLIES 4
6.1 Electronic Water Level Meter 4
6.2 Other Materials 5
7.0 METHODS 5
7.1 General Preparation 5
7.2 Measurement Procedures 5
8.0 DATA AND RECORDS MANAGEMENT 6
9.0 QUALITY CONTROL AND QUALITY ASSURANCE 7
10.0 REFERENCES 7

LIST OF ACRONYMS

SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
QAPP	Quality Assurance Project Plan
OSHA	Occupational Safety and Health Administration
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICABILITY

This Standard Operation Procedure (SOP) describes the methods to be used for measuring depth to groundwater levels and total depth of groundwater monitoring wells and piezometers. Similar procedures will also be used to measure the depth to water in surface water bodies from fixed structures such as bridges or culverts.

Water level and well depth measurements collected from monitoring wells or piezometers are used to assess:

- The horizontal hydraulic gradient and the direction of groundwater flow;
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane); and
- The calibration of a numerical groundwater flow model.

This information, when combined with other location-specific information, such as hydraulic conductivity or transmissivity, may be used to estimate the rate of constituent movement, etc. Total well depth measurements are also collected as an indicator of siltation within the well column, and to calculate well volumes if necessary.

2.0 SUMMARY OF METHOD

Measurements will involve measuring the depth to water or total well depth to the nearest 0.01 foot using an electronic probe (water level meter). The depths within wells will be measured from the top of the inner casing at the surveyed elevation point as marked on the top of the inner casing. Depths to surface water will be measured from a mark placed on the fixed structure (e.g., bridge, culvert) by the surveyor.

3.0 HEALTH AND SAFETY WARNINGS

Collecting water level measurements may involve chemical hazards associated with materials in the water being in contact with the water level measurement equipment. When collecting water level measurements, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result in inaccurate readings if the sensor on the water level meter is wet or dirty, or if the cable cannot be kept vertically upright (for example, from a bridge in the wind). Care shall be taken to keep the probe clean. If wells are not installed plumb, the probe may rest against the side of the well, which may be wet. Care shall be taken in measuring water levels to reduce these interferences. If there is any concern that a particular reading may not be accurate, this shall be noted in the field log book.

5.0 PERSONNEL QUALIFICATIONS

Collecting water level measurements is a relatively simple procedure requiring minimal training and a relatively small amount of equipment. It is recommended that the collection of water level measurements be initially supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP and health and safety requirements outlined within the Sampling Analysis Plan (SAP) and HASP. Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water level measurements, as well as proper documentation in the field logbook or field forms (if appropriate).

6.0 EQUIPMENT AND SUPPLIES

6.1 Electronic Water Level Meter

Electronic water level meters consist of a spool of small-diameter cable (or tape) with a weighted probe attached to the end. The cable (or tape) is marked with measurement increments in feet (accurate to 0.01 feet), with the zero point being the tip of the probe. When the probe comes in contact with the water, an electrical circuit is closed, and a light and/or buzzer within the spool will signal the contact. The probe shall be tested at the start of the field program to ensure proper operation.

6.2 Other Materials

Other materials that may be required:

- Health and safety supplies (as required by the HASP)
- Equipment decontamination materials (as required by ENSR SOP No. 7600Pines – Decontamination of Field Equipment)
- Plastic sheeting or bucket for resting instrument off the ground
- Water level field form (if applicable)
- Well construction records
- Approved plans (e.g., SAP, QAPP, HASP)
- Field project logbook/pen

7.0 METHODS

7.1 General Preparation

7.1.1 Well Records Review: Well completion diagrams should be reviewed to determine well construction characteristics. Historic static water level measurements and survey information should also be reviewed.

7.1.2 Water Level/Well Depth Measurement: The water level and well depth should be measured with a water level meter and written in the field logbook or field form. This information is used to calculate groundwater elevations. All data will be maintained in the project files.

7.1.3 Equipment Decontamination: All equipment should be decontaminated prior to use and between well locations in accordance with ENSR SOP No. 7600Pines - Decontamination of Field Equipment.

7.2 Measurement Procedures

7.2.1 At each location (well, piezometer, staff gauge, etc.), determine the location of the surveyed elevation mark. For wells, general markings include either a notch in the riser pipe or a permanent ink (generally black ink) mark on the riser pipe. For monitoring surface water levels, there may be a painted mark on an existing structure or the reference point must be known if not painted.

7.2.2 To obtain a water level measurement, lower the probe of a water level meter down into the water until the audible sound of the unit is detected or the light on an electronic sounder illuminates. In wells, the probe shall be lowered slowly into the well to avoid disruption of formation water and creation of turbulent surface water within the well. At this time, the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the surveyed elevation mark.

7.2.3 Record the water level measurement as well as the location identification number, measuring point (surveyed elevation point), date, time, and weather conditions in the field logbook and/or field form.

7.2.4 To measure the total depth of a well, lower the probe (turn down signal as appropriate) slowly to the bottom of the well. The depth may be difficult to determine for wells with "soft" or silty bottoms. It may be helpful to lower the probe until there is slack in the tape, and gently pull up until it feels as if there is a weight at the end of the tape. Observe the measurement (to the nearest 0.01 foot) of the tape against the surveyed elevation mark.

7.2.5 Record the total well depth in the field logbook and/or field form.

7.2.6 The meter will be decontaminated in accordance with ENSR SOP No. 7600Pines – Decontamination of Field Equipment. Generally, only that portion of the tape that enters the water table needs to be decontaminated. It is important that the measuring tape is never placed directly on the ground surface or allowed to become kinked.

8.0 DATA AND RECORDS MANAGEMENT

All field information will be recorded in the field logbook or on a field collection form by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the measurement process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Field personnel will follow specific quality assurance guidelines as outlined in the Quality Assurance Project Plan (QAPP) and/or SAP. Where measured depths are not consistent with well records or previously measurements, the depths should be re-measured and verified.

10.0 REFERENCES

ENSR SOP No. 7600– Decontamination of Field Equipment. Revision 0.0.

ENSR | AECOM

Field Measurement of Turbidity

SOP Number 7125

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

CONTENTS

1.0 SCOPE AND APPLICABILITY 3

2.0 SUMMARY OF METHOD 3

3.0 HEALTH AND SAFETY WARNINGS 3

4.0 INTERFERENCES 3

5.0 PERSONNEL QUALIFICATIONS 3

6.0 EQUIPMENT AND SUPPLIES 4
- 6.1 Nephelometric/Turbidity Meter 4
- 6.2 Other Required Materials 4

7.0 METHODS 5
- 7.1 Calibration 5
- 7.2 Collection of Measurements 6

8.0 DATA AND RECORDS MANAGEMENT 7

9.0 QUALITY CONTROL AND QUALITY ASSURANCE 7

10.0 REFERENCES 7

LIST OF ACRONYMS

SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
NIST	National Institute of Standards
NTU	Nephelometric Turbidity Unit
QAPP	Quality Assurance Project Plan
OSHA	Occupational Safety and Health Administration
SOP	Standard Operating Procedure
USEPA	U. S. Environmental Protection Agency

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) provides basic instructions for routine calibration and operation of nephelometers or turbidity meters to measure turbidity (e.g., such as the HF Scientific Model DFT 15CE). This SOP is designed specifically for the measurement of turbidity in accordance with U.S. Environmental Protection Agency (USEPA) Method 180.1 and Standard Methods 2130 B which address turbidity measurements for drinking water, surface water and groundwaters, and saline waters.

2.0 SUMMARY OF METHOD

Turbidity is a measure of the clarity of the water being monitored. Turbidity data can be used to establish sufficiency of well purging prior to groundwater sampling, or provide general water quality information for any water being monitored.

For this project, turbidity will be measured in a separate container, not using a multi-parameter meter placed in a flow-through cell.

3.0 HEALTH AND SAFETY WARNINGS

Measuring turbidity may involve chemical hazards associated with materials in the water being monitored and instrument calibration solutions, and physical hazards associated with general field work. The health and safety considerations will be addressed in the site-specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences will be controlled through appropriate calibration of the instruments, and decontamination between samples.

5.0 PERSONNEL QUALIFICATIONS

To properly perform turbidity measurements, the analyst must be familiar with the calibration and measurement techniques stated in this SOP. The analyst must also be experienced in the operation of the meter.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP and within the Sampling Analysis Plan (SAP), the Quality Assurance Project Plan (QAPP) and the health and safety requirements outlined HASP. Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used in the calibration and operation of the turbidity meter, as well as proper documentation in the field logbook or field forms (if appropriate).

6.0 EQUIPMENT SUPPLIES

6.1 Nephelometer/turbidity meter

The following materials are necessary for this procedure:

- Turbidity meter
- Turbidity meter manufacturer's instruction manual
- Turbidity-free water
- Clean, scratch-free sample tubes
- Formazin or polymer-based calibration standards
- Lint-free tissues
- National Institute of Standards and Technology (NIST)-traceable check standard
- Calibration/field data sheets and/or field logbooks/pen

6.2 Other Required Materials

Other materials that may be required to facilitate use of the instruments in the field include:

- Flow cup, bucket, or other container(s)
- Replacement batteries
- Health and safety supplies (as required by the HASP)
- Distilled/deionized water supply
- Deionized water dispenser bottler

- Equipment decontamination materials (as required by ENSR SOP No. 7600 – Decontamination of Field Equipment)
- Approved plans (e.g., HASP, SAP, QAPP)
- Field project logbook/pen

7.0 METHODS

7.1 Calibration Procedures

7.1.1 The turbidity meter must be calibrated daily before any analyses are performed. The check standard reading should be within the acceptance limits specified in the QAPP. It will also be checked daily with the calibration solutions at the end of use of the equipment (post-calibration).

Calibration records shall be recorded in the field logbook or a calibration form. Calibration documentation must be maintained in a thorough and consistent manner. At a minimum, the following information must be recorded:

- Date and time of calibration
- Signature or initials of person performing the measurement
- Instrument identification number/model
- Expiration dates and batch numbers for all standards
- Reading for calibration standard before and after meter adjustment
- Comments

7.1.2 Follow the manufacturer's operating instructions for calibrating the turbidity meter.

7.1.3 Place check standards into clean, scratch-free sample tubes. Wipe the tube with a lint-free cloth and insert the tube into the analysis chamber.

7.1.4 Follow the manufacturer's operating instructions for reading samples.

7.1.5 Verify the calibration at the end of the day with a check standard (post-calibration). The check standard reading should be within the acceptance limits specified in the QAPP.

7.2 Collection of Measurements

7.2.1 Follow the manufacturer's operating instructions for operating the turbidity meter.

7.2.2 Place water samples into clean, scratch-free sample tubes. Wipe the tube with a lint-free cloth and insert the tube into the analysis chamber.

7.2.3 Follow the manufacturer's operating instructions for reading samples.

7.2.4 Sample turbidity results in Nephelometric Turbidity Units (NTUs) will be recorded on the appropriate field data sheets or logbooks. Turbidity readings should be recorded as follows:

Turbidity Range NTU	Report to the Nearest NTU
0-1.0	0.05
1-10	0.1
10-40	1
40-100	5
100-400	10
400-1000	50
>1000	100

7.2.5 Documentation for recorded data must include a minimum of the following

- Date and time of analysis
- Signature or initials of person performing the measurement
- Instrument identification number/model
- Sample identification/station location
- Comments

8.0 DATA AND RECORDS MANAGEMENT

Calibration records will be recorded in the field logbook or appropriate field form. All field information will be recorded in the field logbook or on a field collection form by field personnel.

In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the calibration and measurement process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Field personnel will follow specific quality assurance guidelines as outlined in the QAPP and/or SAP.

10.0 REFERENCES

ENSR SOP No. 7600 – Decontamination of Field Equipment. Revision 0.0.

Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.

Methods for the Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised 1983.

ENSR | AECOM

Groundwater Sample Collection from Monitoring Wells – Low Flow

SOP Number 7130

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

CONTENTS

1.0 SCOPE AND APPLICABILITY 3

2.0 SUMMARY OF METHOD 3

3.0 HEALTH AND SAFETY WARNINGS 3

4.0 INTERFERENCES 3

5.0 PERSONNEL QUALIFICATIONS 3

6.0 EQUIPMENT AND SUPPLIES 4

7.0 METHODS 5
- 7.1 Instrument Calibration 5
- 7.2 Well Security and Condition 5
- 7.3 Measuring Point Determination 6
- 7.4 Water Level Measurement 6
- 7.5 Purge Volume Calculation 6
- 7.6 Well Purging Methods and Procedures 6
- 7.7 Sample Collection Methods and Procedures 11
- 7.8 Sample Handling and Preservation 12
- 7.9 Equipment Decontamination 12

8.0 DATA AND RECORDS MANAGEMENT 12
- 8.1 Sample Chain-of-Custody Record 13
- 8.2 Sample Collection Record 13
- 8.3 Field Logbook 13
- 8.4 Sample Labels 13

9.0 QUALITY CONTROL AND QUALITY ASSURANCE 14
- 9.1 Field Blank/Equipment Blank Sample Collection 14
- 9.2 Field Duplicate Sample Collection 14
- 9.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Collection 15

10.0 REFERENCES 15

FIGURE 1 – EXAMPLE GROUNDWATER SAMPLE COLLECTION RECORD 16

LIST OF ACRONYMS

DO	Dissolved Oxygen
SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
IDEM	Indiana Department of Environmental Management
L/min	Liter per minute
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NTU	Nephelometric Turbidity Units
OLQ	Office of Land Quality
ORP	Oxygen Reduction Potential
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedure
TOC	Top of Casing
USEPA	United States Environmental Protection Agency

1.0 SCOPE AND APPLICABILITY

This Standard Operation Procedure (SOP) describes the method for collecting valid and representative samples of groundwater from monitoring wells. This SOP is written such that consideration of different sampling equipment may be used in different instances for collecting representative groundwater samples.

2.0 SUMMARY OF METHOD

Groundwater sample collection generally involves purging the stagnant water from a well while monitoring field parameters. After field parameters have stabilized, groundwater samples are then collected into the appropriate bottleware.

3.0 HEALTH AND SAFETY WARNINGS

Groundwater sampling may involve chemical hazards associated with exposure to materials in the groundwater being investigated and physical hazards associated with groundwater sampling equipment. When groundwater sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures will be addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between samples and sample locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per ENSR SOP No. 7600 – Decontamination of Field Equipment.

5.0 PERSONNEL QUALIFICATIONS

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling of groundwater wells be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this SOP, and with specific sampling, quality assurance, and health and safety requirements outlined in the Sampling Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and HASP. Field personnel are responsible for collecting groundwater samples, decontamination of equipment, as well as proper documentation of sampling activities in the field logbook or field forms (as appropriate).

6.0 EQUIPMENT AND SUPPLIES

General field supplies include the following items:

- Purging and Sampling Pumps
  - Grundfos Redi-flo2™ submersible pumps
  - Bladder pumps
- Field Instruments
  - Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity
  - Water level meter
- Sample Collection Records (Figure 1)
- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice)
- Sample Chain-of-Custody forms (as required by ENSR SOP No. 7007 – Chain-of-Custody Procedures)
- Sample packaging and shipping supplies (as required by ENSR SOP No. 7510– Packaging and Shipment of Environmental Samples)
- Waterproof marker or paint
- Distilled/deionized water supply
- Deionized water dispenser bottler
- Flow measurement cup or bucket
- Buckets
- Instrument calibration solutions
- Power source

- Paper towels
- Plastic sheeting
- Trash bags
- Zipper-lock bags
- Equipment decontamination supplies (as required by ENSR SOP No. 7600 – Decontamination of Field Equipment)
- Health and safety supplies (as required by the HASP)
- Approved plans (e.g., HASP, SAP, QAPP)
- Field project logbook/pen

7.0 METHODS

7.1 Instrument Calibration

Field instruments will be calibrated daily according to the requirements of the QAPP and manufacturer's specifications for each piece of equipment (e.g., ENSR SOP No. 7320 - Operation and Calibration of a Multi-Parameter Water Quality Monitor). Equipment will also be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.

7.2 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information may be noted on the Groundwater Sample Collection Record (Figure 1) or in the field logbook:

- Condition of the well's identification marker
- Condition of the well lock and associated locking cap
- Integrity of the well - protective outer casing, obstructions or kinks in the well casing presence of water in the annular space, and the top of the interior casing
- Condition of the general area surrounding the well

7.3 Measuring Point Determination

Before collecting a water level measurement, check for an existing measuring point (notch, or other visible mark) established either at the time of well installation or by the latest survey. Generally, the measuring point is referenced from the top of the well casing (TOC), not the protective casing. If no measuring point exists, a measuring point should be established, clearly marked, and identified on the Groundwater Sample Collection Record (Figure 1) or the field logbook. The same measuring point should be used for subsequent sampling events.

7.4 Water Level Measurement

Water level measurements should be collected in accordance with ENSR SOP No. 7101 – Water Level Measurements. The water level measurement should be entered on the Groundwater Sample Collection Record (Figure 1) or in the field logbook.

7.5 Purge Volume Calculation

Wells designated for sampling require purging to remove stagnant water in the well. A single casing volume of groundwater will be calculated after measuring the length of the water column and checking the well casing diameter. The Groundwater Sample Collection Record (Figure 1) provides information used to compute the casing volume, which includes a diagram, a numerical conversion table, and the standard calculation. The volume of standing water in the well (i.e., one purge volume) should be entered on the Groundwater Sample Collection Record (Figure 1).

7.6 Well Purging Methods and Procedures

7.6.1 Objectives

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove stagnant water from within the casing and gravel pack and to ensure that a representative groundwater sample is obtained.

All groundwater samples will be collected using low stress (low-flow) purging and sampling procedures according to the United States Environmental Protection Agency (USEPA) Region 1 SOP titled "Low Stress Purging and Sampling

Procedure for the Collection of Groundwater Samples from Monitoring Wells", Revision 2, July 1996 (USEPA, 1996) and Indiana Department of Environmental Management (IDEM) Office of Land Quality (OLQ) Geological Services Technical Memorandum titled "Micro-Purge Sampling for Monitoring Wells" dated January 8, 2003 (IDEM, 2003). The low-flow method emphasizes the need to minimize water level drawdown and low groundwater pumping rates to collect samples with minimal alterations to groundwater chemistry.

During well purging, the water level will be measured with a water level meter in accordance with ENSR SOP No. 7101 – Water Level Measurement. Water level drawdown and flow rate will be recorded on the Groundwater Collection Record (Figure 1). A final purging rate will be selected that does not exceed 0.5 liters per minute (L/min) (typically between 0.1 L/min and 0.3 L/min), and results in a stable drawdown, ideally less than 0.3 feet.

The general types of non-dedicated equipment used for well purging include surface pumps and down-well pumps. The purge method and equipment selected is specified in the SAP. For this project, peristaltic pumps will be used where depths to water are sufficiently shallow, and submersible pumps used where depths to water are too great for peristaltic pumps.

Purge water will be pumped through a flow-through cell and the following parameters will be measured: pH, specific conductivity, temperature, DO, and ORP. These parameters will be measured with a water quality meter, calibrated according to the manufacturer's specifications (see ENSR SOP No. 7105 - Operation and Calibration of a Multi-Parameter Water Quality Monitor). Turbidity will be measured separately with a nephelometer, also calibrated to the manufacturer's specifications (see ENSR SOP No. 7125 – Field Measurement of Turbidity). A round of parameter measurements will be recorded after the flow-through cell is full, approximately 10 minutes after the flow-through cell is full, and then approximately every 5 minutes thereafter, until parameter values have stabilized.

Purging is considered complete and sampling may begin when all parameter values have stabilized and turbidity is below 5 Nephelometric Turbidity Units (NTU). Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the following limits:

- Turbidity : less than 5 NTU or ± 10%
- DO : ± 10%
- Specific Conductance : ± 3%
- Temperature : ± 3%
- pH : ± 0.1 standard units
- ORP : ± 10 millivolts

Every effort will be made to lower the turbidity to less than 5 NTU before sampling. If the turbidity cannot be reduced to below 5 NTU, the pumping rate should be reduced. If turbidity still cannot be reduced below 5 NTU, samples may be collected if all other parameters are stable and the turbidity is stable, that is, not improving. The condition will be noted on the field form or in the logbook.

If low-flow purging cannot be achieved for a particular well (typically due to insufficient yield to establish a stable drawdown), the well may be purged dry, then sampled when sufficient water has recharged. The condition will be noted on the field form or in the logbook.

7.6.2 Surface Pumps

General

Well purging using pumps located at the ground surface can be performed with a peristaltic pump if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/minute (gal/min) (0.075-0.750 L/min). Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses and where volatile organic compounds are not being analyzed.

7.6.3 Down-Well Pumps

General

Groundwater withdrawal using non-dedicated down-well pumps may be performed with a submersible pump or a bladder pump.

Electric submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than 20 feet and where the depth or diameter of the well requires that a large purge volume be removed before sample collection.

A commonly available submersible pump, the Grundfos Redi-Flo2™ pump, is suited for operation in 2-inch or larger internal diameter wells. Pumping rates are adjusted to low-flow levels by adjusting the current to the pump motor rather than using a flow valve.

As an alternative method to using the submersible pump, bladder pumps may also be used. Bladder Pumps usually consist of a stainless steel pump housing with an internal Teflon® or polyethylene bladder. Discharge and air line tubing is connected to the bladder pump to the air compressor and control unit. The pump is operated by lowering it into the water column within the well screen, then pulsing air into the bladder from the air compressor and pump controller unit. Pumps and controllers are often not interchangeable between manufacturers; therefore, it is usually necessary to have both items provided by the same manufacturer. Pump bladders are generally field-serviceable and replaceable.

A check of well condition may be required prior to inserting any down-well pump if the well has not been sampled for some time or if groundwater quality conditions are not known. The well condition check should include a check of casing plumbness as a bent well casing could cause a pump to get stuck. Casing plumbness can be checked by lowering a clean cylindrical tube with the approximate pump dimensions into the well. If the well casing is not plumb then an alternative purging method should be used.

Submersible pumps (i.e., Grundfos Redi-Flo2™) will generally be used in wells where water levels are too deep to allow use of a peristaltic pump.

Electric Submersible Pump Procedure

Slowly lower the submersible pump with attached discharge line into the monitoring well taking notice of any roughness or restriction within the well riser pipe. The pump should be placed in the uppermost section of the static water column of the monitoring well. The power cord should be attached to the discharge line with an inert material (i.e., zip-ties) to prevent the power cord from getting stuck between the pump, discharge line, and the well casing. Secure the discharge line and power cord to the well casing, using tape or a clamp, taking care not to crimp or cut either the discharge line or power cord.

Connect the power cord to the power source (i.e., rechargeable battery pack, auto battery, or generator) and turn the pump on. Voltage and amperage meter readings on the pump controller (if provided) should be monitored closely during purging. The operations manual for the specific pump used should be reviewed regarding changes in voltage/amperage and the potential impacts on pump integrity. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet. Pumping should be discontinued if warning conditions occur and/or if the well is pumped to where drawdown falls below the pump's intake level.

Bladder Pump Procedure

As an alternative method to the submersible pump, bladder pumps may be used. To operate the bladder pump system, the pump and discharge line should be lowered into the well close to the bottom of the well screen, then secured to the well casing with a clamp. The air compressor should then be turned on to activate pumping. The pump controller is used to vary the discharge rate to the required flow. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

7.7 Sample Collection Methods and Procedures

7.7.1 Objectives

Groundwater samples can be collected using similar methods employed for purging. In most cases during sampling, groundwater will be transferred to the appropriate containers directly from the discharge source. It is important that the tubing from the pump to the flow-through cell be disconnected prior to sample collection. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers.

7.7.2 Down-Well Pumps

Using the pump methods described in Section 7.6.3, groundwater samples can be collected from either the electric submersible or bladder pump directly from the discharge line (after tubing has been disconnected from the flow-through cell). Sample bottles will be filled directly from the discharge line of the pump.

7.8 Sample Handling and Preservation

- Once each sample container is filled, clean the rim and threads of the sample container by wiping with a paper towel.
- Cap and label the container with (at a minimum) the sample identifier and sampling date and time. Additional information such as preservation information and analytical tests may also be added to the sample label as appropriate.
- Place the sample containers into a cooler and maintain on ice.
- Complete sample chain-of-custody and other documentation per ENSR SOP No. 7007 – Chain-of-Custody Procedures.
- Package the samples for shipment to the laboratory per ENSR SOP No. 7510 – Packaging and Shipment of Environmental Samples.

7.9 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., submersible pumps) should be decontaminated in accordance with ENSR SOP No. 7600 – Decontamination of Equipment protocol before moving to the next location. Dedicated or disposable equipment does not need to be decontaminated.

8.0 DATA AND RECORDS MANAGEMENT

Specific information regarding sample collection should be documented in several areas: the sample chain-of-custody record, sample collection record, field logbook, and sample labels or tags. Additional information regarding each form of documentation is presented in the following paragraphs:

8.1 Sample Chain-of-Custody Record

This standard form requires input of specific information regarding each collected sample for laboratory analytical purposes, as specified in ENSR SOP No. 7007 – Chain-of-Custody Procedures and ENSR SOP No. 7510 – Packaging and Shipment of Environmental Samples.

8.2 Sample Collection Record

This form (Figure 1) requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements.

8.3 Field Logbook

This logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. This logbook should be used in support of, and in combination with, the sample collection record. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

8.4 Sample Labels

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Sample labeling will be conducted per the SAP and QAPP. Labels may include the information listed below.

- Project number (not project name)
- Sample number
- Sample designation

- Analysis type
- Preservative
- Sample collection date
- Sample collection time
- Sampler's name

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or SAP.

Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements are outlined in the SAP and QAPP. Additional information regarding quality assurance sample collection relevant to groundwater sampling is described below.

9.1 Field Blank/Equipment Blank Sample Collection

Field blank samples serve as a quality assurance check of equipment and field conditions at the time of sampling. Field blank samples are usually prepared by transferring analyte-free water into a clean set of sample containers, then analyzing it as a sample. Sometimes, the analyte-free water is transferred over or through the sampling device before it is placed into the sample containers. This type of field blank sample is known as an equipment blank. The SAP and QAPP contains specific information regarding the type and number of field blanks or equipment blanks required for collection.

9.2 Field Duplicate Sample Collection

Field duplicate samples are collected for the purpose of providing two sets of results for comparison. To the extent possible based on available information, field duplicates will be selected at locations with the likelihood of detectable concentrations of constituents.

These samples are used to assess precision. Duplicate samples are usually prepared by splitting the sample into two sets of sample containers, then analyzing each set as a separate sample. The QAPP contains specific information regarding the type and number of duplicate samples for collection.

9.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Collection

MS/MSDs provide information about the effect of the sample matrix on digestion and measurement methodology. For samples submitted for MS/MSD analysis, triple sample volume is generally required. The QAPP contains specific information regarding the frequency of MS/MSD samples.

10.0 REFERENCES

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

ENSR SOP No. 7320 - Operation and Calibration of a Multi-Parameter Water Quality Monitor.

ENSR SOP No. 7101– Water Level Measurements.

ENSR SOP No. 7125 – Field Measurement of Turbidity.

ENSR SOP No. 7007 – Chain-of-Custody Procedures.

ENSR SOP No. 7510 – Packaging and Shipment of Environmental Samples.

ENSR SOP No. 7600 – Decontamination of Field Equipment.

IDEM. 2003. OLQ Geologic Services Technical Memorandum – Micro-Purge Sampling for Monitoring Wells. Indiana Department of Environmental Management Office of Land Quality. January 8, 2003.

USEPA. 1996. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples From Monitoring Wells, Revision 2. U.S. Environmental Protection Agency, Region 1. July 30, 1996.

FIGURE 1 – EXAMPLE GROUNDWATER SAMPLE COLLECTION RECORD

ENSR

Well ID:

Low Flow Ground Water Sample Collection Record

Client: ____________ Date: ____________ Time: Start ______ am/pm
Project No: ____________ Finish ______ am/pm
Site Location: ____________
Weather Conds: ____________ Collector(s): ____________

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length ______ c. Length of Water Column ______ (a-b) Casing Diameter/Material ______

b. Water Table Depth ______ d. Calculated System Volume (see back) ______

2. WELL PURGE DATA

a. Purge Method: ____________

b. Acceptance Criteria defined (see workplan)

- Temperature	3%	- D.O.	10%
- pH	± 1.0 unit	- ORP	± 10mV
- Sp. Cond.	3%	- Drawdown	< 0.3'

c. Field Testing Equipment used: Make Model Serial Number

Time (24hr)	Volume Removed (Liters)	Temp. (°C)	pH	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (feet)	Color/Odor

(continued on back)

d. Acceptance criteria pass/fail	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

If no or N/A - Explain below.

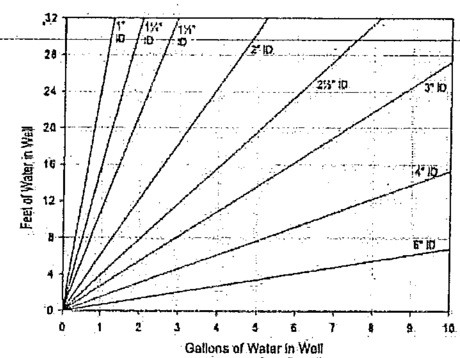
3. SAMPLE COLLECTION: Method: ____________

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments ____________

Signature ____________ Date ____________

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (24 hr)	Volume Removed (Liters)	Temp (°C)	pH	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (ft)	Color/Odor

ENSR | AECOM

Monitoring Well Development

SOP Number 7221

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

Monitoring Well Development

CONTENTS

1.0 SCOPE AND APPLICABILITY 3
2.0 SUMMARY OF METHOD 3
3.0 HEALTH AND SAFETY WARNINGS 3
4.0 INTERFERENCES 4
5.0 PERSONNEL QUALIFICATIONS 4
6.0 EQUIPMENT AND SUPPLIES 4
6.1 Bailer Purging 5
6.2 Surge Block Development 5
6.3 Pump Development 5
6.4 Other Required Materials 5
7.0 METHODS 6
7.1 General Preparation 6
7.2 Development Procedure 7
7.3 Equipment Decontamination 10
8.0 DATA AND RECORDS MANAGEMENT 10
9.0 QUALITY CONTROL AND QUALITY ASSURANCE 11
10.0 REFERENCES 11
FIGURE 1 – RECOMMENDED SURGE BLOCK DESIGN ..... 12FIGURE 2 – EXAMPLE WELL DEVELOPMENT RECORD 13

APPENDICES

APPENDIX A - GLOSSARY

LIST OF ACRONYMS

SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the methods used for developing newly installed monitoring wells and/or existing wells that may require redevelopment/rehabilitation. This SOP is applicable to any wells that require development in accordance with the Sampling Analysis Plan (SAP).

Monitoring well development and/or redevelopment is necessary for several reasons:

- To improve/restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt;
- To remove drilling fluids (water, mud), when used, from the borehole and surrounding formations; and
- To remove residual fines from well filter materials and reduce turbidity of groundwater, therefore, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments and provide representative groundwater samples.

2.0 SUMMARY OF METHOD

Well development generally involves withdrawal of an un-specified volume of water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water bearing unit and is suitable for obtaining representative groundwater samples or for other testing purposes.

3.0 HEALTH AND SAFETY WARNINGS

Monitoring well development may involve chemical hazards associated with exposure to materials in the groundwater being investigated and physical hazards associated with use of well development equipment. When well development is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between sample locations. Minimization of the cross-contamination will occur through the use of clean tools at each location, which will require decontamination of sampling equipment as per ENSR SOP No. 7600 – Decontamination of Field Equipment.

The process of installing a well necessarily disturbs the geologic formation. Wells will be developed appropriately as described in this SOP. The wells will be allowed to stabilize a minimum of two weeks after development before a well is sampled. In no cases will methods using air (e.g., air jetting) be used for well development on this project as they have a high potential to change geochemical conditions in the vicinity of the well.

5.0 PERSONNEL QUALIFICATIONS

Well development procedures vary in complexity. It is recommended that initial development attempts be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within the SAP, Quality Assurance Project Plan (QAPP), and HASP. Field personnel are responsible for proper well development, decontamination of equipment, as well as proper documentation in the field logbook or field forms (if appropriate).

6.0 EQUIPMENT AND SUPPLIES

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of constituents present, if any.

The following list of equipment, each with their own particular application, may be used to develop and/or purge monitoring wells. In no cases will methods using air (e.g., air jetting) be used on this project as they have a high potential to change geochemical conditions in the vicinity of the well.

6.1 Bailer Purging

A bailer is used to purge silt-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping. A bailer can be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

6.2 Surge Block Development

Surge blocks are commercially available for use with Waterra™-type pumping systems or may be manufactured using a "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks if requested. A recommended design is shown in Figure 1.

6.3 Pump Development

A pump is often necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by overpumping. Because the purpose of well development is to remove suspended solids from a well and the surrounding filter pack, the pump must be capable of moving some solids without damage. The preferred pump is a submersible pump, which can be used in both shallow and deep ground water situations. A centrifugal pump may be used in shallow wells, but will work only where the depth to static ground water is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

6.4 Other Required Materials:

- Well Development Records (Figure 2)
- Boring and well construction logs (if available)
- Utility knife
- Plastic sheeting
- Buckets

- Paper towels
- Trash bags
- Power source (generator or 12-volt marine battery)
- Water level meter and/or well depth measurement device
- Water quality instrumentation to measure turbidity (i.e., nephelometer)
- Instrument calibration solutions
- Equipment decontamination supplies (as required by ENSR SOP No. 7600 – Decontamination of Field Equipment)
- Health and safety supplies (as required by the HASP)
- Appropriate containers and materials to manage investigation-derived waste (IDW) (as specified in the SAP)
- Approved plans (e.g., HASP, QAPP, SAP)
- Field project logbook/pen

7.0 METHODS

7.1 General Preparation

Well completion diagrams should be reviewed to determine well construction characteristics. Formation characteristics should also be determined from review of available boring logs.

Well development, similar to groundwater sampling, should be conducted in as clean an environment as possible. This usually requires, at a minimum, placing sheet plastic on the ground to provide a clean working area for development equipment.

Provisions should be in place for collection and management of IDW, specifically well development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements.

The water level and well depth should be measured in accordance with ENSR SOP No. 7101 – Water Level Measurements and written on the Well Development Record (Figure 2). This information is used to calculate the volume of standing water (i.e., the well volume) within the well.

Drilling fluids such as mud or water, if used during the drilling and well installation process, should be removed during the well development procedure. It is recommended that a minimum of 3 times the volume of added fluid be removed from the well during development. If the quantity of added fluid is not known or cannot be reasonably estimated, removal of a minimum of 20 well volumes of water is recommended during the development procedure.

7.2 Development Procedure

7.2.1 Development Method Selection

The construction details of each well shall be used to define the most suitable method of well development. Some consideration should be given to the potential concentrations of constituents in each well as this will impact IDW containment requirements.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and potential concentrations of constituents, and characteristics of the geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

7.2.2 General Water Quality Measurements (optional)

Measurements for water quality parameters such as specific conductance may be monitored periodically during development using the available water quality instruments (e.g., ENSR SOP No. 7320 - Operation and Calibration of a Multi-Parameter Water Quality Monitor). These measurements may be used to determine whether or not well development is proceeding efficiently, determine whether or not the development process is effective with any given well and, potentially, may identify well construction irregularities (i.e., grout in well, poor well screen slot-size selection). Water quality parameters will be recorded on the Well Development Record (Figure 2).

7.2.3 Turbidity

Turbidity will be monitored during well development to monitor the progress of development. Visual observations on turbidity, such as silty or cloudy water, should be noted in the Well Development Record (Figure 2). Turbidity should also be measured quantitatively using a nephelometer. Turbidity should be measured a minimum of three times during development, including at the completion of development. All turbidity readings will be recorded in the Well Development Record (Figure 2).

7.2.4 Bailer Procedure

As stated previously, bailers shall preferably not be used for well development but may be used in combination with a surge block to remove silt-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of it.
- Lower the bailer into the screened interval of the monitoring well. Silt, if present, will generally accumulate within the lower portions of the well screen.
- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.
- Remove the bailer from the well and empty it into the appropriate storage container.
- Continue surging/bailing the well until sediment-free water is obtained. If moderate to heavy siltation is still present, the surge block procedure should be repeated and followed again with bailing. If it is not possible to further reduce the visible turbidity, the well will be purged a maximum of four hours.
- Check turbidity and any other water quality parameters, periodically.

7.2.5 Surge Block Procedure

A surge block effectively develops most monitoring wells. This device first forces water within the well through the well screen and out into the formation, and then pulls water back through the screen into the well along with fine soil particles. Surge blocks may be manufactured to meet the design criteria shown in the example (Figure 1) or may be purchased as an adaptor to fit commercially available well purging systems such as the Waterra™ system.

- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material that is blocking the screen to separate and become suspended.

- After 5 to 10 plunger strokes, silt-laden water will be removed from the well using a pump integrated with the surge block, or removing the surge block to purge the well using a pump or bailer. The returned water should be heavily laden with suspended silt and clay particles. Discharge the purged water into the appropriate storage container.

- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material. If it is not possible to further reduce the visible turbidity, the well will be purged a maximum of four hours.

- Check turbidity and any other water quality parameters periodically.

7.2.6 Pump Procedure

Well development using only a pump is most effective in monitoring wells that will yield water continuously. Theoretically, pumping will increase the hydraulic gradient and velocity of groundwater near the well by drawing the water level down. The increased velocity will move residual fine soil particles into the well and clear the well screen of this material. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.

- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water.

- Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations. If it is not possible to further reduce the visible turbidity, the well will be purged a maximum of four hours.

- Check turbidity and any other water quality parameters periodically.

7.3 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., surge block) will be decontaminated in accordance with ENSR SOP No. 7600 – Decontamination of Field Equipment before moving to the next location. The bailer should be properly discarded and disposed of in accordance with procedures for managing IDW.

8.0 DATA AND RECORDS MANAGEMENT

All field information will be recorded in the field logbook or on a field collection form by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the development process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Field personnel should follow specific quality assurance guidelines as outlined in the Quality Assurance Project Plan (QAPP) and/or SAP.

A well will have been successfully developed when one or more of the following criteria are met:

- The sediment load in the well has been eliminated or greatly reduced. Use of a nephelometer is required during the well development procedure to measure water turbidity if meeting a specific turbidity value is required by the SAP. Attaining low turbidity values in fine-grained formations may be difficult to achieve.

- If it is not possible to reduce turbidity to acceptable levels, the well will be developed for a maximum of four hours.

10.0 REFERENCES

ENSR SOP No. 7320 - Operation and Calibration of a Multi-Parameter Water Quality Monitor.

ENSR SOP No. 7101 – Water Level Measurements.

ENSR SOP No. 7600 – Decontamination of Field Equipment. Revision 0.0.

FIGURE 1 – RECOMMENDED SURGE BLOCK DESIGN

SURGE BLOCK DESIGN
(Not to Scale)

Steel washers should be 1/2" to 3/4" smaller in diameter than the well ID. Gasket can be rubber or leather and should be the same diameter or 1/8" smaller than the well ID to compensate for swelling of the leather/ Rod can be steel, fiberglass, or plastic but must be strong and lightweight.

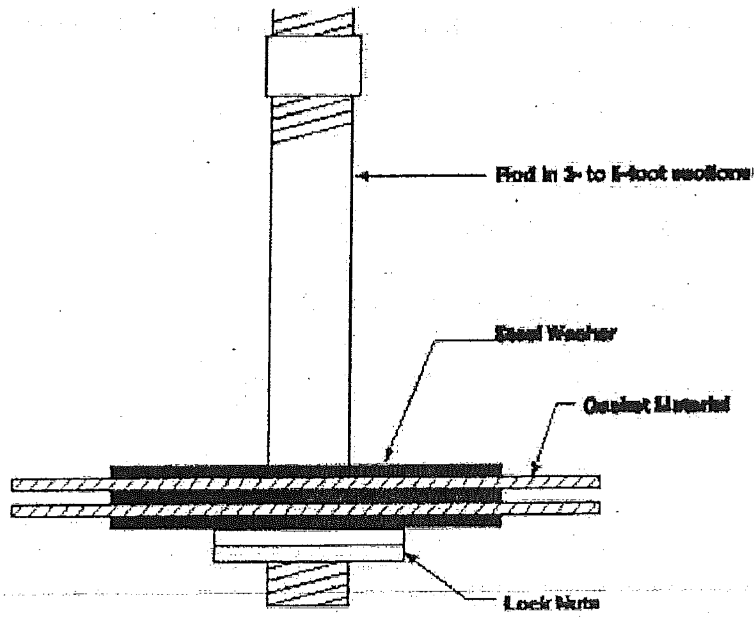


FIGURE 2 – EXAMPLE WELL DEVELOPMENT RECORD

ENSR

Well/Piez. ID:

Well/Piezometer Development Record

Client: ____________

Project No: ____________ Date: ________ Developer: ____________

Site Location: ____________

Well/Piezometer Data

Well ☐ Piezometer ☐ Diameter ________ Material ________

Measuring Point Description ________ Geology at Screen Interval (if known) ________

Depth to Top of Screen (ft.) ________

Depth to Bottom of Screen (ft.) ________ Time of Water Level Measurement ________

Total Well Depth (ft.) ________ Calculate Purge Volume (gal.) ________

Depth to Static Water Level (ft.) ________ Disposal Method ________

Headspace ________

Original Well Development ☐ Redevelopment ☐ Date of Original Development ________

DEVELOPMENT METHOD ____________

PURGE METHOD ____________

Time	Total Volume Purged (gal.)	Flow Rate (gpm)	Turbidity (NTU)	Color	pH	Temp	Other

ACCEPTANCE CRITERIA (from workplan)

Minimum Purge Volume Required _____ gallons
Maximum Turbidity Allowed _____ NTUs
Stabilization of parameters _____%

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Has parameters stabilized	☐	☐	☐

If no or N/A explain below:

____

Signature ____________ Date: ________

APPENDIX A – GLOSSARY

Bridging: A condition within the filter pack outside the well screen whereby the smaller particles are wedged together in a manner that causes blockage of pore spaces.

Hydraulic Conductivity: a characteristic property of aquifer materials which describes the permeability of the material with respect to flow of water.

Hydraulic Connection: A properly installed and developed monitoring well should have good hydraulic connection with the aquifer. The well screen and filter material should not provide any restriction to the flow of water from the aquifer into the well.

Permeability Test: Used to determine the hydraulic conductivity of the aquifer formation near a well screen. Generally conducted by displacing the water level in a well and monitoring the rate of recovery of the water level as it returns to equilibrium. Various methods of analysis are available to calculate the hydraulic conductivity from these data.

Static Water Level: The water level in a well that represents an equilibrium or stabilized condition, usually with respect to atmospheric conditions in the case of monitoring wells.

Well Surging: That process of moving water in and out of a well screen to remove fine sand, silt and clay size particles from the adjacent formation.

Well Purging: The process of removing standing water from a well to allow surrounding formation water to enter the well.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. The perforated, or slotted, portion of a well is also known as the screened interval.

ENSR | AECOM

Operation and Calibration of a Photoionization Detector

SOP Number 7315

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

ENSR

SOP NUMBER: 7315

Operation and Calibration of a Photoionization Detector (PID)

CONTENTS

1.0 SCOPE AND APPLICABILITY 3

2.0 SUMMARY OF METHOD 3

3.0 HEALTH AND SAFETY WARNINGS 4

4.0 INTERFERENCES 4

5.0 PERSONNEL QUALIFICATIONS 5

6.0 EQUIPMENT AND SUPPLIES 5

7.0 METHODS 6
- 7.1 Preliminary Steps 6
- 7.2 Calibration 6
- 7.3 Operation 7
- 7.4 Routine Maintenance 7

8.0 DATA AND RECORDS MANAGEMENT 8

9.0 QUALITY CONTROL AND QUALITY ASSURANCE 8

10.0 REFERENCES 9

LIST OF ACRONYMS

SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
PID	Photoionization Detector
QAPP	Quality Assurance Project Plan
OSHA	Occupational Safety and Health Administration
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICABILITY

This document describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID will be used to determine the presence of volatiles in soil, either by screening the core or by headspace measurements.

2.0 SUMMARY OF METHOD

The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.

The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV)) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.

Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive-biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

3.0 HEALTH AND SAFETY WARNINGS

Collecting PID measurements may involve chemical hazards associated with materials in the soil being in contact with the PID. When collecting measurements, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project HASP for instructions pertaining to instrument use in explosive atmospheres.

4.0 INTERFERENCES

Potential interferences could result in inaccurate readings under the following conditions.

4.1.1 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

4.1.2 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

4.1.3 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

4.1.4 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

4.1.5 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

4.1.6 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

Care shall be taken in using the PID to reduce these interferences. If there is any concern that a particular reading may not be accurate, this shall be noted in the field log book.

5.0 PERSONNEL QUALIFICATIONS

Collecting PID measurements is a relatively simple procedure requiring minimal training and a relatively small amount of equipment. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual. It is recommended that the collection of PID measurements be initially supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP and health and safety requirements outlined within the Sampling Analysis Plan (SAP) and HASP. Field personnel are responsible for the proper use and maintenance of the PID, as well as proper documentation in the field logbook or field forms (if appropriate).

6.0 EQUIPMENT AND SUPPLIES

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated.

- Regulator for calibration gas cylinder

- Approximately 6 inches of Teflon® tubing
- Tedlar bag (optional)

- Commercially-supplied zero grade air (optional)

- "Magic Marker" or "Sharpie" or other waterproof marker
- Battery charger
- Moisture traps
- Spare lamps
- Manufacturer's instructions
- Field data sheets or logbook/pen

7.0 METHODS

7.1 Preliminary Steps

7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.

7.2.2 Calibrate the instrument according to the manufacturer's instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.

7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

7.3 Operation

7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.

7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer's instructions. Record the calibration information in the field records.

7.3.3 The instrument is now operational. Readings should be recorded in the field records.

7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a "bump" test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.

7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

7.3.6 Recharge the battery after each use (Section 7.4).

7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

7.4 Routine Maintenance

7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

7.4.2 All routine maintenance should be performed in a non-hazardous environment.

8.0 DATA AND RECORDS MANAGEMENT

All field information will be recorded in the field logbook or on a field collection form by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the measurement process. Information to be recorded includes:

- Project name and number.
- Instrument manufacturer, model, and identification number.
- Operator's signature.
- Date and time of operation.
- Calibration gas used.
- Calibration check at beginning and end of day (meter readings before adjustment).
- Span setting after calibration adjustment.
- Meter readings (monitoring data obtained).
- Instances of erratic or questionable meter readings and corrective actions taken.
- Instrument checks and response verifications

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Calibration of the PID will be conducted at the frequency specified in the Quality Assurance Project Plan (QAPP) and/or SAP. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within ±10%. If the instrument responds outside this tolerance, it must be recalibrated.

10.0 REFERENCES

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

ENSR | AECOM

Operation and Calibration of a Multi-Parameter Water Quality Monitor

SOP Number 7320

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

CONTENTS

1.0 SCOPE AND APPLICABILITY 3
2.0 SUMMARY OF METHOD 3
3.0 HEALTH AND SAFETY WARNINGS 3
4.0 INTERFERENCES 4
5.0 PERSONNEL QUALIFICATIONS 4
6.0 EQUIPMENT AND SUPPLIES 4
 6.1 Multi-Parameter Meter 4
 6.2 Other Required Materials 5
7.0 METHODS 5
 7.1 General Preparation 5
 7.2 Calibration 5
 7.3 Collection of Measurements 9
 7.4 Equipment Decontamination 9
8.0 DATA AND RECORDS MANAGEMENT 10
9.0 QUALITY CONTROL AND QUALITY ASSURANCE 10
10.0 REFERENCES 10

LIST OF ACRONYMS

DO	Dissolved Oxygen
SAP	Sampling Ananlysis Plan
HASP	Health and Safety Plan
ORP	Oxydation-Reduction Potential
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the procedure that will be followed by field staff for measuring water quality characteristics using a multi-parameter water quality meter.

The model used for the purposes of this SOP is model YSI 6920, and equivalent procedures may be used to operate similar instruments. Other multi-parameter meters are available and can be used as effectively as the YSI models. Specific calibration methods specified by the manufacturer should be used if a non YSI multi-parameter meter is used. The multi-parameter meters are equipped with sensors for the measurement of dissolved oxygen (DO), specific conductance, temperature, pH, and oxidation-reduction potential (ORP). Data can be viewed in real-time using a hand-held data logger.

2.0 SUMMARY OF METHOD

The multi-parameter meter is used to measured water quality parameters in the field, including DO, specific conductance, temperature, pH, and ORP. These may be used to establish the sufficiency of purging prior to collecting groundwater samples from monitoring wells, or to document water quality conditions in groundwater, surface water, and/or private well water.

The multi-parameter meter may be set directly into a water body, or within a flow-through cell or other container into which the water is placed or pumped. The instrument readings are displayed on a hand-held data logger. These readings may be recorded electronically by the datalogger or transcribed to the field log book or appropriate field data form.

3.0 HEALTH AND SAFETY WARNINGS

Measuring water quality parameters may involve chemical hazards associated with materials in the water being monitored and instrument calibration solutions, and physical hazards associated with general field work. When measuring water quality parameters, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences will be controlled through appropriate calibration of the instruments, and decontamination between sample locations.

5.0 PERSONNEL QUALIFICATIONS

To properly calibrate the instrument and perform water quality measurements, the field personnel must be familiar with the calibration and measurement techniques stated in this SOP. The field personnel must also be experienced in the operation of the meter.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP and health and safety requirements outlined within the Sampling Analysis Plan (SAP) and HASP. Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used in the calibration and operation of the multi-parameter meter, as well as proper documentation in the field logbook or field forms (if appropriate).

6.0 EQUIPMENT SUPPLIES

6.1 Multi-Parameter Meter

The following materials are necessary for calibration and operation of this instrument:

- YSI 6920 or equivalent multi-parameter meter with hand-held datalogger
- Calibration Standards
    - pH 4.0, 7.0, and 10.0 standard buffer solutions
    - Conductivity standard appropriate for field conditions expected
- YSI transport cup
- YSI probe guard
- Chemical-free paper towels
- YSI DO calibration kit (electrolyte solution and Teflon® membranes)
- Ring stand and clamps suitable for holding YSI unit during calibration

- Barometer
- Calibration Form (Figure 1)

6.2 Other Required Materials

Other materials that may be required to facilitate use of the instruments in the field include:

- YSI flow-through cell, bucket, or other container(s)
- Tubing to connect multi-parameter meter to pumps (as necessary)
- Replacement batteries for the datalogger display unit
- Health and safety supplies (as required by the HASP)
- Distilled/deionized water supply
- Deionized water dispenser bottler
- Equipment decontamination materials (as required by ENSR SOP No. 7600 – Decontamination of Field Equipment)
- Approved plans (e.g., HASP, SAP, QAPP)
- Field project logbook/pen

7.0 METHODS

7.1 General Preparation

Calibration of the YSI-6920 is required to assure performance of the meter. Specific calibration solutions are use for the calibration of specific conductance, pH, and ORP. Water is used for the calibration of DO. Temperature is not calibrated but may be checked against a secondary thermometer, if necessary.

7.2 Calibration

The YSI-6920 (or equivalent) will be calibrated daily prior to use according to the requirements of the QAPP and manufacturer's specifications. It will also be checked daily with the calibration solutions at the end of use of the equipment (post-calibration). Calibration records shall be recorded in the field logbook or Calibration Form (Figure 1). The required calibration procedures are summarized below.

All instruments except temperature may require calibration. During calibration, ensure that all sensors are immersed in the standard solutions. Use recommended volumes when performing calibrations.

Rinse the probes between calibration solutions using clean ambient temperature deionized water. For maximum accuracy, follow up by pre-rinsing the probes with a small amount of the calibration solution required for the next calibration.

Have clean, absorbent, lint-free, paper towels to dry the probes between rinses and calibration solutions. It is important to remove as much residual liquid as possible from the probes after each rinse. Drying the probes in this way reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.

After powering up the YSI-6920, the Main Menu will be displayed on the data logger. To access the calibration menu select option "2-Calibrate" from the Main Menu, the unit will display all the installed sensors which necessitate a pre-calibration prior to deployment and data acquisition (i.e., specific conductance, DO, pH, and ORP). The calibration procedure for each of the sensors is explained individually below.

7.2.1 Specific Conductance Sensor

Place enough specific conductance calibration solution in the YSI transport cup so that the probe will be entirely submerged in the solution.

Select the conductivity sensor off the Calibrate Menu to access the conductivity calibration procedure, then select SpCond to access the specific conductance calibration procedure.

Enter the calibration value of the standard you are using (mS/cm at 25 °C) and press ENTER. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

Observe the readings under SpCond and when no significant change occurs in the display for approximately 30 seconds, record the initial temperature and value in the field logbook or Calibration Form (Figure 1). Then press ENTER. The screen will indicate that the calibration has been performed successfully.

Now record the temperature, calibration value as well as date and time the calibration was performed in the field logbook or Calibration Form (Figure 1).

After the appropriate data has been recorded, the data logger will prompt you to press ENTER to return to the Calibrate Menu.

Rinse the probes in clean, deionized water and thoroughly dry.

7.2.2 DO Sensor

Place approximately 1/8" (3 mm) of water into the YSI transport cup and engage 1 or 2 threads on the probe. Make certain that the DO and temperature probes are not immersed in the water. Do not tighten; a loose connection which allows the transport cup to freely vent to the atmosphere is required to properly complete this calibration step. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperatures of the thermistor and the oxygen probe to equilibrate.

Select 2-Dissolved Oxy from the Calibrate Menu, then select 1-DO% to access the DO% calibration procedure. Enter the current local barometric pressure in mm Hg (inches Hg x 25.4 = mm Hg). Do not use barometer readings obtained from meteorological reports, these are corrected to sea level and will produce an inaccurate calibration.

A countdown timer will be displayed on the lower left of the screen that allows for the proper warm up time for the DO sensor. Wait for the countdown to be completed before proceeding. A message that indicates to press ENTER to continue will appear. Pressing ENTER will return the display to the DO calibration. When the DO% values reach a stabilized value, record the initial temperature and value in the field logbook or Calibration Form (Figure 1). Then press ENTER to accept the calibration.

The temperature, calibration value as well as date and time the calibration was performed should be recorded in the field logbook or Calibration Form (Figure 1).

NOTE: Calibration of the DO sensor following the DO% procedure will simultaneously achieve calibration in the DO mg/L mode and vice versa.

7.2.3 pH Probe (3-Point Calibration)

Place the appropriate volume of pH 7.0 standard buffer solution into a pre-rinsed transport cup and allow 1 minute for temperature equilibration before proceeding. From the Calibrate Menu, select 4-ISE1 pH to access the pH calibration procedure and select 3-3-point. Press ENTER and input the value of the buffer (7.0) at the prompt. Press ENTER and the current values received from the sensors will be displayed. When the unit has stabilized and there are no significant changes for approximately 30 seconds, record the initial temperature and value in the field logbook or Calibration Form (Figure 1). Then press ENTER to accept this calibration step. Now record the temperature, calibration value as well as date and time the calibration was performed in the field logbook or Calibration Form (Figure 1).

Press ENTER to continue with the second point in the calibration procedure. Rinse the probe in water and dry thoroughly before proceeding. Select the pH 4.0 standard buffer solution and place the appropriate volume into pre-rinsed transport cup. Press ENTER and input the value of the second buffer at the prompt. Following the same procedure as above, press ENTER and the current values received from the sensors will be displayed. When the unit has stabilized and there are no significant changes for approximately 30 seconds, record the initial temperature and value in the field logbook or Calibration Form (Figure 1). Then press ENTER to accept and complete this calibration step. Now record the temperature, calibration value as well as date and time the calibration was performed in the field logbook or Calibration Form (Figure 1).

Thoroughly rinse the probe and the calibration container in water and thoroughly dry. Repeat this procedure with the pH 10.0 standard solution.

Note that once field conditions are known, it may be possible to perform a 2-point calibration using the 4.0 to 7.0 or 7.0 to 10.0 range, ensuring that the expected range of field conditions is captured.

7.2.4 ORP

Calibration is not usually required for the ORP sensor. However, for some older probes, there may be deviation from the theoretical ORP value. To check for functionality, the ORP probe is placed in Zobell solution. If the probe is functioning properly, the reading should be within the range of 221 to 241 at normal ambient temperatures. If the reading is outside this range, the probe should be calibrated.

To calibrate, select ISE2-Orp from the calibrate menu. Immerse the probe into the Zobell solution and press ENTER. Enter in the Zobell solution value. Press ENTER and monitor the stabilization of the ORP and temperature readings. After no significant change occurs for approximately 30 seconds, record the initial temperature and value in the field logbook or Calibration Form (Figure 1). Then press ENTER to confirm the calibration. Now record the temperature, calibration value as well as date and time the calibration was performed in the field logbook or Calibration Form (Figure 1).

7.3 Collection of Measurements

Attach the field cable to the probe and hand tighten – DO NOT use tools! Make sure all port plugs are installed in all port connections where probes are not installed, it is extremely important to keep these electrical connections dry. Immerse the multi-parameter meter into the water being monitored. Ensure that the YSI data logger is properly connected and in RUN mode displaying data.

***NOTE:* Do not collect data until the sensor display has stabilized, particularly the parameters of DO and pH. Allow the DO sensor to warm up from 40 to 180 seconds after being immersed on station, depending on the water temperature.**

Record the displayed data on a field log sheet or in the field logbook.

7.4 Equipment Decontamination

The YSI-6920 multi-parameter meter should be decontaminated in accordance with ENSR SOP No. 7600 – Decontamination of Field Equipment between each sample location. Dedicated or disposable equipment does not need to be decontaminated.

Where the multi-parameter meter is used to monitor stabilization of parameter values during well purging, decontamination between locations is not needed as the purging process will effectively decontaminate the instruments as verified when parameters are stabilized.

8.0 DATA AND RECORDS MANAGEMENT

Calibration records will be recorded in the field logbook or appropriate field form. All field information will be recorded in the field logbook or on a field collection form by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the calibration process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

Field personnel will follow specific quality assurance guidelines as outlined in the Quality Assurance Project Plan (QAPP) and/or SAP.

10.0 REFERENCES

ENSR SOP No. 7600 – Decontamination of Field Equipment.

YSI 6920 Multi-Parameter Water Quality Monitor Operations and Instructions Manual.

FIGURE 1 – Example Calibration Form

Project Name:____________________

Project Number:__________________

Date:___________________________

Calibration Form

Parameter	Instrument Manf/Model	Instrument Serial No.	Standard Manf/Model	Standard SN/Exp. Date	Standard Value @ C	Ambient Temp. C	Initial Value	Adjusted Value	Initials & Time	Comments
pH 4.00	YSI 6920				4.00 @ 25C					
								——		Post Cal
pH 7.00					7.00 @ 25C					
								——		Post Cal
pH 10.00					10.00 @ 25C					
								——		Post Cal
Specific Cond.					____uS/cm @ 25C					
								——		Post Cal
ORP					____mV @ ____C					
								——		Post Cal
DO			H2O Saturated Air		____mg/L @ ____C					BP =
								——		Post Cal: BP =

BP = Barometric Pressure (mmHg)

ENSR | AECOM

Packaging and Shipment of Environmental Samples

SOP Number 7510

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

CONTENTS

1.0 SCOPE AND APPLICABILITY 3
2.0 SUMMARY OF METHOD 3
3.0 HEALTH AND SAFETY WARNINGS 3
4.0 INTERFERENCES 4
5.0 PERSONNEL QUALIFICATIONS 4
6.0 EQUIPMENT AND SUPPLIES 4
7.0 METHODS 5
7.1 Preparation 5
7.2 Sample Packaging 6
7.3 Sample Shipping 8
7.4 Sample Receipt 8
8.0 DATA AND RECORDS MANAGEMENT 8
9.0 QUALITY CONTROL AND QUALITY ASSURANCE 9
10.0 REFERENCES 9

LIST OF ACRONYMS

COC	Chain-of-Custody
DOT	Department of Transportation
HASP	Health and Safety Plan
OSHA	Occupational Safety and Health Adminstration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conversation and Recovery Act
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the procedures associated with the packaging and shipment of environmental samples consisting of water, soil, and sediment submitted for routine environmental testing. Environmental samples are not considered a Resource Conservation and Recovery Act (RCRA) classified hazardous waste by definition; therefore, more stringent RCRA and Department of Transportation (DOT) regulations regarding sample transportation do not apply. Environmental samples do, however, require fairly stringent packaging and shipping measures to ensure sample integrity as well as safety for those individuals handling and transporting the samples.

This SOP is designed to provide a high degree of certainty that environmental samples will arrive at their destination intact. This SOP assumes that samples will often require shipping overnight by a commercial carrier service; therefore, the procedures are more stringent than may be necessary if a laboratory courier is used or if samples are transported directly to their destination by a field personnel. Should either of the latter occur, the procedures may be modified to reflect a lesser degree of packaging requirements.

2.0 SUMMARY OF METHOD

Sample packaging and shipment involves the placement of individual sample containers into a cooler or other similar shipping container and placement of packing materials and coolant in such a manner as to isolate the samples, maintain the required temperature, and to limit the potential for damage to sample containers when the cooler is transported.

3.0 HEALTH AND SAFETY WARNINGS

Sampling personnel should be aware that packaging and shipment of samples involves potential exposure and physical hazards primarily associated with handling of occasional broken sample containers and lifting of heavy objects. Adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Sample containers with presumed high constituent concentrations should be isolated within their own cooler with each sample container placed into a zipper-lock bag.

5.0 PERSONNEL QUALIFICATIONS

Sample packaging and shipment is a relatively simple procedure requiring minimal training and a minimal amount of equipment. It is recommended that initial attempts be supervised by more experienced personnel.

Field personnel should be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within the SAP, Quality Assurance Project Plan (QAPP), and HASP. Field personnel are also responsible for proper documentation in the field logbook.

6.0 EQUIPMENT AND SUPPLIES

General field supplies include the following items:

- Sample coolers
- Sample containers
- Shipping labels
- Chain-of-custody (COC) form (Figure 1)
- Custody tape (Figure 2)
- Bubble wrap or Styrofoam pellets
- Ice
- Temperature blank
- Transparent tape, or rubber bands
- Fiber tape
- Duct tape
- Utility knife

- Zipper-lock plastic bags
- Trash bags
- Health and safety supplies (as required by the HASP)
- Field project logbook/pen

7.0 METHODS

7.1 Preparation

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. U.S. Environmental Protection Agency (USEPA) regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under RCRA when any of the following conditions are applicable:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis;
- Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, or (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

7.1.1 Laboratory Notifications

Prior to sample collection, the ENSR Task Manager or designee must notify the laboratory project manager of the number, type, and approximate collection and shipment dates for the samples. If the number, type, or date of sample shipment changes due to program changes that may occur in the field, the ENSR Task Manager or alternate must notify the laboratory of the changes. Additional notification from the field is often necessary when shipments are scheduled for weekend delivery.

7.1.2 Cooler Inspection and Decontamination

Laboratories will often re-use coolers. Every cooler received at a project location should be inspected for condition and cleanliness. Any coolers that exhibit cracked interiors or exterior linings/panels or hinges should be discarded because the insulating properties of the coolers would be considered compromised. Any coolers missing one or both handles should also be discarded if replacement handles (i.e., knotted rope handles) can not be fashioned in the field.

The interior and exterior of each cooler should be inspected for cleanliness before using it. Excess strapping tape and old shipping labels should be removed. If the cooler interior exhibits visible contamination or odors it should not be used. Drain plugs should be sealed on the inside with duct tape.

7.2 Sample Packaging

7.2.1 Place plastic bubble wrap matting over the base of each cooler or shipping container as needed.

7.2.2 Insert a clean trash bag into the cooler to serve as a liner.

7.2.3 Check that each sample container is sealed, labeled legibly, and is externally clean. Re-label and/or wipe bottles clean if necessary. Clear tape should be placed over the labels to protect them and keep them from falling off the container. Wrap each sample bottle individually with bubble wrap secured with tape or rubber bands. For aqueous samples in glass containers, each sample should be sealed in a zipper-lock bag to prevent leakage and cross-contamination in the case of breakage. Place bottles into the cooler in an upright single layer with approximately one inch of space between each bottle. Do not stack bottles or place them in the cooler lying on their side. If plastic and glass sample containers are used, alternate the placement of each type of container within the cooler so that glass bottles are not placed side by side.

7.2.4 Insert the cooler temperature blank supplied by the laboratory into each cooler (if any).

7.2.5 Place additional vermiculite, bubble wrap, and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler to a level that meets the approximate top of the sample containers. Packing material may require tamping by hand to reduce the potential for settling.

7.2.6 Double bag cubed ice in heavy duty zipper-lock plastic bags, close the bags, and distribute the bagged ice in a layer over the top of the samples. Loose ice should never be used. Cold packs should be used only if the samples are chilled before being placed in the cooler.

7.2.7 Add additional bubble wrap/styrofoam pellets or other packing materials to fill the balance of the cooler or container.

7.2.8 Obtain two pieces of COC tape as shown in Figure 2 and enter the custody tape numbers in the appropriate place on the COC form (Figure 1). Sign and date the COC tape.

7.2.9 Complete the COC form per ENSR SOP No. 7007 – Chain-of-Custody Procedures. If shipping the samples involves use of a third party commercial carrier service, sign the COC record thereby relinquishing custody of the samples. Shippers should not be asked to sign COC records. If a laboratory courier is used, or if samples are transported to the laboratory by field personnel, the receiving party should accept custody and sign the COC records. Remove the last copy from the multi-form COC and retain it with other field notes. Place the original (with remaining copies) in a zipper-lock plastic bag and tape the bag to the inside lid of the cooler or shipping container.

7.2.10 Close the lid of the cooler or the top of the shipping container.

7.2.11 Place the COC tape at two different locations (i.e., one tape on each side) on the cooler or container lid and overlap with transparent packaging tape.

7.2.12 Packaging tape should be placed entirely around the sample shipment containers. A minimum of two full wraps of packaging tape will be placed at least two places on the cooler/container.

7.2.13 Repeat the above steps for each cooler or shipping container.

7.3 Sample Shipping

Transport the cooler/container to the package delivery service office or arrange for package pick-up at the site. Fill out the appropriate shipping form or airbill and affix it to the cooler/container. Some courier services may use multi-package shipping forms where only one form needs to be filled out for all packages going to the same destination. If not, a separate shipping form should be used for each cooler/container. The receipt for package tracking purposes should be kept in the project files, in the event a package becomes lost.

Each cooler/container also requires a shipping label that indicates point of origin and destination. This will aid in recovery of a lost cooler/container if a shipping form gets misplaced.

Never leave coolers/containers unattended while waiting for package pick-up.

Airbills or waybills will be maintained as part of the custody documentation in the project files.

7.4 Sample Receipt

Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each COC form. The laboratory will verify that the COC tape has not been broken previously and that the tape number corresponds with the number on the COC record. The laboratory will note the condition of the samples upon receipt and will identify any discrepancies between the contents of the cooler/container and COC. The analytical laboratory will then forward the back copy of the COC record to the project Quality Assurance (QA) Officer to indicate that sample transmittal is complete.

8.0 DATA AND RECORDS MANAGEMENT

Documentation supporting sample packaging and shipment consists of COC records and shipping records. All documentation will be retained in the project files following project completion.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

The potential for samples to break during transport increases greatly if individual containers are not snugly packed into the cooler. Packed coolers may be lightly shake-tested to check for any loose bottles. The cooler should be repacked if loose bottles are detected.

Environmental samples are generally shipped so that the samples are maintained at a temperature of approximately 4°C. Temperature blanks may be required for some projects as a quality assurance check on shipping temperature conditions. These blanks usually are supplied by the laboratory and consist of a 40-ml vial or plastic bottle filled with tap water. Temperature blanks should be placed near the center of the cooler.

10.0 REFERENCES

ENSR SOP No. 7007 – Chain-of-Custody Procedures.

FIGURE 1 - Example Chain of Custody Form

M931376

ENSR

CHAIN OF CUSTODY RECORD

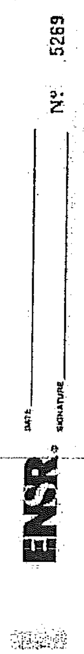
Page ____ of ____

Client/Project Name:	Project Location:	Analysis Requested
Project Number:	Field Logbook No.:	
Sampler: (Print Name) /Affiliation Signature:	Chain of Custody Tape No.: Send Results/Report to:	

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination): ENSR 4303 W. LaPorte Ave. Fort Collins, CO 80521 (970) 416-0916
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No.

FIGURE 2 - Example Chain of Custody Tape



SOP NUMBER: 7515

Recording of Field Data

Date:	April 2005
Revision Number:	0
Author:	Debra McGrath
Discipline:	Quality Assurance

1.0 INTRODUCTION

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) provides instructions for recording data when documenting a sample collection event, field measurements, or a site visit. Field data may be recorded in field logbooks, on standardized forms, as annotated maps, as photo documentation, or electronically. Chain-of-custody records are also considered field data; however, these records are specifically addressed in SOPs 1007 (Chain-of-Custody Procedures) and 7510 (Packaging and Shipping of Environmental Samples).

1.2 Quality Assurance Planning Considerations

Field records provide evidence and support for technical decisions, interpretations, and judgments. It is therefore critical that procedures and systems be in place to ensure that they are legible, identifiable, and retrievable, and protected from loss or damage. In addition, client or regulatory requirements, or the end use of the data (e.g., to support litigation) may determine the format in which the data must be recorded. For example, some projects may require that all field information be recorded in the field logbook and may not allow the use of standardized forms. The requirements necessary to meet the data quality objectives for a particular project will be defined in the site-specific workplan and/or Quality Assurance Project Plan (QAPP) hereafter referred to as the project plan.

1.3 Health and Safety Considerations

Not applicable.

2.0 RESPONSIBILITIES

2.1 The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project plan. In the absence of a Field Team Leader, the Project Manager is responsible for ensuring that field records are reviewed and approved as described below.

2.2 The Field Team Leader is responsible for reviewing and approving the field records for accuracy, completeness, and conformance to the procedures in this SOP.

2.3 Field personnel are responsible for recording data according to the procedures outlined in this SOP.

3.0 REQUIRED MATERIALS

The following materials are necessary for this procedure:

- Bound field logbook (preferably waterproof, such as Rite-in-Rain™)
- Standardized field data sheets (refer to individual SOPs for test pit logs, boring logs, groundwater sample collection logs, etc.)
- Pen or Sharpie™
- Watch or other time-keeping device

The following materials may also be needed:

- Site maps
- Clipboard
- Three-ring binder or equivalent
- Camera
- Hand-held electronic recording device (e.g., PDA, laptop, or tablet PC)

4.0 METHOD

4.1 General

4.1.1 Field activities vary widely and no general rules can specify the exact information that must be recorded for each event. However, the field records must contain sufficient detail so that persons going to the site could reconstruct a particular situation without reliance on the collector's memory.

4.1.2 Field logbooks may be supplemented by standardized forms (e.g., well construction and development, sample collection forms, drum logs). In that case, the logbook provides a chronology of events, summary of personnel on site, and a narration of events not covered by the standardized forms. It is recommended that the details recorded on the standardized forms not be replicated in the logbook due to the potential for transcription errors and inconsistencies. References to standardized forms must be included in the logbook.

4.1.3 Entries will be recorded legibly in permanent ink (a black ballpoint pen is preferable) and will be signed and dated. No erasures or obliterations will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark which is initialed and dated by the sampler, and the correct information added.

4.1.4 Pencil should not be used. If a ballpoint pen cannot be used because of adverse weather conditions (rain or freezing temperatures), a fine-point Sharpie™ is an acceptable substitute. If conditions are such that only pencil can be used, an explanation must be included in the logbook and the affected data should be photocopied, signed as verified copy, and maintained in the project files as documentation that the data has not been changed.

4.1.5 Information to be recorded should address the questions of who, where, what, when, how, and why. A specific list of information that should be recorded is included in Table 1.

4.1.6 Entries will be objective, factual, and free of personal feelings or inappropriate language. Cryptic notes and undefined abbreviations or acronyms should be avoided.

4.1.7 Information will be made in as close to real time as possible. Information recorded significantly after the fact must be dated as such.

4.2 Field Logbooks

4.2.1 Field logbooks will be bound water-proof field survey books or notebooks with consecutively numbered pages.

4.2.2 Logbooks will be assigned to field personnel, and will be identified by a unique document number. The logbook should be kept in the field person's possession or in a secure location during field activities and archived in the project files upon completion of the field program.

4.2.3 Logbooks should be specific to a project. Multiple projects should not be included in one logbook because of document retention and evidentiary reasons.

4.2.4 The title page of each logbook will contain the following:

- Person to whom the logbook is assigned, ENSR office location, and phone number,
- The logbook number,
- Project name and number, and
- Start and end dates of work covered by the logbook.

4.2.5 Logbook entries documenting sample collection or field measurements must clearly identify the task being completed (for example, water level measurements, headspace readings). Units must be included for all measurements.

4.2.6 For ease of reference, it is recommended that a new page be started for each sampling day and that the time be recorded in the far left column. Each day's entries will be signed and dated by the person making the entries. A diagonal line across the bottom of the page will indicate the end of an entry.

4.3 Standardized Forms

4.3.1 At a minimum, each form must include a title identifying the activity being documented and the project identification (name and number).
4.3.2 Each form must be signed and dated by the person completing the form.
4.3.3 There should be no blank spaces on the form. Each space must be filled in with the information requested or "NA" (not applicable).
4.3.4 Forms should not be loose, but should be maintained in an organized manner (e.g., clipboards, binders).

4.4 Maps and Drawings

4.4.1 Maps and drawings that document final sampling locations and which are separate from the field logbook must be referenced in the logbook. These maps or drawings must include the project name and number, site identification and location, and must be signed and dated by the person recording the locations.
4.4.2 Maps and drawings must include compass orientation and scale.

4.5 Photographs and Other Photo Documentation

4.5.1 Photo documentation, if permitted at the site, can provide invaluable information on site conditions, sample locations, and the sample itself.
4.5.2 Photographs, videos, or slides must be cross-referenced to entries in the field logbook or on a photo documentation log. Information to be recorded includes name of photographer, date, time, direction faced, description of subject, and sequential number of the photograph and roll number. An indication of scale is also helpful. Image-enhancing techniques (lenses, film) should also be noted.

4.6 Electronic Files

4.6.1 Electronically captured data may include data logging systems and hand-held electronic recording devices such as PDAs, laptops, or tablet PCs.
4.6.2 Field data that is captured electronically must be cross-referenced in the field logbook. Information to be recorded includes the identity of the person

recording the data, instrument make and model number, measurement time and date, and file identification.

4.6.3 Sufficient backup systems must be in place to protect against the loss of data. Electronic files must be saved to a disk or backed up immediately upon completion. The backup disk or other media (CD, flash drive) should then be stored in a secure location separate from the laptop, tablet, or PDA.

4.6.4 Files must be uniquely identified and should be stored in the project files on the network. An unedited version of the file must be maintained and all subsequent manipulations tracked.

5.0 QUALITY CONTROL

5.1 The field records will be reviewed by the Field Team Leader, or by the Project Manager or his/her designate, for accuracy, completeness, and adherence to the requirements of this SOP. At a minimum, this must occur at the end of the field event. For field activities of extended duration, it is recommended that this review occur more frequently (e.g., daily or weekly).

5.2 If information recorded in the field is transcribed to another format, the original record must be retained for comparison purposes.

5.3 Periodic copying of the field records should be considered to insure against the loss or destruction of the original documents.

6.0 RECORDS MANAGEMENT

At the end of the field program, original field records must be placed in the project files and maintained for a certain retention time. The duration of record retention will be determined by project-specific requirements, or, in the absence of project requirements, by ENSR Corporate policy.

7.0 TRAINING/QUALIFICATIONS

The individual recording field data must have read, and be familiar with, the requirements of this SOP.

ENSR INTERNATIONAL

8.0 REFERENCES

USACE. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. United States Army Corps of Engineers. 1 February 2001.

USEPA. 2004. Contract Laboratory Program Guidance for Field Samplers. OSWER 9240.0-35. EPA540-R-00-003. United States Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation. August 2004.

USEPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. United States Environmental Protection Agency, Region 4, Athens, GA. November 2001.

USEPA. 1998. Test Methods for Evaluating Solid Wastes. Physical/Chemical Methods (SW-846). Third edition, including all final updates.

USEPA. 1992. RCRA Ground-water Monitoring: Draft Technical Guidance. United States Environmental Protection Agency, Office of Solid Waste, Washington, DC. November 1992.

ENSR INTERNATIONAL

Table 1 Specific Information to be Recorded

- Site name and location
- Personnel on site (ENSR, clients, site contacts, regulators, oversight personnel, subcontractors, general public)
- Results of phone calls, conversations
- Chronology of activities, including mobilization, investigatory activities, and demobilization
- Weather conditions (initial and any changes; temperature, barometric pressure, wind conditions, precipitation)
- Tidal stage (if applicable)
- Inspections of equipment, materials, supplies (problems, corrective action)
- Subcontractor name, description of services to be provided, and any issues (problems, stand by time)
- Description of major equipment (drill rigs, backhoe, survey vessels, sampling platforms)
- Field measurements
  - –Description of procedure
  - –Instruments (make, model, serial number, lamp)
  - –Instrument calibration (date, time, personnel, standard, lot number, standard expiration date, true/measured results, units, corrective action, calibration checks and results)
  - –Results (including units of measure, any correction factors applied, documentation of calculations (if applicable)
  - –Date and time of measurement
  - –Identity of person performing the measurements
  - –Atmospheric conditions (if applicable)
- Equipment decontamination procedures and materials
- Well information (depth to water, static water depth, condition of well)
- Well purging information (procedure, equipment, volumes, pumping rate, criteria for acceptance, time and date)
- Presence and detection of immiscible layers, detection method, sampling method
- Sampling information
  - –Procedures and equipment (type and material)
  - –Sample (soil) selection criteria/rationale (PID, staining, water table)
  - –Sample location identification (e.g., boring, well identification)
  - –Sample location description (sketch, GPS coordinates, compass and distance measurements from fixed points).
  - –Sample depth
  - –Sample flow rate/drawdown
  - –Sample description (recovery, moisture, color, odor, texture, turbidity, artifacts)
  - –Sample manipulations (filtration, homogenization, compositing, preservation)
  - –Sample date and time
  - –Unique sample ID
  - –Identity of sampler
  - –Sample parameters, containers (size/type), preservation
  - –QC samples (field duplicates, trip blanks, field/equipment blanks, MS/MSDs, split samples) – include ID, associated field sample, method of collection
- Any pertinent field observations that could affect data quality (instrument problems, contamination sources)
- Deviations from approved plan (schedule modifications, relocation or elimination of sample locations, change orders), including rationale
- Investigation-derived waste (IDW) types, volumes, storage, and disposal
- Health and safety (H&S) meetings, personal protective equipment (PPE) worn, H&S monitoring

ENSR | AECOM

Decontamination of Field Equipment

SOP Number 7600

Revision Number: 0.0

January 2008

Jamie C Stevens, P.E.
ENSR Project Manager
January 23, 2008

Renee Knecht, L.G.
ENSR Project QA Officer
January 23, 2008

ENSR Corporation
January 23, 2008

LIST OF ACRONYMS

SAP	Sampling Analysis Plan
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
OSHA	Occupational Safety and Health Administration
QC	Quality Control
SOP	Standard Operating Procedure
QAPP	Quality Assurance Project Plan

taken to protect field personnel. These measures are addressed in the project Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Equipment decontamination should be performed a safe distance away from the sampling area so as not to interfere with sampling activities, but close enough to the sampling area to maintain an efficient working environment.

5.0 PERSONNEL QUALIFICATIONS

Decontamination of field equipment is a relatively simple procedure requiring minimal training. It is recommended that the initial decontamination of field equipment be supervised by more experienced personnel. Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the decontamination procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within Sampling Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP). Field personnel are responsible for decontamination of field equipment and for proper documentation in the field logbook.

6.0 EQUIPMENT AND SUPPLIES

General field supplies include the following items:

- Decontamination agents
  - Simple Green, or other non-phosphate and non-borate biodegradable detergent/degreaser
  - Distilled/deionized water
- Health and safety supplies (as required by the HASP)
- Chemical-free paper towels
- Waste storage containers: drums, 5-gallon buckets with covers, plastic bags
- Cleaning containers: plastic buckets or tubs
- Cleaning brushes
- Pressure sprayers (if applicable)

7.2 Decontamination for Inorganic (Metals) Analyses

7.2.1 This procedure applies to equipment used in the collection of environmental samples submitted for inorganic constituent analysis. Examples of relevant items of equipment include split-spoons, trowels, scoops/spoons, and other small items. Submersible pump decontamination procedures are outlined in Section 7.2.

7.2.2 Decontamination is to be performed before sampling events and between sampling points, unless otherwise noted in the SAP.

7.2.3 After a sample has been collected, remove all gross contamination from the equipment or material by brushing and then rinsing with available tap water. This initial step may be completed using a 5-gallon bucket filled with tap water. A water pressure sprayer may also be used to remove solids and/or other contamination.

7.2.4 Wash the equipment with a non-phosphate and non-borate detergent and tap water solution. This solution should be kept in a 5-gallon bucket with its own brush.

7.2.5 Rinse with tap water or distilled/deionized water until all detergent and other residue is washed away. This step can be performed over an empty bucket using a squeeze bottle or pressure sprayer.

7.2.6 Rinse with 10% nitric acid.

7.2.7 Rinse with distilled/deionized water to remove any residual acid.

7.2.8 Allow the equipment to air-dry in a clean area or blot with chemical-free paper towels before reuse. Wrap the equipment in aluminum foil with the shiny side out and/or seal it in a zipper-lock plastic bag if it will not be reused immediately.

7.2.9 Dispose of soiled materials and spent solutions in the designated IDW disposal containers.

7.3.7 Using a pressure sprayer with distilled/deionized water, rinse the exterior of the pump, discharge line, and power cord thoroughly, shake all excess water, then place the pump system into a clean trash bag for storage. If the pump system will not be used immediately, the pump itself should be wrapped with aluminum foil before placing it into the bag.

7.4 Decontamination of Large Equipment

7.4.1 A temporary decontamination pad may be established for decontamination of heavy equipment. This pad may include a membrane-lined and bermed area large enough to drive heavy equipment (e.g., drill rig, backhoe) onto with enough space to spread other equipment and to contain overspray. Usually a small sump is necessary to collect and contain rinsate (a pump is used to remove these wastes from the sump). A water supply and power source is also necessary to run steam cleaning and/or pressure washing equipment.

7.4.2 Upon arrival at the Area of Investigation, all heavy equipment (such as drill rigs) should be thoroughly cleaned. This can be accomplished by steam cleaning or high pressure water wash and manual scrubbing.

Between each sample location (i.e., between boreholes), heavy equipment that has been in the ground must be cleaned by steam cleaning or high pressure water wash and manual scrubbing. This may be performed at the decontamination pad or in the vicinity of the drilling location.

8.0 DATA AND RECORDS MANAGEMENT

Specific information regarding decontamination procedures should be documented in the project-specific field logbook. Documentation within the logbook should thoroughly describe the construction of any decontamination facility and the decontamination steps implemented in order to show compliance with the SAP. Decontamination events should be logged when they occur with the following information documented:

- Date, time, and location of each decontamination event
- Equipment decontaminated
- Method
- Solvents and/or acids used

Appendix C

Boring Logs

Geological Boring Log and Well Completion Diagram

OVM	Blows/6"	Inches Driven	Inches Recovered	USCS
				GP
3.5	5 7 9	18	18	SM / SP
0	4 6 9	18	18	SM
0	2 2 2	18	18	ML
0	5 5 8	18	18	SP
0				
0				
0	3 5 2	18	18	

Depth in Feet: 0, 5, 10, 15, 20

Lithologic Description

ASPHALT with gravel base course. (fill)

Reddish brown silty fine grained SAND; slightly moist, medium dense.

Black medium grained SAND with trace gravel; slightly moist, medium dense.

Reddish brown silty fine grained SAND; slightly moist, medium dense.

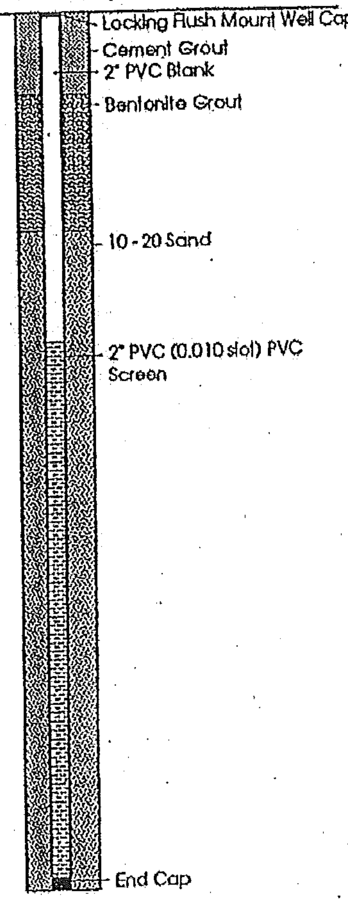
- grading moist at 5' bgs.

Brown fine grained sandy SILT with trace clay; wet, loose.

Brown fine to medium grained SAND; wet, medium dense to loose.

Boring completed at 16 1/2' bgs on 5/4/92.
Groundwater measured at 8.4' bgs on 5/4/92.

Well Description



Boring/Well No:	B-2 (MW-1)	Drilling Method:	Mobile B-61 Drill Rig w/ 4.25" ID Hollow Stem Auger
Client:	General Electric	Sample Method:	D&M U-Type Sampler driven by 300lb Hammer w/ 2.5" x 3" Stainless Steel Liners
Job No:	01674-881-005	Drill Contractor:	GeoBoring & Development, Inc.
Location:	Plant #1	Drill Date:	5/4/92
Geologist:	BF	Well Installed:	5/4/92

Dames & Moore

FILENAME: GE_MW.DRW 10/13/92

Geological Boring Log and Well Completion Diagram

Depth in Feet	OVM	Blows/6"	Inches Driven / Inches Recovered	USCS	Lithologic Description
0				GP	ASPHALT with gravel base course. (fill)
	3.5	11 9 6	18 18	SP	Black medium grained SAND with little fine gravel; slightly moist, medium dense. Grading brown fine grained SAND with trace silt; slightly moist, medium dense.
	2	2 1 2	18 18	ML	Gray clayey SILT; slightly moist, soft.
5	0	3 3 5	18 18	SM	Gray silty fine grained SAND with root material; moist, loose.
	0	4 4 4	18 18	SP	- grading brown fine to medium grained SAND; wet, loose to medium dense.
10	0	2 1 4	18 18	SP	
15	0	4 5 7	18 18	SP	Boring completed at 16 1/2' bgs on 5/5/92. Groundwater level measured at 8.08' bgs at 5/5/92.
20					

Well Description

- Locking Flush Mount Well Cap
- Cement Grout
- 2" PVC Blank
- Bentonite Grout
- 10 - 20 Sand
- 2" PVC (0.010 slot) PVC Screen
- End Cap

Boring/Well No:	B-4 (MW-2)	Drilling Method:	Mobile B-61 Drill Rig w/ 4.25" ID Hollow Stem Auger
Client:	General Electric	Sample Method:	D&M U-Type Sampler driven by 300lb Hammer w/ 2.5" x 3" Stainless Steel Liners
Job No:	01674-881-005		
Location:	Plant #1	Drill Contractor:	GeoBoring & Development, Inc.
Geologist:	BF	Drill Date:	5/5/92
		Well Installed:	5/5/92

Geological Boring Log and Well Completion Diagram

USCS	Lithologic Description	OVM	Blows/6"	Inches Driven / Inches Recovered
GP	ASPHALT with gravel base course. (fill)			
SM	Gray - brown fine grained SAND with little silt; slightly moist, medium dense.	0	5 7 9	18 18
ML	Brown SILT with little sand; slightly moist, medium dense.	0	5 7 9	18 18
SM	Brown silty fine grained SAND; moist, medium dense.	0	5 7 9	18 18
	- grading wet at 7' bgs.	0	5 7 9	18 18
SP	grading fine to medium grained SAND; wet, medium dense.	0	5 7 9	18 18
		0	5 7 9	18 18

Depth in Feet: 0, 5, 10, 15, 20

Boring completed at 16' bgs on 5/5/92.
Groundwater level measured at 7.09' bgs on 5/5/92.

Well Description

Boring/Well No:	B-3 (MW-3)	Drilling Method:	Mobile B-61 Drill Rig w/ 4.25" ID Hollow Stem Auger
Client:	General Electric	Sample Method:	D&M U-Type Sampler driven by 300lb Hammer w/ 2.5" x 3" Stainless Steel Liners
Job No:	01674-881-005	Drill Contractor:	GeoBoring & Development, Inc.
Location:	Plant #1	Drill Date:	5/5/92
Geologist:	BF	Well Installed:	5/5/92

Dames & Moore

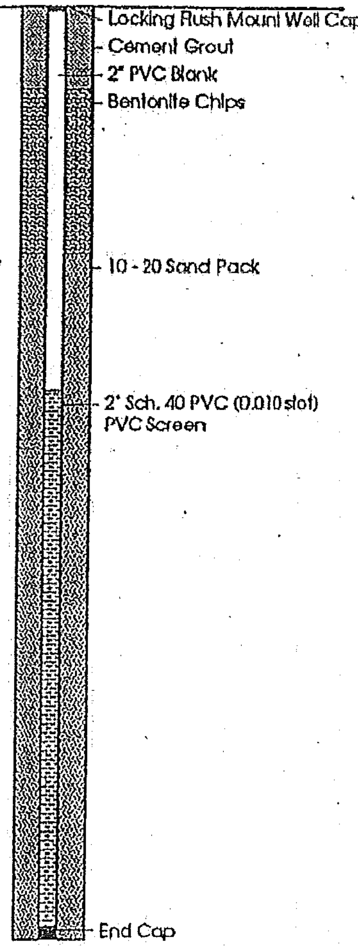
FILENAME: GE_MWDRW 10/13/92

Geological Boring Log and Well Completion Diagram

OVM	Blows/6"	Inches Driven / Inches Recovered
2	8 12 12	18 18
0	3 6 6	18 18
2	4 2 4	18 18
0	4 5 7	18 18
0	2 2 4	18 18
0	4 5 7	18 18
0	4 6 9	18 18
0	4 5 9	18 18

Depth in Feet	USCS / Lithology	Lithologic Description
0	GP	ASPHALT with gravel base course. (fill)
	SM	Gray, fine grained SAND with little silt; slightly moist, loose to medium dense.
		- grading to black at 2' bgs.
		Brown silty fine grained SAND; moist, medium dense.
5		
		- grading to gray at 7' bgs.
10	ML	Grayish brown sandy SILT; wet, loose. - 3" layer of bark and organics encountered at 10' bgs.
	SP	Gray fine grained SAND with some silt; wet, medium dense.
15		
		Boring completed at 17' bgs on 5/4/92. Groundwater level measured at 9.52' on 5/4/92 and 5/5/92.
20		

Well Description



Boring/Well No:	B-1 (MW-4)	Drilling Method:	Mobile B-61 Drill Rig w/ 4.25" ID Hollow Stem Auger
Client:	General Electric	Sample Method:	D&M U-Type Sampler driven by 300lb Hammer w/ 2.5" x 3" Stainless Steel Liners
Job No:	01674-881-005		
Location:	Plant #1	Drill Contractor:	GeoBoring & Development, Inc.
Geologist:	BF	Drill Date:	5/4/92
		Well installed:	5/4/92

Dames & Moore

FILENAME: GE_MW.DRW 10/13/92

RETEC

Boring/Well Log

Well #: MW-8M
Sheet 1 of 1

Project: Dawson St.	Monument: flush mount	Stick Up: --
Project #: GE001-18600-600	Northing: 5182.23 Easting: 5429.19	Ground Elevation: 17.86'
Location: Seattle, WA	Drill Rig Type: CME-75	MP Elevation: 17.41'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 30'
Start Date & Time: 9/16/05 0920	Casing ID: 2"	Filter Pack: 10/20 Col. Silica Sand / 18-30'
Finish Date & Time: 9/16/05 1105	Boring ID: 8.5"	Seal: 3/8" bentonite chips / 2-18'
Contractor: Cascade Drilling Inc.	Bit Type: 4.25" HSA	Grout: --
Operator: Frank Scott	Logged By: Chris Gero	Screen: 10-slot / 20-30'

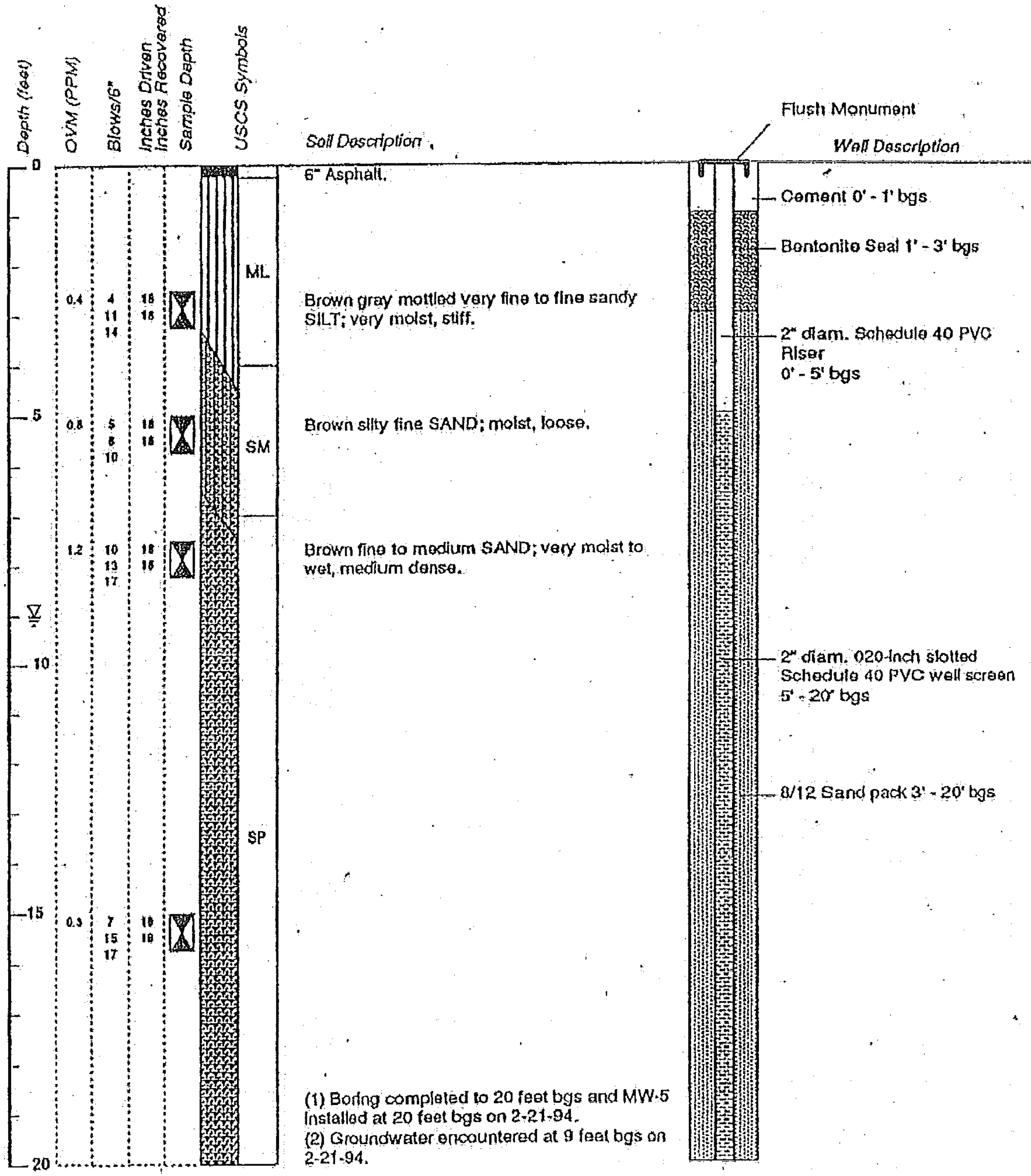
Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
ss	5-6.5'	60%	4/5/8		5	(5-6.5') SM: Dry to slightly moist, loose, medium brown, SILTY SAND. Fine to medium grained, no odor.		
ss	10-11.5'	85%	6/11/8		10	(10-11.5') SM: Wet, medium dense, dark grayish brown SILTY SAND. Fine to medium grained, no odor. Some orange-brown iron oxide staining.		
ss	15-16.5'	100%	6/9/11		15	(15-16.5') SM: Wet, medium dense, dark grayish brown SILTY SAND. Fine to medium grained, no odor. Heaving sands.		
ss	20-21.5'	85%	11/11/15		20	(20-21.5') SM: Wet, medium dense, dark grayish brown SILTY SAND. Fine to medium grained, no odor. Heaving sands.		
ss	25-26.5'	100%	22/23/26		25	(25-26.5') SM: Wet, dense, dark grayish brown SILTY SAND. Fine to medium grained, no odor. Heaving sands make sample appear loose. Fine silty stringer 1/4" thick at 26'.		
ss	30-31.5'	100%	5/7/25		30	(30-31.5') SM: Wet, medium dense, dark grayish brown SILTY SAND. Fine to medium grained, no odor. Heaving sands.		

Remarks and Datum Used: 300 lb. hammer, 30" stroke

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)

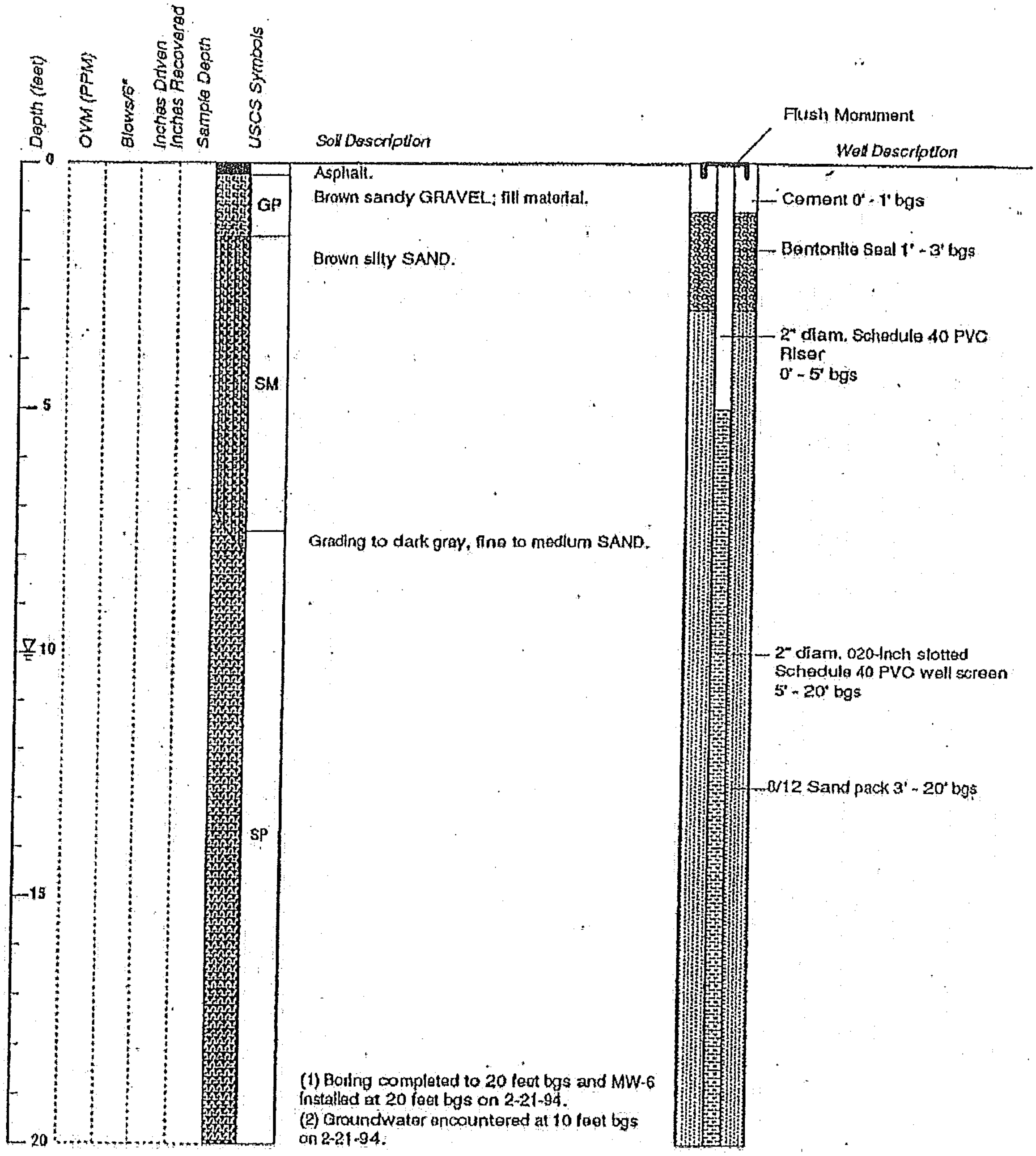


Client:	GEAE Plant1
Geologist:	JAK
Drilling Method:	8" Hollow Stem Auger, 140# Hammer
Sample Method:	D&M Split Spoon Sampler w/ 3" Stainless Steel Rings
Drill Contractor:	Cascade Drilling, Inc.
Drill Date:	February 21, 1994
TOC Elevation:	8.33
Ground Elevation:	8.62

MW-5

Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW5.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant1
Seattle, WA



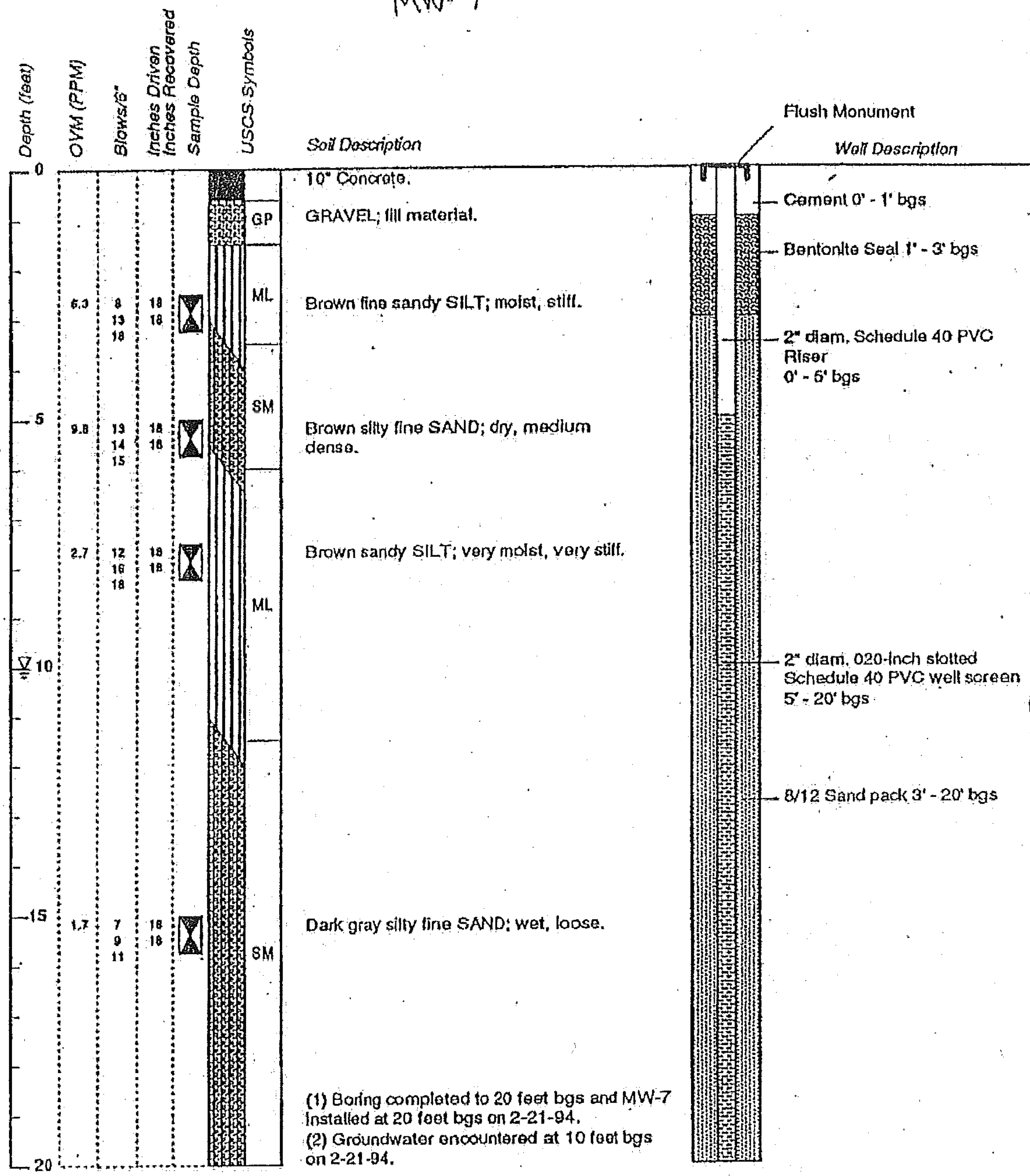
Client: GEAE Plant1
Geologist: JAK
Drilling Method: 8" Hollow Stem Auger, 140# Hammer
Sample Method: No soil samples collected, logged from cuttings
Drill Contractor: Cascade Drilling, Inc.
Drill Date: February 21, 1994
TOC Elevation: 8.17
Ground Elevation: 8.55

MW-6

Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW6.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant1
Seattle, WA

MW-7

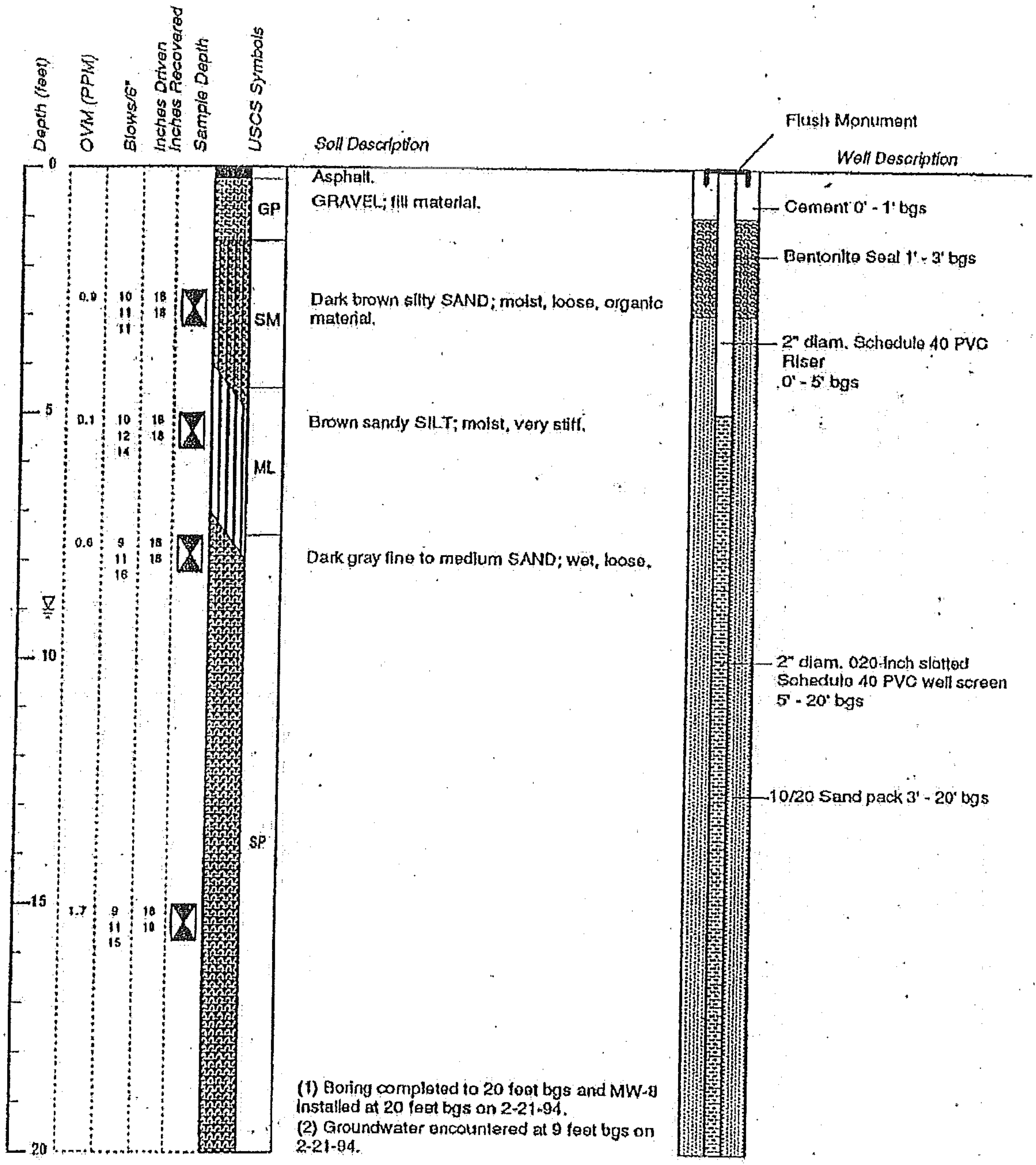


Client:	GEAE Plant1
Geologist:	JAK
Drilling Method:	8" Hollow Stem Auger , 140# Hammer
Sample Method:	D&M Split Spoon Sampler w/ 3" Stainless Steel Rings
Drill Contractor:	Cascade Drilling, Inc.
Drill Date:	February 21, 1994
TOC Elevation:	10.81
Ground Elevation:	11.08

MW-7

Page 1 of 1
Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW7.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant
Seattle, W

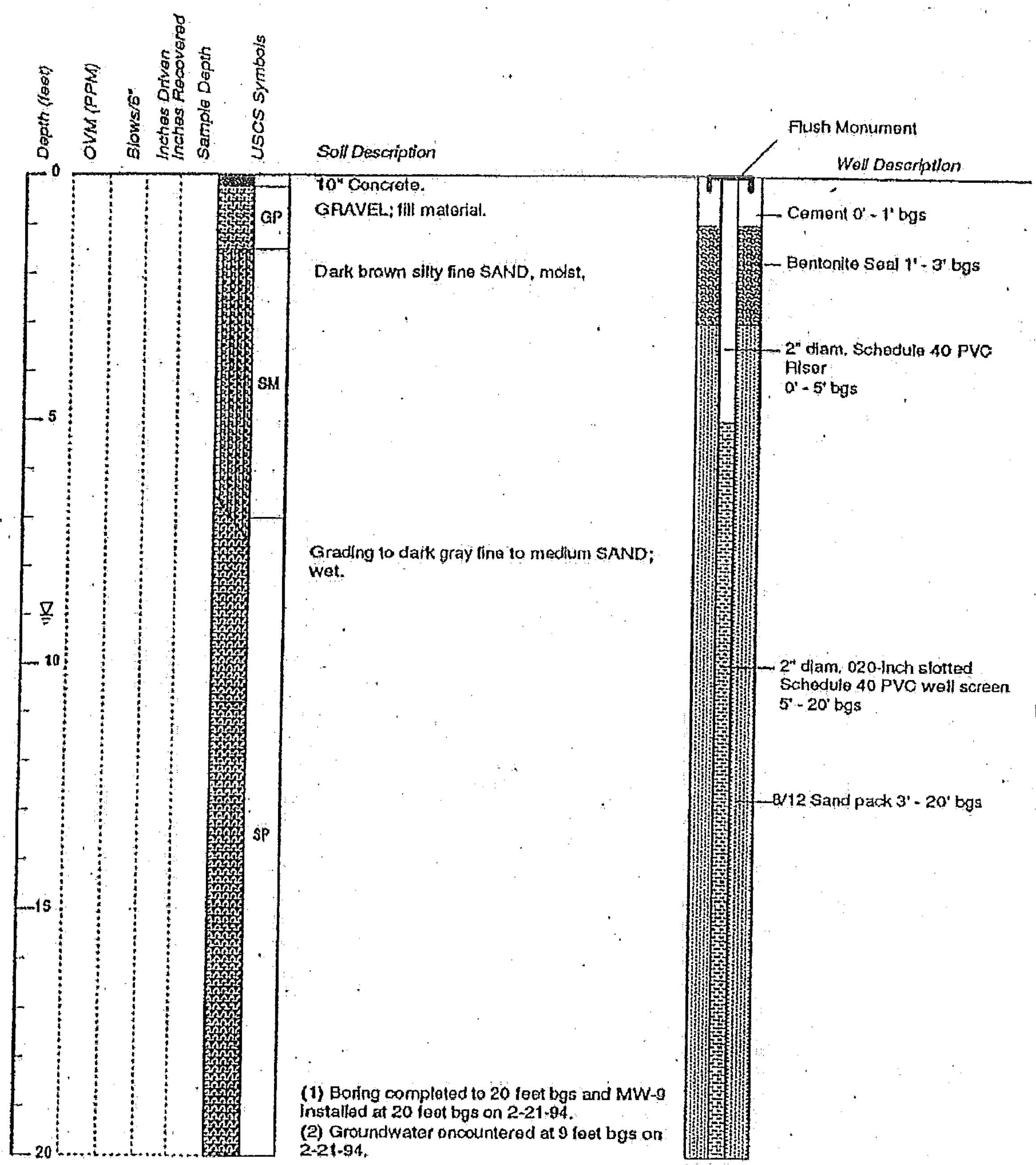


Client: GEAE Plant1
Geologist: JAK
Drilling Method: 8" Hollow Stem Auger, 140# Hammer
Sample Method: D&M Split Spoon Sampler w/ 3" Stainless Steel Rings
Drill Contractor: Cascade Drilling, Inc.
Drill Date: February 21, 1994
TOC Elevation: 8.06
Ground Elevation: 8.29

MW-8

Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW8.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant1
Seattle, WA

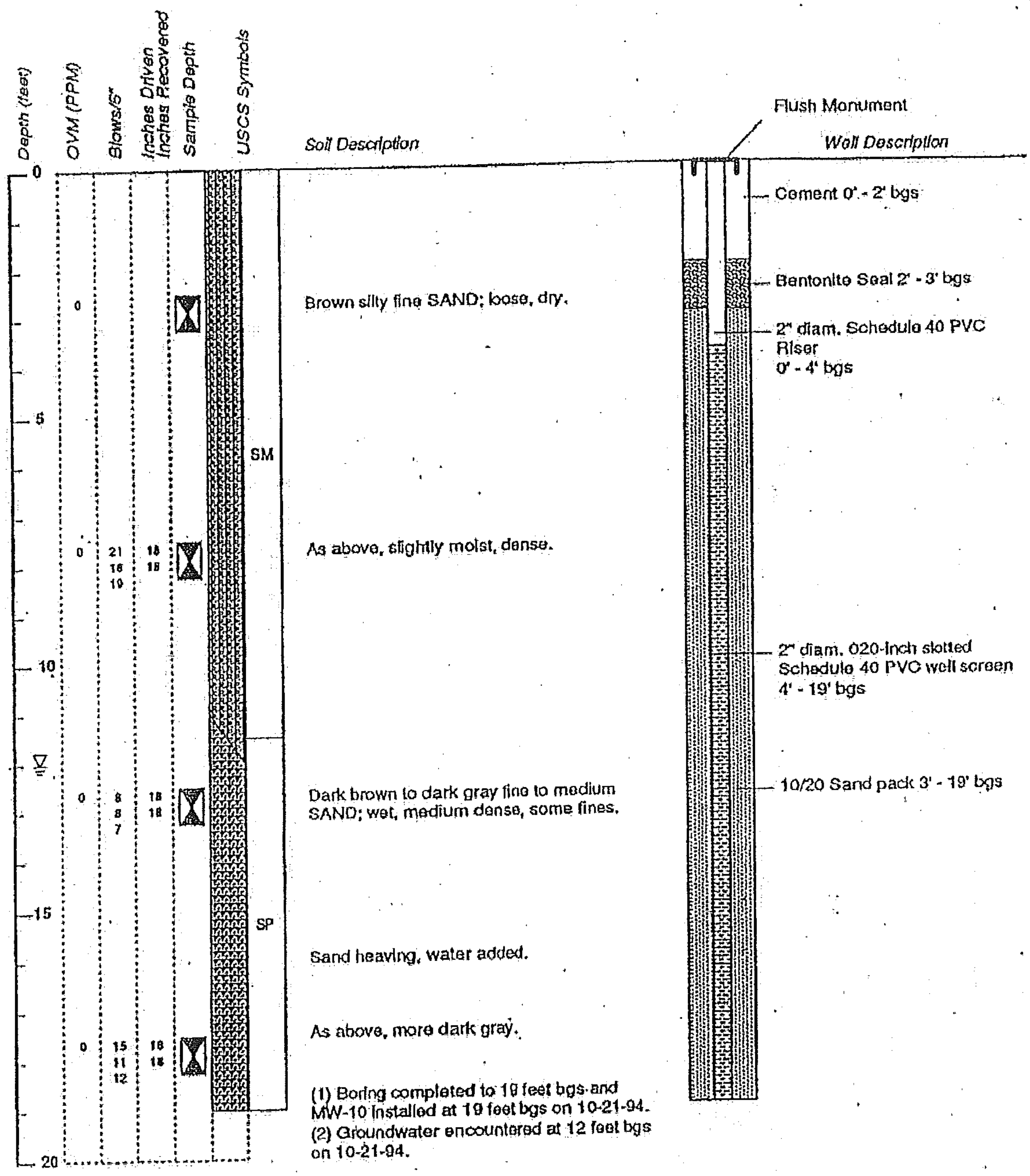


Client:	GEAE Plant1
Geologist:	JAK
Drilling Method:	8" Hollow Stem Auger, 140# Hammer
Sample Method:	No soil samples collected, logged from cuttings
Drill Contractor:	Cascade Drilling, Inc.
Drill Date:	February 21, 1994
TOC Elevation:	6.97
Ground Elevation:	7.33

MW-9

Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW9.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant1
Seattle, WA



Client: GEAE Plant1
Geologist: JAK
Drilling Method: Limited Access Hollow Stem Auger, 140# Hammer
Sample Method: Split Spoon Sampler
Drill Contractor: Cascade Drilling, Inc.
Drill Date: October 21, 1994
TOC Elevation: 7.88
Ground Elevation: 8.17

MW-10

Job No. 01674-970-005
DAMES & MOORE
File Name: GE-MW10.DRW

Boring Log and Monitoring Well As-Built Diagram
GE Plant1
Seattle, WA

RETEC

Boring/Well Log

Well #: MW-13
Sheet 1 of 2

Project: **GEAE Interim Action**	Monument: **Flush Mount**	Ground Elevation: **NM**
Project #: **GE001-15547-730**	Northing: **NM** Easting: **NM**	MP Elevation: **NM**
Client: **GEAE**	Drill Rig Type: **Limited Access**	Total Depth: **19**
Well Area: **Seattle, Wa**	Method: **HSA**	Filter Pack: **#2/12 Monterey Sand**
Start Date & Time: **12/13/02 9:00 a.m.**	Casing ID: **NA**	Seal: **Bentonite Chips**
Finish Date & Time: **12/13/02 9:30 a.m.**	Boring ID: **9 inches**	Grout: **NA**
Contractor: **Cascade**	Bit Type: **Auger/5-tooth**	Riser: **2-inch, SCH 40 PVC**
Operator: **James Goble**	Logged By: **Rikka Bothun**	Screen: **4-19 ft, 20 slot, 2-in SCH 40 PVC**

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
							0	0-0.5 ASPHALT	0	
	2.5-3.5	100	46-29-24	0				2.5-3 SANDY GRAVEL, gravel up to 1.5 inches in diameter, GP. Medium brown, slightly moist. Then about 1-2 inches of GRAVELLY SAND, very fine gravel and fine to coarse sand, SW. Grades to...		
								3-3.5 SILTY/CLAYEY SAND, ML. Medium to light brown, slightly moist, no odor or visible contamination (OVC).		
	5-6	75	50 for 6"	NM			5	5-6 (Top 2 inches SILTY/CLAYEY SAND (ML) as above.) SILTY SAND, very fine to very coarse sand with silt, SM. Medium brown, dry to slightly moist, no OVC.	5	
	7.5-8.5	100	19-21-26	NM				7.5-7.8 SANDY GRAVEL, gravel up to 1 inch diameter, GP. Medium brown, very moist, no OVC.		
								7.8-8.5 SILTY SAND, very fine to very coarse sand and silt, trace gravel, SM. Medium brown, hard, very moist, possibly saturated (water on outside of spoon barrel), no OVC.		
	10-11	100	15-22-17	NM			10	10-11 Well graded SAND. Very fine to very coarse sand (predominantly medium to very coarse size), SW. Dark grayish brown with approximately 15-20% light yellow grains. Saturated, no OVC.	10	

Remarks and Datum Used: Battery malfunction on OVA meter, unable to take PID measurements.

The RETEC Group, Inc.
29 Old Town Square Suite 250
Fort Collins, CO 80524
Phone: (970) 493-3700
Fax: (970) 493-2328

Sample Type
N = SPT
DP = Direct Push
GS = Grab Sample
C = Core

Groundwater		
Date	Time	Depth (ft.)
12/13/02	9:15	8

RETEC

Boring/Well Log

Sample Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
	12.5-13.5	100	50 for 6"	NM				12.5-13.5 Well graded SAND as above, SW. Slightly darker color than above. Saturated. No OVC.		
								Sand is beginning to heave in the augers at 13.5 feet. Stop sampling, plug auger, and drill to TD. Cuttings indicate more SAND (SW).		
							15		15	

Remarks and Datum Used: Battery malfunction on OVA meter, unable to take PID measurements.

The RETEC Group, Inc.
23 Old Town Square Suite 250
Fort Collins, CO 80524
Phone: (970) 493-3700
Fax: (970) 493-2328

Sample Type
N = SPT
DP = Direct Push
GS = Grab Sample
C = Core

Groundwater		
Date	Time	Depth (ft.)
12/13/02	9:15	8

Boring/Well Log

Well #: MW-14D
Sheet 1 of 2

Project: GE Int. Action Add. MW Install	Monument: Flushmount	Stick Up:
Project #: GE001-15547-730	Northing: Easting:	Ground Elevation:
Location: N. of Dawson, E. side of 1st.	Drill Rig Type: HSA limited access	MP Elevation:
Client: GEAE	Method: HSA augering	Total Depth: 55 ft
Start Date & Time: 07/16/03 0715	Casing ID: 8"	Filter Pack: 43-55' 10/20 silica sand
Finish Date & Time: 07/16/2003 1015	Boring ID: 6"	Seal: 2-43' 3/8" bentonite chips
Contractor: Cascade Drilling	Bit Type:	Grout:
Operator: Brian Gose	Logged By: N. Bacher	Screen: 45-55' 0.020-slot Sch. 40 PVC

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme:)	Elevation (ft.)	Comments
	0-4	100			0	ASPHALT (0-0.5'): asphalt	0	
						ROAD BASE (0.5-1.5'): moist, loose, brown, sandy gravel.	-1, -2	
	4-8	100				SM (1.5-3'): moist, medium dense, brown gray FINE SAND w/ minor silt.	-3, -4	
					5	ML (3-3.5'): moist, firm, olive gray, slightly sandy SILT.	-5, -6	
	8-12	90				SP (3.5-4'): moist, medium dense, orange brown FINE SAND.	-7, -8	
						SP (4-7'): Same as above.	-9	
					10	SM (7-8.5'): wet, medium dense, orange brown, slightly silty FINE SAND.	-10, -11	
	12-16	100				SP (8.5-12'): wet, medium dense, dark gray FINE to MEDIUM SAND.	-12, -13	
					15	SP (12-15.5'): saturated, medium dense, dark gray FINE to MEDIUM SAND.	-14, -15	
	16-20	60				ML (15.5-16'): moist, firm, brown gray SILT w/ minor fine sand.	-16, -17	
						SP (16-20'): moist to wet, dense, dark gray FINE SAND, 3" firm, gray SILT lens at 18'.	-18, -19	
	20-24	80			20	SP (20-24'): Same as above with 1/2" firm, gray SILT lens at 20.5'.	-20, -21, -22, -23	
	24-28	100			25	SP (24-28'): Same as above with 6" firm, gray SILT lens at 25'.	-24, -25, -26, -27	

Remarks and Datum Used: Lithology for GeoProbe WP-243 across 1st Ave. No odor or visual contamination throughout core.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)

RETEC

Boring/Well Log

Well #: MW-14D

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme:)	Elevation (ft.)	Comments
	28-32	50				SP (28-32'): Same as above with 6" firm, gray SILT lens at 31'.	-28 to -32	
	32-36	80				SP (32-36'): moist to wet, medium dense, dark gray FINE SAND.	-32 to -36	
							-36 to -40	
	40-42	75			40	SP (40-42'): wet, medium dense to dense, dark gray FINE SAND.	-40 to -42	
						ML (45-45.5'): wet, firm, gray SILT w/ minor to trace sand.	-42 to -44	
	45-47	100			45	SP (45.5-47'): wet, medium dense, dark gray FINE SAND.	-46 to -47	
						ML (47-47.5'): wet, firm, gray SILT w/ trace sand.	-47 to -48	
						SP (47.5-48'): wet, medium dense, dark gray FINE SAND.	-48 to -50	
	50-52	100			50	SP (50-52'): wet, dense, dark gray FINE SAND w/ trace silt.	-50 to -52	
					55		-55	

Remarks and Datum Used: Lithology for GeoProbe WP-243 across 1st Ave. No odor or visual contamination throughout core.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater Date	Time	Depth (ft.)

RETEC

Boring/Well Log

Well #: MW-15D ·
Sheet 1 of 2

Project: GE Int. Action Add. MW Install	Monument: Flushmount	Stick Up:
Project #: GE001-15547-730	Northing: Easting:	Ground Elevation:
Location: N. of Dawson on Utah St.	Drill Rig Type: HSA	MP Elevation:
Client: GEAE	Method: Hollow-stem auger	Total Depth: 56.5 ft
Start Date & Time: 07/14/2003 0920	Casing ID: 8"	Filter Pack: 43-55' 10/20 silica sand
Finish Date & Time: 07/17/2003 1230	Boring ID: 4"	Seal: 2-43' 3/8" bentonite chips
Contractor: Cascade Drilling	Bit Type:	Grout:
Operator: Brian Gose	Logged By: N. Bacher	Screen: 45-55' 0.020-slot Sch. 40 PVC

Sample: Type & #	Sample: Depth Range	Sample: % Rec	Sample: Blows per 6"	Sample: PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
							0	ASPHALT (0-0.5'): asphalt	-1	
								ROAD BASE (0.5-1.5'): moist, brown, sandy gravel. Slight odor.	-2, -3	
								SM (1.5-3.0'): moist, loose, dark brown, SILTY SAND.	-4	
	5-6.5	100	6/6/8				5	SM (5-6.5'): moist, slightly dense, dark brown, SILTY SAND.	-5, -6	
	7.5-9	100	6/6/8					SP (7.5-9'): moist, slightly dense, dark brown (multicolored specs) FINE SAND w/ trace silt.	-7, -8, -9	
	10-11.5	80	7/7/7				10	SP (10-11.5'): Same as above but wet.	-10, -11	
	12.5-14	100	15/12/15					SP (12.5-14'): Same as above, still wet, more dense.	-12, -13, -14	
	15-16.5	100	10/10/11				15	SP (15-16.5'): Same as above but with minor silt.	-15, -16	
	17.5-19	100	3/6/15					SP/ML (17.5-18): moist, medium dense/soft, gray, interbedded fine sand and silt lenses.	-17, -18	
								SP (18-19'): moist, dense, dark gray, multicolored grains FINE SAND w/ trace silt.	-19	
	20-21.5	100	19/25/28				20	SP (20-21.5'): Same as above.	-20, -21	
	22.5-24	75	4/14/21					SP (22.5-24'): moist to wet, medium dense, dark gray, FINE SAND.	-22, -23, -24	
	25-26.5	100	12/24/30				25	SP (25-26.5'): wet, medium dense to dense, dark gray, FINE SAND.	-25, -26, -27	

Remarks and Datum Used: Hand cleared to 3 ft.
No odor or visual contamination throughout core except for in the road base layer.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater: Date	Time	Depth (ft.)

Boring/Well Log

Well #: MW-15D
Page 2 of 2

Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
	27.5-29	100	12/15/27			SP (27.5-29'): Same as above but with 2" silty clay lens at 28'.	-28, -29	
	30-31.5	100	15/24/35		30	SP/ML (30-31'): moist to wet, medium dense, gray, interbedded fine sand and silt lenses.	-30, -31, -32	
						SP (31-31.5'): wet, medium dense, dark gray (multicolored grains) FINE SAND.		
	32.5-34	80	15/25/35			SP (32.5-34'): soaking wet, medium dense, dark gray, FINE SAND.	-33, -34	
	35-36.5	100	21/30/41		35	SP (35-36.5'): Same as above.	-35, -36, -37	
	37.5-39	100	4/17/29			SP (37.5-39'): Same as above.	-38, -39	
	40-41.5	100	21/26/40		40	SP (40-41.5'): Same as above.	-40, -41	
	42.5-44	100	8/15/50			SP (42.5-44'): wet, medium dense, dark gray, FINE SAND.	-42, -43, -44	
	45-46.5	100	15/21/27		45	SP (45-46.5'): moist, medium dense, dark gray, FINE SAND.	-45, -46, -47	
	47.5-49	100	15/21/37			SP (47.5-49'): wet, medium dense, dark gray, FINE SAND.	-48, -49	
	50-51.5	100	21/28/31		50	SP (50-51.5'): wet, medium dense, dark gray (multicolored grained) FINE SAND.	-50, -51, -52	
	52.5-54	100	8/10/17			SP (52.5-54'): moist to wet, medium dense, gray (multicolored grains) FINE SAND.	-53, -54	
	55-56.5	100	8/10/20		55	SP (55-56.5'): Same as above.	-55, -56	

Remarks and Datum Used: Hand cleared to 3 ft.
No odor or visual contamination throughout core except for in the road base layer.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)

Boring/Well Log

RETEC

Well #: MW-16D
Sheet 1 of 2

Project: GE Int. Action Add. MW Install	Monument: Flushmount	Stick Up:
Project #: GE001-15647-730	Northing: Easting:	Ground Elevation:
Location: S. of Rabanco on Dawson St.	Drill Rig Type: HSA and GeoProbe	MP Elevation:
Client: GEAE	Method: HSA and GeoProbe	Total Depth: 57 ft
Start Date & Time: 07/16/2003 0800	Casing ID: 8"	Filter Pack: 43-55' 10/20 silica sand
Finish Date & Time: 07/16/2003 1145	Boring ID: 4"	Seal: 2-43' 3/8" bentonite chips
Contractor: Cascade Drilling	Bit Type:	Grout:
Operator: Dan XXX/Brian Gose	Logged By: N. Bacher	Screen: 45-55',020-slot Sch. 40 PVC

Sample: Type & #	Sample: Depth Range	Sample: % Rec	Sample: Blows per 6"	Sample: PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
	0-4	100						ASPHALT (0-0.5'): asphalt. ROAD BASE (0.5-2'): moist, brown, sandy gravel. SP (2-4'): dry to moist, loose to slightly dense, brown (orange oxidation stains) FINE SAND.		
	4-8	80						SP (4-5.5'): Same as above. SP (5.5-8'): moist, slightly dense, dark gray (multicolored grains) FINE SAND.		
	8-12	90						SP (8-10.5'): Same as above with scattered 1/2" thick rust colored layers. SP (10.5-12'): wet, medium dense, dark gray (multicolored grains) FINE SAND.		
	12-16	100						SP (12-16'): Same as above with rust colored interbeds of fine sand between 14.5-15.5.		
	16-20	70						SP (16-20'): saturated, medium dense, dark gray (multicolored grains) FINE SAND.		
	20-24	75						SP (20-24'): Same as above with a 2' gray silt lens at 21'.		
	24-28	100						SP (24-28'): Same as above with two 2" dense, gray silt lenses. One at 25' and the other at 25.5'.		

Remarks and Datum Used: Hole probed for lithology before well was set. No odor or contamination throughout the core.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater: Date	Time	Depth (ft.)

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
	28-32	5					30	SP (28-32'): Very poor recovery. Recovered sample was same as above.	-28 to -32	
	32-36	100					35	SP/ML (32-36'): Interbeds of dense, gray silt adn dense, dark gray fine sands. Silt beds (6" thick) at 32.5' and 33.5'. Saturated.	-32 to -36	
	36-40	100					40	SP (36-40'): Core liner stuck in sampler, sample poured out. Wet, medium dense, dark gray FINE SAND.	-36 to -40	
	45-47	100					45	SP (45-47'): wet, medium dense, dark gray, FINE SAND.	-45 to -47	
	50-52	100					50	SP (50-52'): Same as above.	-50 to -52	
	55-57	100					55	SP (55-57'): Same as above.	-55 to -57	

Elevation (ft.) scale: -28, -29, -30, -31, -32, -33, -34, -35, -36, -37, -38, -39, -40, -41, -42, -43, -44, -45, -46, -47, -48, -49, -50, -51, -52, -53, -54, -55, -56, -57

Remarks and Datum Used: Hole probed for lithology before well was set. No odor or contamination throughout the core.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)

RETEC Boring/Well Log

Well #: MW-17M
Sheet 1 of 1

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-18600-730	Northing: 5097.54 Easting: 4675.32	Ground Elevation: 18.235'
Location: Seattle, WA	Drill Rig Type: CME 75	MP Elevation: 17.735'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 30.0'
Start Date & Time: 1/31/05 1332	Casing ID: 2"	Filter Pack: 18.0-30.0' 10/20 sand
Finish Date & Time: 1/31/05 1420	Boring ID: 4"	Seal: Bentonite chips, 2.0-18.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: -
Operator: Scott	Logged By: Renee Knecht	Screen: 0.020-inch slot, 20.0-30.0'

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description Classification Scheme: USGS	Elevation (ft.)	Comments
							0	No lithology samples taken. See MW-17D boring log for lithology details.	0	
							5		-5	
							10		-10	
							15		-15	
							20		-20	
							25		-25	
							30		-30	

Remarks and Datum Used: 4" bottom cap on well.
Wood plug used during drilling to depth.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
1/31/05	1205	9.20'

RETEC

Boring/Well Log

Well #: MW-17D
Sheet 1 of 3

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-18600-730	Northing: 5103.6 Easting: 4675.2	Ground Elevation: 18.23'
Location: Seattle, WA	Drill Rig Type: CME 75	MP Elevation: 17.795'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 55.0'
Start Date & Time: 1/31/05 0804	Casing ID: 2"	Filter Pack: 43.0-55.0' 10/20 sand
Finish Date & Time: 1/31/05 1035	Boring ID: 4"	Seal: Bentonite chips, 4.0-43.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: -
Operator: Scott	Logged By: Renee Knecht	Screen: 0.020-inch slot, 45.0-55.0'

Sample Type & #	Sample Depth Range	Sample % Rec	Sample Blows per 6"	Sample PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
							0	0.0-5.0' Not sampled.	0	
SS	5-6.5	13.5/18	7 9 10				5	5.0-6.5' SP: Sand, fine, brown to dark grayish brown, 10-15% silt, loose todense, damp to wet, no odor, no visual product.	-5	
								6.5-10.0' Not sampled.		
SS	10-11.5	11/18	7 9 10				10	10.0-11.5' SP: Sand, fine, dark grayish brown, 10% silt, 5% sand, medium, abundant quartz, loose, wet, no odor, no visual product.	-10	
								11.5-15.0' Not sampled.		
SS	15-16.5	18/18	16 18 22				15	15.0-16.5' SP: Sand, fine, dark rayish brown, 10% silt, 5% sand, medium, abundant quartz, dense, wet, no odor, no visual product.	-15	
								16.5-20.0' Not sampled.		

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
1/31/05	1200	6.38'

RETEC

Boring/Well Log

Well #: MW-17D

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	20-21.5	17/18	15 18 20				20	20.0-21.5' SP: Sand, fine, dark grayish brown, 30% sand, medium, 5% silt, abundant quartz, dense, wet, no odor, no visual product. Top of sampler few wood pieces and coal fragments seen on stuff.	-20	
								21.5-25.0' Not sampled.		
SS	25-26.5	15/18	12 16 16				25	25.0-26.5' SP: Sand, fine, dark grayish brown, 20% silt, 15% sand, medium, grayish brown, silt lense at 25.75', abundant quartz, dense, wet.	-25	
								26.5-30.0' Not sampled.		
SS	30-31.5	18/18	13 15 16				30	30.0-31.5' SP: Sand, fine, dark grayish brown, 20% sand, medium, 5% silt, silt increasing going down hole, abundant quartz, dense, wet, no odor, no visual product.	-30	
								31.5-35.0' Not sampled.		
SS	35-36.5	17/18	15 16 17				35	35.0-36.5' SP; Sand, fine, dark grayish brown to grayish brown, silt lense at 36.0', abundant quartz, dense, wet, no odor, no visual product.	-35	
								36.5-40.0' Not sampled.		

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
1/31/05	1200	6.38'

Boring/Well Log

RETEC

Well #: MW-17D

Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	40-41.5	18/18	11 13 15		40	40.0-41.5' SP: Sand, fine, dark grayish brown, 15% sand, medium, 10% silt, abundant quartz, loose to dense, wet, no odor, no visual product.	-40	
						41.5-45.0' Not sampled.		
SS	45-46.5	14/18	12 15 18		45	45.0-46.5' SP: Sand, fine, dark grayish brown, 10% sand, medium, 5% silt, abundant quartz, wet, no odor, no visual product.	-45	
						46.5-50.0' Not sampled.		
SS	50-51.5	18/18	14 16 19		50	50.0-51.5' SP: Sand, fine, dark grayish brown to grayish brown, 10-15% sand, medium, 5% silt, abundant quartz, brownish gray silt 51.2-51.5', loose to dense, wet, no odor, no visual product.	-50	Bottom of hole collapsed in to 55.0'.
						51.5-55.0' Not sampled.		
SS	55-56.5	18/18	10 15 19		55	55.0-55.75' SP: Sand, fine, grayish brown, 15% sand, medium, dense, wet, no odor, no visual product.	-55	
						55.75-56.5' SM: Sand, fine, and silt, grayish brown, dense, wet, no odor, no visual product.		

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
1/31/05	1200	6.38'

Boring/Well Log

RETEC

Well #: MW-18M
Sheet 1 of 1

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-18600-730	Northing: 4899.05 Easting: 4693.18	Ground Elevation: 16.15'
Location: Seattle, WA	Drill Rig Type: CME 75	MP Elevation: 15.755'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 30.0'
Start Date & Time: 1/31/05 1332	Casing ID: 2"	Filter Pack: 18.0-30.0' 10/20 sand
Finish Date & Time: 1/31/05 1420	Boring ID: 4"	Seal: Bentonite chips, 2.0-18.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: -
Operator: Scott	Logged By: Renee Knecht	Screen: 0.020-inch slot, 20.0-30.0'

Sample: Type & #	Sample: Depth Range	Sample: % Rec	Sample: Blows per 6"	Sample: PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
							0	No lithology samples taken. See MW-18D boring log for lithology details.	0	
							5		-5	
							10		-10	
							15		-15	
							20		-20	
							25		-25	
							30		-30	

Remarks and Datum Used: 4" bottom cap on well.
Wood plug used during drilling to depth.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater: Date	Time	Depth (ft.)
1/31/05	1446	7.35'

RETEC

Boring/Well Log

Well #: MW-18D
Sheet 1 of 3

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-16600-730	Northing: 4904.02 Easting: 4692.82	Ground Elevation: 16.225'
Location: Seattle, WA	Drill Rig Type: CME 75	MP Elevation: 15.545'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 55.0'
Start Date & Time: 2/1/05 0910	Casing ID: 2"	Filter Pack: 43.0-55.0' 10/20 sand
Finish Date & Time: 2/1/05 1050	Boring ID: 4"	Seal: Bentonite chips, 4.0-43.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: --
Operator: Scott	Logged By: Renee Knecht	Screen: 0.020-inch slot, 45.0-55.0'

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
							0	0.0-5.0' Not sampled.	0	
SS	5-6.5	15/18	8 9 9				5	5.0-6.5' SP: Sand, fine, grayish brown, 10% silt, 5% sand, medium, 5% gravel, medium, subangular to subrounded, loose to dense, damp, no odor, no visual product.	-5	
								6.5-10.0' Not sampled.		
SS	10-11.5	10/18	11 13 15				10	10.0-11.5' SP: Sand, fine, grayish brown to brown, 10% sand, medium, 5% silt top 5", loose, wet, abundant quartz, no odor, no visual product.	-10	
								11.5-15.0' Not sampled.		
SS	15-16.5	18/18	9 10 15				15	15.0-16.5' SP: Sand, fine, dark grayish brown, 10% sand, medium, loose, wet, abundant quartz, no odor, no visual product.	-15	
								16.5-20.0' Not sampled.		

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
2/1/05	1130	7.32'

RETEC

Boring/Well Log

Sample Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	20-21.5	18/18	4, 15, 15		20	20.0-21.5' SP: Sand, fine, dark grayish brown, 10% sand, medium, loose to dense, wet, abundant quartz, no odor, no visual product.	-20	
						21.5-25.0' Not sampled.		
SS	25-26.5	18/18	11, 13, 16		25	25.0-26.5' SP: Sand, fine, dark grayish brown, 10% sand, medium, loose to dense, wet, abundant quartz, no odor to slight chemical odor, no visual product.	-25	
						26.5-30.0' Not sampled.		
SS	30-31.5	18/18	10, 15, 17		30	30.0-31.0' SP: Sand, fine, dark grayish brown, 10% sand, medium, abundant quartz, loose to dense, wet, no odor, no visual product.	-30	
						31.0-31.5' SM: Silt and sand, fine, dark grayish brown, loose to dense, wet, no odor, no visual product.		
						31.5-35.0' Not sampled.		
SS	35-36.5	14/18	10, 12, 14		35	35.0-35.9' SP: sand, fine, dark grayish brown, 10% sand, medium, loose to dense, wet, no odor, no visual product.	-35	
						35.9-36.5' SM: Sand, fine, and silt, alternating lenses, dark grayish brown, loose to dense, wet, no odor, no visual product.		
						36.5-40.0' Not sampled.		

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
2/1/05	1130	7.32'

RETEC

Boring/Well Log

Well #: MW-18D

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	40-41.5	14/18	10 14 16		40	40.0-41.5' SP: Sand, fine, dark grayish brown, 30% silt, silt lense at 40.75-41.0', 5 to 10% sand, medium, dense, wet, no odor, no visual product.	-40	
						41.5-45.0' Not sampled.		
					45	45.0-45.75' SP: Sand, fine, dark grayish brown to dark gray, 10% sand, medium, dense, wet, no odor, no visual product.	-45	
SS	45-46.5	10/18	10 11 12			45.75-46.5' ML: Silt, dark grayish brown to dark gray, 30% sand, fine, dense, wet, no odor, no visual product.		
						46.5-50.0' Not sampled.		
SS	50-51.5	8/18	10 10 11		50	50.0-51.5' ML: Silt, dark grayish brown to drak gray, 10% sand, fine, 5% clay, dense, wet, no odor, no visual product.	-50	Bottom of hole collapsed in to 55.0'.
						51.5-56.0' Not sampled.		
SS	55-56.5	18/18	11 11 13		55	55.0-56.5' SP: Sand, fine, dark grayish brown to dark gray, 10% sand, medium, 10% silt, abundant quartz, loose to dense, wet, no odor, no visual.	-55	

Remarks and Datum Used: Slight sand heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
2/1/05	1130	7.32'

RETEC

Boring/Well Log

Well #: MW-19M
Sheet 1 of 2

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-18600-730	Northing: 5211.42 Easting: 4992.8	Ground Elevation: 17.965'
Location: Seattle, WA	Drill Rig Type: Limited Access	MP Elevation: 17.645'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 30.0'
Start Date & Time: 2/2/05 1050	Casing ID: 2"	Filter Pack: 18.0-30.0' 10/20 sand
Finish Date & Time: 2/2/05 1215	Boring ID: 4"	Seal: Bentonite chips, 2.0-18.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: -
Operator: Andy	Logged By: Renee Knecht	Screen: 0.020-inch slot, 20.0-30.0'

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
					0	0.0-5.0' Not sampled.	0	
SS	5-6.5	18/18	19 20 22		5	5.0-6.5' SM: Sand, fine, and silt with silt lenses 1" thick, medium gray brown, dense, damp to wet, no odor, no visual product.	-5	
						6.5-10.0' Not sampled.		
SS	10-11.5	12/12	12 50/6		10	10.0-11.5' SP: Sand, fine to medium, dark grayish brown, 5% silt, dense to loose, wet, no odor, no visual product.	-10	
						11.5-15.0' Not sampled.		

Remarks and Datum Used: Moderate sands heaving at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
2/2/05	1214	8.92'

RETEC

Boring/Well Log

Well #: MW-19M

Sample: Type & #	Sample: Depth Range	Sample: % Rec	Sample: Blows per 6"	Sample: PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	15-16.5	2/ 18	6 8 9				15	15.0-16.5' SP: Sand, fine to medium, dark gray, 5% silt, loose, wet, no odor, no visual product.	-15	
								16.5-20.0' Not sampled.		
SS	20-21.5	10/ 18	50/0				20	20.0-21.5' SP: Sand, fine to medium, dark gray, 5% silt, loose, wet, no odor, no visual product.	-20	
								21.5-25.0' Not sampled.		
SS	25-26.5	1/ heave	50/0				25	25.0-26.5' SP: Sand, fine with sand, medium, dark gray, 5% silt, loose, wet, no odor, no visual product.	-25	
								26.5-30.0' Not sampled.		
SS	30-31.5	12/ 12	22 50/6				30	30.0-31.5' SP: Sand, fine with sand, medium, dark gray, 5% silt, 1/2" silt lense at 31.0' with wood pieces, loose to dense, wet, no odor, no visual product.	-30	Soil unconsolidated and heaving, hole collapsed to 30' bgs.

Remarks and Datum Used: Moderate sands heaving at this location.

4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater: Date	Time	Depth (ft.)
2/2/05	1214	8.92'

RETEC

Boring/Well Log

Well #: MW-20M
Sheet 1 of 2

Project: GE South Dawson St.	Monument: Flush mount road box	Stick Up: --
Project #: GE001-18600-730	Northing: 4999.64 Easting: 5043.26	Ground Elevation: 17.885'
Location: Seattle, WA	Drill Rig Type: LA	MP Elevation: 17.625'
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 30.0'
Start Date & Time: 2/2/05 0800	Casing ID: 2"	Filter Pack: 18.0-30.0' 10/20 sand
Finish Date & Time: 2/2/05 1018	Boring ID: 4"	Seal: Bentonite chips, 2.0-18.0'
Contractor: Cascade	Bit Type: 4" HSA	Grout: -
Operator: Andy	Logged By: Renee Knecht	Screen: 0.020-inch slot, 20.0-30.0'

Sample Type & #	Sample Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
					0	0.0-5.0' Not sampled.	0	
SS	5-6.5	13/18	19 20 22		5	5.0-6.5' SP: Sand, fine, grayish brown to brown, 5% sand, medium, 5% silt, dense, wet, no odor, no visual product.	-5	
						6.5-10.0' Not sampled.		
SS	10-11.5	9/9	12 50/6		10	10.0-11.5' SP: Sand, fine, dark brown, 30% sand, medium, dense, wet, abundant black grains and quartz, no odor, no visual product.	-10	
						11.5-15.0' Not sampled.		

Remarks and Datum Used: Moderate heaving sands at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater Date	Time	Depth (ft.)
2/2/05	1024	8.85'

RETEC

Boring/Well Log

Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Depth (ft.)	Soil and Rock Description (Classification Scheme: USGS)	Elevation (ft.)	Comments
SS	15-16.5	13/18	6 8 9		15	15.0-16.5' SP: Sand, fine to medium, dark brown, 5% sand, coarse, abandant quartz, few wood pieces, wet, no odor, no visual product.	-15	
						16.5-20.0' Not sampled.		
SS	20-21.5	8/12	50/0		20	20.0-21.5' SP: Sand, fine, dark brown, 30% sand, medium, abundant quartz, loose to dense, wet, no odor, no visual product.	-20	
						21.5-25.0' Not sampled.		
SS	25-26.5	18/18	50/0		25	25.0-26.5' SP: Sand, fine, dark grayish brown, 20% silt, abundant quartz, loose to dense, wet, no odor, no visual product.	-25	
						26.5-30.0' Not sampled.		Soil unconsolidated and heaving, hole collapsed to 30' bgs.
SS	30-31.5	6/6	22 50/6		30	30.0-31.5' SP: Sand, fine, dark grayish brown, 5% sand, medium to coarse, dense, wet, no odor, no visual product.	-30	

Remarks and Datum Used: Moderate heaving sands at this location.
4" bottom cap on well.

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater		
Date	Time	Depth (ft.)
2/2/05	1024	8.85'

RETEC Boring/Well Log

Well #: MW-21S
Sheet 1 of 1

Project: Dawson St.	Monument: flush mount	Stick Up: --
Project #: GE001-18600-600	Northing: 5027.73 Easting: 4687.66	Ground Elevation: 17.48'
Location: Seattle, WA	Drill Rig Type: CME-55 Limited Access	MP Elevation: 17.09
Client: GEAE	Method: Hollow Stem Auger	Total Depth: 16'
Start Date & Time: 9/16/05 0755	Casing ID: 2"	Filter Pack: 10/20 Col. Silica Sand / 3-16'
Finish Date & Time: 9/16/05 0855	Boring ID: 8.5"	Seal: 3/8" bentonite chips / 2-3'
Contractor: Cascade Drilling Inc.	Bit Type: 4.25" HSA	Grout: --
Operator: David Gose	Logged By: Chris Gero	Screen: 10-slot / 6-16'

Sample: Type & #	Sample: Depth Range	Sample: % Rec	Sample: Blows per 6"	Sample: PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
							0	Soils logged from soil cuttings were uniformly SM: Moist, loose, medium to dark brown SILTY SAND. Few pebbles up to 0.5". Fine to medium grained, no odor. Boring located less than 10' from MW-15D. Refer to MW-15D boring log for detailed stratigraphy. Total boring depth = 16.8 ft.	0	
							5		-1 to -16	
							10			
							15			

Remarks and Datum Used:

The RETEC Group, Inc.
1011 SW Klickitat Way, Suite 207
Seattle, WA 98134-1162
Phone: (206) 624-9349
Fax: (206) 624-2839

Sample Type
N = SPT
DP = Direct Push
SS = Split Spoon
C = Core

Groundwater: Date	Time	Depth (ft.)

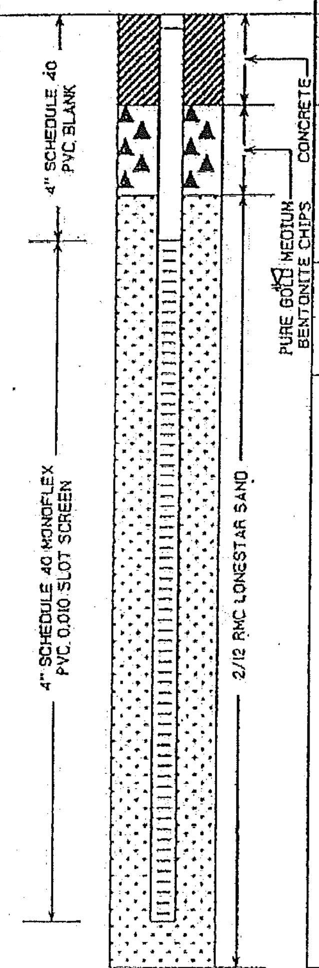
RETEC

BORING/WELL INSTALLATION LOG
Recovery Well RW-1

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 1-2402-200 GE - S. Dawson St.		CLIENT: General Electric
LOCATION: Seattle, WA		DRILLING CO.: Cascade Drilling
START DATE: 5/13/96 TIME: 0730	BORING ID: 9"	DRILLER: Brent Maloy/James/Mike
COMPLETION DATE: 5/13/96 TIME: 0930	TOTAL DEPTH: 21'	RIG TYPE: CME 55
WATER LEVEL DURING DRILLING: 8' bgs	PVC STICK-UP: '	METHOD: HSA
SURFACE ELEV.: ' MSL	MP ELEV.: ' TOC PVC	LOGGED BY: S. Laxson

WELL CONSTRUCTION



SOIL DESCRIPTION / SAMPLE DATA

DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft	%RECOVERY	PID (ppm)
0		ASPHALT:				
		FILL: broken concrete				
	SP	SAND: Brown; fine to medium; with trace silt; moist; loose; no odor; no sheen				
5			SS	9	100	0
	SM	SILTY SAND: Brown; fine to medium sand; moist; loose; no odor; no sheen				
			SS	11	100	0
	SP	SAND: Brown; fine to medium; wet; loose; no odor; no sheen				
10		Same as above; fine to coarse	SS	18	100	0
		Same as above; dark gray				
		Heaving sands; water added				
			SS	17	0	0
15		Same as above	SS	12	30	0
		Same as above; fine to medium sand	SS	25	10	0
20						
		Total depth = 21 feet bgs				
25						

REMARKS: SS = Split Spoon

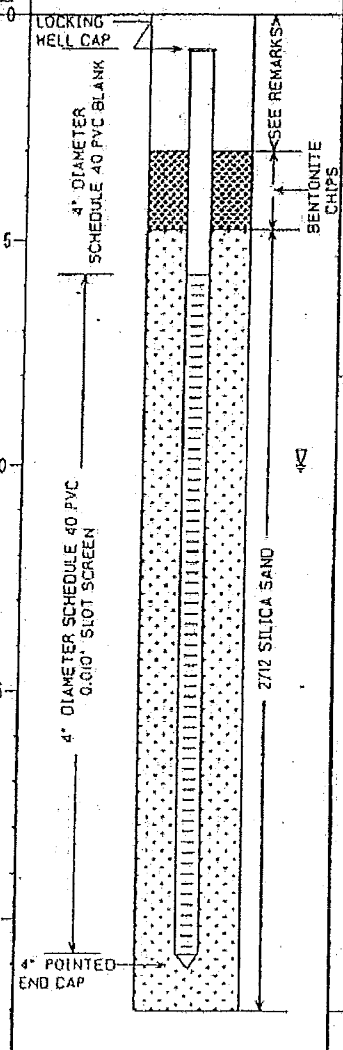
BORING/WELL INSTALLATION LOG

Recovery Well RW-2

RETEC
1011 S.W. Klickitat Way
Suite #207
Seattle, Washington 98134
(206) 624-9349

PROJECT NO: 1-2402-300 S. Dawson Street	CLIENT: General Electric Company
LOCATION: Seattle, Washington; 80' North, 50' West of RW-1	DRILLING CO.: Cascade Drilling Company
START DATE: 07/26/98 TIME: 04:30 / BORING ID: 12 inches	DRILLER: B. Maloy
COMPLETION DATE: 07/26/98 TIME: 06:30 / TOTAL DEPTH: 22 feet	RIG TYPE: CME 55
WATER LEVEL DURING DRILLING: 10' bgs / TOP OF CASING: -0.75 feet	METHOD: HSA
SURFACE ELEV.: / MP ELEV.: Ground Surface	LOGGED BY: G. Sega

DEPTH (in feet) | WELL CONSTRUCTION



Depth	U.S.C.S.	SOIL DESCRIPTION
0	GP	GRAVEL: Gravel roadbed (FILL).
	SW	SAND: Brown; fine- to medium-grained, well sorted; dry; no odor (FILL).
5		5.0'-8.0' - Brown; fine- to medium-grained, well sorted; trace silt; dry to moist; no odor.
	SW	SAND: Dark grey with reddish grains; medium-grained, moderately sorted; trace silt in 3-10 mm lenses; moist to wet; no odor.
10		10.0' - Becomes wet.
15		17.0'-22.0' - No sample recovery. Heaving sands; cuttings indicate sand as above.
20		
25		Total depth = 22.0' bgs.

SAMPLE DATA

TYPE	BLOWS/ft	%RECOVERY	PID (ppm)
SS	5 5 5	100	
SS	6 5 6	75	
SS	4 5 5	100	
SS	4 3 3	75	
SS	4 5 3	50	

REMARKS: ⊠ - Split-spoon Sample
Concrete vault to be installed at a later date.

REMEDIATION TECHNOLOGIES, INC.
A Thermo Electron Company

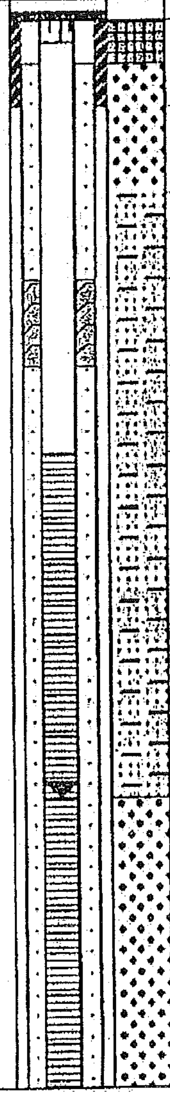
RETEC

Boring/Well Log

Well #: RW-3
Sheet 1 of 2

Project: GEAE Interim Action	Monument: Recovery Well	Ground Elevation: NM
Project #: GE001-16547-730	Northing: NM Easting: NM	MP Elevation: NM
Client: GEAE	Drill Rig Type: Limited Access	Total Depth: 20
Well Area: Seattle, Wa	Method: HSA	Filter Pack: #2/12 Monterey Sand
Start Date & Time: 12/13/02 11:10 a.m.	Casing ID: NA	Seal: Bentonite Chips
Finish Date & Time: 12/13/02 11:40 a.m.	Boring ID: 9 inches	Grout: NA
Contractor: Cascade	Bit Type: Auger/5-tooth	Riser: 4-inch, SCH 40 PVC
Operator: James Goble	Logged By: Rikka Bothun	Screen: 5-20 ft, 20 slot, 4-in SCH 40 PVC

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
							0	0-0.5 ASPHALT	0	
								0.5-2 GRAVELLY SAND; mix of sand (fine to very coarse) and gravel (up to 1.5 inch diameter), SW. Medium brown, slightly moist, no odor or visible contamination (OVC).		
								2-9 SILTY/CLAYEY SAND, fine sand and silt, SM. Medium brown to grayish brown, slightly moist, saturated at about 9 or 10 feet, no OVC.		
							5		5	
								9-20 Well graded SAND, fine to very coarse grained, SW. Saturated. No OVC.		
							10		10	



Remarks and Datum Used: Logged from cuttings. Used knock-out plug to prevent sands from heaving into augers.

The RETEC Group, Inc.
29 Old Town Square Suite 250
Fort Collins, CO 80524
Phone: (970) 493-3700
Fax: (970) 493-2328

Sample Type
N = SPT
DP = Direct Push
GS = Grab Sample
C = Core

Groundwater		
Date	Time	Depth (ft.)
12/13/02	11:20	9

Boring/Well Log

Well #: RW-3

Sample: Type & #	Depth Range	% Rec	Blows per 6"	PID (ppm)	Well Completion Log	Graphic	Depth (ft.)	Soil and Rock Description (Classification Scheme: USCS)	Elevation (ft.)	Comments
							15		15	
							20		20	

Remarks and Datum Used:		Sample Type	Groundwater		
	Logged from cuttings. Used knock-out plug		Date	Time	Depth (ft.)
The RETEC Group, Inc. 23 Old Town Square Suite 250 Fort Collins, CO 80524 Phone: (970) 493-3700 Fax: (970) 493-2328	to prevent sands from heaving into augers.	N = SPT DP = Direct Push GS = Grab Sample C = Core	12/13/02	11:20	9

Table D-1 Groundwater Monitoring Well Sampling Plan

Well	Depth (bgs)	Frequency	Notes
MW-1	6-16	Q	Frequency modified on June 30, 2010
MW-2	6.5-16.5	A	
MW-3	6-16	S	
MW-4	7-17	Q	
MW-5	5-20	S	
MW-6	5-20	S	
MW-7	5-20	S	
MW-8S	5-20	Q	Renamed to MW-8S
MW-8M	20-30	Q	
MW-9	5-20	A	
MW-10	4-19	S	
MW-11	5-20	Q	
MW-12	5-20	S	
MW-13	4-19	S	
MW-14M	20-30	Q	Renamed to MW-14M
MW-14D	45-55	Q	
MW-15M	20-30	Q	Renamed to MW-15M
MW-15D	45-55	Q	
MW-16M	20-30	Q	Renamed to MW-16M
MW-16D	45-55	Q	
EPI-MW-1S	5-15	Not Sampled	
EPI-MW-1D	25-30	Not Sampled	
EPI-MW-2S	5-15	Not Sampled	Damaged - Not Available
EPI-MW-2D	25-30	S	
EPI-MW-3S	5-15	S	
EPI-MW-3D	25-30	S	
EPI-MW-4S	5-15	S	
EPI-MW-4D	25-30	S	
MW-17M	M (20-30)	S	Frequency modified on June 30, 2010
MW-17D	D (45-55)	S	Frequency modified on June 30, 2010
MW-18M	M (20-30)	S	Frequency modified on June 30, 2010
MW-18D	D (45-55)	S	Frequency modified on June 30, 2010
MW-19M	M (20-30)	S	
MW-20M	M (20-30)	S	
MW-21S	6-16	Q	
Total Samples Per Event		Q=12, S=30, A=32	
Total Samples Per Yr		84	

Notes:
Q = Sampled Quarterly (May and November)
S = Sampled Semi Annually (August)
A = Sampled Annually (February)

EXHIBIT I

Operation and Monitoring Plan, dated March 2010

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

March 25, 2010

Mr. Jim Sumner
Manager, Group Environmental Programs
General Electric Aircraft Engine
One Neumann Way MD T165
Cincinnati, OH 45215

RE: Ecology Approved Revisions to the Agreed Order No. DE 5477, Exhibit G – Recovery Well Operation and Maintenance (O&M) Plan

Dear Mr. Sumner:

The Washington State Department of Ecology (Ecology) has written this letter to approve the revised Recovery Well Operation and Maintenance (O&M) Plan, Revision 3. Based on your environmental consultant's (AECOM) electronic mail response to Ecology, dated March 16, 2010, The General Electric Company (GE) has accepted all of the Ecology redline revisions in full, as provided in the February 24, 2010 Ecology letter to you. Ecology appreciates your review and concurrence with those redline revisions.

The Ecology approved revised O&M Plan is attached to this letter and incorporates all of the previous Ecology redline revisions. This revised O&M Plan is now incorporated into the Agreed Order No. DE 5477, Exhibit G, by reference. Rather than appending Ecology's redline revisions to the previous Ecology approved O & M plan, Ecology thought having an "all revisions accepted" O&M Plan would be less confusing and more convenient for your consultant field staff. Please have your consultant field staff refer to this Ecology approved revised O & M Plan for all future recovery well operation and maintenance procedures.

Please feel free to call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

Dean Yasuda, P.E., Environmental Engineer
Hazardous Waste and Toxics Reduction Program

By certified mail: 7009 1410 0002 4171 1529

cc: Melissa Rourke, Ecology AAG
Jamie Stevens, AECOM
Bill Chapman, K&L Gates
Alex Cordas, Keymac-LCC
Bill Teplicky, McKinstry Co
Bill Joyce, Salter, Joyce, Ziker- PLLC
Marcia Bailey, EPA-X
Julie Sellick & Ed Jones, Ecology HWTR/NWRO
Central Records: WAD009278706 HZW 6.2
Tong Li, Ground Water Solutions
Brien Flanagan, Schwabe, Williamson & Wyatt
Thomas Morin, Environmental Partners
Elizabeth McManus, Ross and Associates
Randy Maciel, Hudson Bay Insulation
Linda Baker, AECOM
James King, Hudson Bay Insulation

Operation and Maintenance Plan - Revision 3

March 2010

Contents

1.0 Introduction **1**
1.1 Process Description 1
1.2 Contact Information 2
1.3 Health and Safety 3

2.0 System Maintenance **4**
2.1 Routine Weekly Procedures 4
2.2 Acid Recirculation 4
2.2.1.1 Materials Needed 5
2.2.1.2 Detailed Steps 5
2.3 Pump Cleaning Steps 5
2.3.1 Materials Needed 5
2.3.2 Steps 5
2.4 Routine Quarterly Procedures 6
2.5 Additional Procedures 6
2.6 Record Keeping 6
2.7 Emergency Contingency Procedures 6
2.8 Well Relocation or Well Decommissioning 7

3.0 Reporting Requirements **7**
3.1 City of Seattle Permit 7
3.2 Ecology Requirements 7

List of Appendices

Appendix A Field Forms

Appendix B Equipment Catalogs

Appendix C Photographic Log of Recovery Well RW-1

List of Tables

Table 1-1 Recovery System Details 1

Table 1-2 Contact Information 2

List of Figures

Figure 1-1 Site Map

1.0 Introduction

This Operation and Maintenance Plan (O&M Plan) includes an overview of the groundwater recovery system installed at the former General Electric facility located at 220 S. Dawson Street, Seattle WA (Site). The objective of this document is to provide guidance for routine operation and maintenance of the current system and to provide guidance for unexpected events associated with the recovery system.

1.1 Process Description

The groundwater recovery system was installed at the former GE facility in 1996. The original design included two recovery wells (RW-1 and RW-2) located along 2nd Avenue South, pumping at a combined maximum pumping rate of 17 gallons per minute (gpm). In August 2003, the recovery system was modified by adding a new recovery well (RW-3) and discontinuing pumping from RW-1. The modified pumping system continues to operate at a combined flow of 17 gpm. Extracted groundwater is directly discharged to the King County sewer under Discharge Authorization 543-02.

The objective of the groundwater extraction system is to contain and recover groundwater beneath the former GE facility. The current configuration of recovery wells focuses recovery and mass removal on the northern portion of the site.

Table 1-1 Recovery System Details

Recovery Well	Details	Spare Parts
RW-1	Well Diameter: 4 inch Not currently pumping King County Sample port identification number: A4487	
RW-2	Well Diameter: 4 inch Type of Pump: 3 inch stainless steel Redi-Flo3, SQE-NE Grundfos Pump Flow controller: Toshiba Model No: LF424FBB211BBB Flow Totalizer Serial Number: 034241095 Safety features: A safety shut off on the flow controller is triggered when the water level falls below the inlet of the pump.	1 pump body (without controller head)
RW-3	Well Diameter: 4 inch Type of Pump: 3 inch stainless steel Redi-Flo3, SQE-NE Grundfos Pump Flow controller: Toshiba Model No: LF424FBB211BBB Flow Totalizer Serial Number: 034241093 Safety features: A safety shut off on the flow controller is triggered when the water level falls below the inlet of the pump.	1 complete pump (with controller head)

1.2 Contact Information

Table 1-2 Contact Information

Responsibility	Point of Contact
Recovery system owner	James Sumner - GE Aviation (513) 672-3986 Email: jim.sumner@ge.com
General system O&M, monitoring, system performance, project engineer	Jamie Stevens - Project Manager AECOM Phone: (206) 624-9349 Email: jamie.stevens@aecom.com
Site access, facilities concerns	Alex Cordas Keymac/McKinstry Phone: (206) 762-3311 Email:Acordas@McKinstry.com
Ecology contact	Dean Yasuda WA Department of Ecology – NW Regional Office Phone: (425) 649-7264 Email: DYAS461@ECY.WA.GOV
King County Spill/Release Notification	Patricia Magnuson King County Industrial Waste Phone: (206) 263-3000
Discharge Permitting –King County Monthly Flow Reports	Cheryl Jones King County Industrial Waste Phone: (206) 263-3000
Discharge Permitting –King County Annual Reporting and Discharge limits	Patricia Magnuson King County Industrial Waste Phone: (206) 263-3000
Waste disposal	Emerald Services (Envirotech Systems) Phone: (206) 363-9000
Analytical Laboratory	Mark Harris - ARI Phone: (206) 695-6200
Sewer Jetting	Glacier Environmental Phone: (425) 355-2826
Pump manufacturer/parts/repairs	QED Phone: 303-989-7737
Toshiba Flow Controller Parts/Repairs	Axiom-Northwest Inc Phone: (425) 576-9123
55 Gallon Drums	Industrial Container Services Phone: (206) 763-2345
Chemicals	AquaQuip Phone: (206) 624-4394

1.3 Health and Safety

The project Heath and Safety Plan (HASP) contains all site procedures for the site. The HASP includes Job Hazardous Analysis plans for all activities, including contaminant action levels and contingency plans, associated with the routine operation of the recovery system.

It is the responsibility of the office and site health and safety officers to ensure that the all personnel review, understand, and comply with the project HASP. Responsibilities for the office and site health and safety officers are described below.

The Office Health and Safety Officer (HSO) has the following responsibilities:

- Interface with the Project Manager as required in matters of health and safety
- Approve the site-specific Health and Safety Plan (HASP) for the project and require amendment as site conditions warrant
- Appoint or approve a Site Safety Officer (SSO) to assist in implementing the HASP
- Monitor compliance with the HASP
- Assist the Project Manager in ensuring that proper health and safety equipment is available for the project
- Approve personnel to work on the site with regard to medical examinations and health and safety training.

The Site Safety Officer (SSO) is responsible for verifying that project personnel and visitors adhere to the site safety requirements outlined in the HASP. These responsibilities include:

- Conducting the health and safety training for project personnel as appropriate;
- Modifying health and safety equipment or procedure requirements based on data gathered during the site work;
- Determining the posting locations and routes to medical facilities, including poison-control centers, and arranging for emergency transportation to medical facilities;
- Posting the telephone numbers of local public emergency services and facilities; and
- Performing site audits to verify adherence to the requirements of the HASP.

The SSO has authority to stop any operation that threatens the health or safety of the work team, visitors or surrounding populace. The daily health and safety activities may be conducted by the SSO or a designated replacement.

2.0 System Maintenance

2.1 Routine Weekly Procedures

Weekly procedures at the site include checking flow rates at RW-2 and RW-3. Flow readings are recorded on field monitoring forms (Appendix A).

Total flow measurements should not exceed 17.0 gallons per minute (gpm) - this is the maximum discharge limit set by King County. The total flow should be divided between RW-2 and RW-3, with best efforts to maintain the design groundwater extraction of 10 gallons per minute at RW-3 and 6 gallons per minute at RW-2.

The first step will be to visually confirm the pump flow rates from RW-3. If the RW-3 pump flow rate is below the design criteria of 10 gpm, then GE will adjust (further open) the outflow valve to increase the RW-3 pump rate to the design criteria.

If the RW-3 pump flow rate is below its 80% threshold, 8.0 gallons per minute, then GE will use all reasonable efforts to increase the flow rate to its design criteria of 10.0 gallons per minute with methods such as, acid recirculation, and physically cleaning the pump impellers and vault interior piping. If after all of these steps are performed and the design flow rate is not achieved, then replace the pump impeller unit with a new or refurbished/cleaned impeller unit, as this may be the cause of the low pump rates. If GE suspects that the motor unit is not operating properly, the entire motor and impeller unit should be replaced. GE shall keep at least one new or fully refurbished pump motor and impeller unit available at all times in case of any pump partial or full failure. This prevents the down time that would result in ordering the pump and scheduling time to install the pump components after receipt. The spare pump and impeller unit is brought to the site along with other O&M equipment for each weekly O&M check of the recovery well system. In this manner, a poorly functioning pump motor or impeller unit can be immediately replaced.

Next, the same procedures shall be followed for the O&M work at RW-2. However, the design criteria target is 6.0 gallons per minute and the 80% threshold is 4.8 gallons per minute. GE shall include in the RCRA CA progress reports tabulated RW-2 and RW-3 recovery well flow rates both prior to corrective action and after corrective action is implemented.

2.2 Acid Recirculation

An acid recirculation or pump cleaning is performed when system flows are less than 20% of the pumping design capacity at each well (a reduction of 20% pumping capacity results in a flow at RW-2 of 4.8 gpm and at RW-3 of 8 gpm).

The acid recirculation uses muriatic acid to dissolve ferrous iron bioflock accumulation in the pipes in the immediate vicinity of the pumping system. Acid recirculation is performed at both RW-2 and RW-3. The system is generally down for 2 to 4 hours during the acid recirculation and pump cleaning process.

Each time an acid recirculation is performed the pumps are cleaned with muriatic acid to dissolve any ferrous iron bioflock accumulation.

2.2.1.1 Materials Needed

Equipment: pH probe
Supplies: Site keys, safety cones, half face respirator with acid cartage, gloves, and eye protection
Chemicals: Muriatic acid and pH Balancer 200 Paperwork: Field Forms, Health and Safety Plan

2.2.1.2 Detailed Steps

- Secure work area. Set up safety cones around each recovery well; follow HASP steps for securing area and handling chemicals.
- Record initial flow rates at both RW-2 and RW-3.
- Set each recovery well to recirculation mode.
- Wearing respirator, eye protection, gloves, use funnel to pour 1 gallon of muriatic acid into each recovery well.
- Let recovery wells run in recirculation for a minimum of 2 hours. Do not exceed 4 hours.
- Take pH reading of water in recirculation mode; if required, add pH buffer to raise pH to neutral range (6.5-7.5). Follow manufacturer's instructions and site HASP if using pH buffer.
- Return each recovery well to normal flow mode.

If the pumping rate does not increase following acid recirculation, the resistance to flow may be further down the pipe system and sewer jetting may be required, or at the pump itself, in which case perform wirebrush pump cleaning.

2.3 Pump Cleaning Steps

2.3.1 Materials Needed:

Tools: Pipe wrench, screw drivers, pump changing tripod, pump cleaning brushes
Supplies: One 55-gallon/poly/open top drum, 5-gallon buckets, heavy plastic for ground protection, site keys, safety cones, half face respirator with acid cartage, gloves, and eye protection
Chemicals: Alconox and Water
Paperwork: Field forms, Health and Safety Plan

2.3.2 Steps:

- Secure work area. Set up safety cones around each recovery well; follow HASP steps for securing area and handling chemicals. Place plastic on ground, secure edges to minimize slipping.
- Record initial flow rates at both RW-2 and RW-3.
- Turn off both recovery wells, disconnect all power sources (at electrical boxes).
- Using gloves and eye protection remove and dismantle pumps at RW-2 and RW-3. Use guidelines in the HASP for lifting pumps and working with hand tools.
- Dismantle pumps on plastic and clean individual pump parts using wire bush in 5-gallon buckets.
- Attach clean pumps and lower into recovery well vault.

- Turn on each recovery well and check total flows. Adjust flow controls to try to achieve the design flow rates for each extraction well (RW2 = 6.0 gpm; RW-3 = 10.0 gpm). Do not exceed a total flow of 17 gpm.
- Procedures listed above generated a very low volume of water. All rinse water should be returned to the recovery wells for discharge through the piping to the King County treatment facility in accordance with the Discharge Authorization.

If the backup pump is off line during pump cleaning, the recovery system may remain off line for up to 4 hours while the cleaning is preformed. Best efforts will be made to ensure that backup pumps are operational at the time of pump cleanings.

2.4 Routine Quarterly Procedures

Once a quarter, or if recovery system does not respond to monthly acid recirculation and pump cleanings, and pump component replacement, all accessible parts of the recovery piping is cleaned. The pipes are cleaned using a high pressure sewer jetter. Discharged water is collected in 55-gallon drums and disposed of off-site. Contact Emerald Services for drum pick up. This waste has already been characterized by Emerald Services as non-hazardous IDW water. Once pick up date is confirmed, inform building manager (Alex Cordas) of pick up date. The system is generally down for 4-8 hours during routine sewer jetting.

A subcontractor is hired to perform the sewer jetting. The subcontractor is responsible for all equipment and personnel needed. ENSR is responsible for ensuring that subcontractor complies with project HASP, securing site access, providing subcontractor oversight, and disposing of any waste generated.

2.5 Additional Procedures

Additional procedures may include minor pipe repair, electrical repairs, and part replacement. All repairs to the system are done under the supervision of the project engineer. All electrical work is done by a WA licensed electrician. All part replacement is done directly with the manufacturer or through a representative and in accordance with all specified manufactures instructions.

Copies of all available equipment catalogs are included in Appendix B.

2.6 Record Keeping

All field work will be recorded by ENSR staff on daily field logs. Field logs are revised by the project manger and filed at the ENSR office.

2.7 Emergency Contingency Procedures

In the event that the recovery system is malfunctioning the Project Manager will be notified immediately. The project manager will contact Ecology and the City, if necessary, according to the reporting process described in Section 3.0.

Best efforts will be made to correct all system malfunctions immediately. Other than the requirement to have on hand at least one new or fully refurbished pump (motor and impeller unit), other additional needed spare parts will be "rush" ordered to expedite system operations. Each pump has an independent flow controller, if one pump needs to be off-line to repair the flow controller the pumping at the reaming on line well can be increased only temporarily to compensate until both groundwater extraction wells are operating at their design flow rates.

Guidelines for personnel safety and responding to personnel accidents - including property damage and environmental releases - are called out in the site HASP. All employees must review and comply with the site HASP. In the event of an environmental release Ecology and King County will be immediately notified.

2.8 Well Relocation or Well Decommissioning

Site activities may require that the location of a recovery well, associated piping, or equipment be permanently moved to accommodate site use. If this is required, ENSR will submit to Ecology a memorandum summarizing site conditions, detailing the proposed changes, and summarizing the effects on the performance system. This memo will include a detailed scope of work, include operating procedures for implementing the proposed changes, and list any updates or changes to the recovery system operation and maintenance. Ecology will review and approve this work prior to implementation. Any design changes will be based, at a minimum, on the current recovery system performance and operating objectives. Best efforts will be made to minimize the system down time during relocation. In the event that a recovery well is decommissioned and abandoned, all work will be performed by a Washington licensed driller and will be conducted in accordance with WAC 173-160-381.

3.0 Reporting Requirements

3.1 City of Seattle Permit

Extracted groundwater is directly discharged to the King County sewer under Discharge Authorization #543-03, effective through August 2, 2014.

Biannual discharge samples are collected from the combined discharge point of RW-3 and RW-2, located in the vault for RW-1 twice a year per the King County Discharge Authorization (August 2009). Samples are collected for non-polar oils and grease (NP-FOG) and VOC (EPA Method 8260). Results are submitted to King County annually. A photograph of the RW-1 sample port is included in Appendix C.

Weekly discharge flow readings are collected to ensure that the extraction system is operating within the permitted conditions. Monthly reported flow totals are submitted to King County for billing purposes.

3.2 Ecology Requirements

Ecology notification by email and telephone within 48-hours of system shut down or if the groundwater extraction system operation is operating less than its intended manner. The notification should also include corrective actions taken and a timeline for corrective actions.

Appendix A

Field Forms

ENSR | AECOM

Extraction System Monitoring Form

Date: ______________________

Flow Readings (GPM)	Initial	Corrected
RW-2 Flow Rate	________	________
RW-3 Flow Rate	________	________
Total Flow Readings (gallons)		
Flow Totalizer	________	________

Discharge Water Quality Observations

Odor	________	Solvent	________	Gasoline	________	Hydrogen Sulfide	________
Visual	________	Oil Sheen	________	Unusual Color	________	Turbidity	________

Additional Observations: ____

____

____

____

Corrective Measures: ____

____

____

____

Were groundwater levels measured? Yes ________ No ________

If yes, attach measurements to this form.

Monitoring Performed by: ______________________

Signed: ______________________

ENSR | AECOM

FIELD ACTIVITY LOG

PROJECT ____________________ COMPLETED BY ____________________
PROJECT NO. ________________ REVIEWED BY ____________________
DAY & DATE ________________ SHEET _____ OF _____

TIME	SUMMARY OF DAILY ACTIVITIES AND EVENTS

VISITORS ON SITE:

CHANGES FROM PLANS OR IMPORTANT DECISIONS

WEATHER CONDITIONS:

IMPORTANT TELEPHONE CALLS:

CONTRACTOR PERSONNEL & EQUIPMENT ON SITE:

Merged with ENSR 1-2007

Appendix B

Equipment Catalogs

Electromagnetic Flowmeter

LF430 /LF600
LF430 /LF602
15 to 450 mm (1/2" to 18")

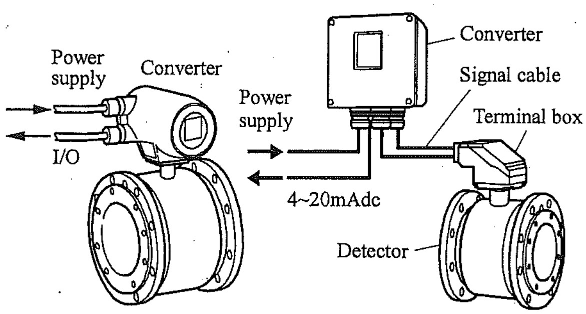
Introduction

The electromagnetic flowmeter uses Faraday's Law of electromagnetic induction to measure the process flow. The device consists of two units: a detector, through which the fluid to be measured flows and in which low-level signals proportional to flow rates are obtained; and a converter, which supplies excitation current to the detector, and amplifies the signals from the detector and then processes and converts the signals into the 4–20mAdc current signal. Thanks to the unique patented magnetic field distribution technology, the meter is highly immune to upstream flow disturbances. Combined with multi-functional converter LF600 (combined type) or LF602 (separate type) equipped with its original noise-suppression circuit and arithmetic operation capability, LF430 has high tolerance to noise, giving stable output even for slurry fluid measurement. IR (Infrared) switch enables parameter setting of the converter without removing the cover. Flow direction can be set in either way, and its 128 x 128 dot matrix LCD display allows the LCD rotated to 90, 180 and 270 degrees with a software.

The AF900 hand-held terminal or Model 375 HART*[1,2] communicator can be used to communicate with the flowmeter from remote places.

*1: HART protocol (Highway Addressable Remote Transducer) is a communication protocol for industrial sensors recommended by the HCF (HART Communication Foundation).

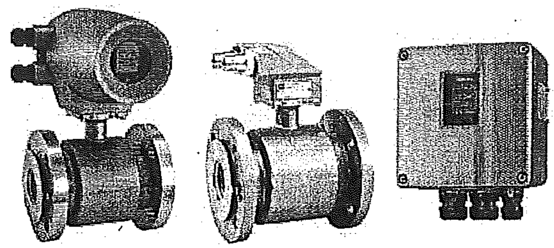
*2: 375 HART is being registered.



Combined type
LF430/LF600
LF434/LF600

Separate type
LF430/LF602
LF434/LF602

Figure1. Configuration



LF430/LF600 **LF434/LF600** | **LF430** **LF434** | **LF602**

Figure2. LF430 series Flowmeters

Note : CE is being applied.

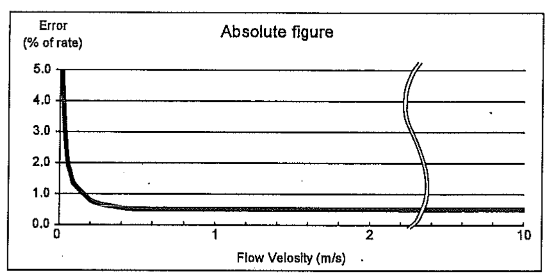
Specifications

■ Overall Specifications

Measurement range in terms of flow velocity:
0 – 0.3 m/s to 0 – 10 m/s (0 – 1.0 ft/s to 0 – 32.8 ft/s).
0 – 0.1 m/s to 0 – 0.3 m/s (0 – 0.3 ft/s to 0 – 1.0 ft/s) range is available optionally.

Accuracy: See the following graph.
Pulse output:
Vs > 0.5 m/s (1.64 ft/s): +/-0.5 % of rate.
Vs < 0.5 m/s (1.64 ft/s): +/-0.3 % of rate +/-1 mm/s (0.039 inch/s).
Current output: plus +/-8 uA (0.05 % of span)

Note: Span = Range in the magmeters.



Note: The accuracy above is measured under standard operating conditions using the weighing method at Toshiba's flow calibration facility.

Fluid conductivity: 5μS/cm minimum

Fluid temperature:

-10 to +120 °C: Teflon PFA lined flowmeter (14 to 248 °F)

-10 to +80 °C: EPDM rubber lined flowmeter (14 to 176 °F)

Ambient temperature: -20 to +60 °C (-4 to 140 °F)

Structure:

Standard — NEMA 4X (IP 67) Watertight

Option — NEMA 6 (IP 68) Submersible type is available.

Power consumption: approximately 10W(17VA)

Conformance to European Community Directives:

EMC directive 89/336/EEC
The low voltage 93/68/EEC
PED 97/23/EC (Note 1)

Note : See table 2 for detail.

Approved hazardous location certifications:
Model: LF434/LF600 and LF434/LF602

- FM explosion proof:
  FM Class I, Division 2, Groups A,B,C, and D.
  FM Class II, Division 2, Groups F and G.
  FM Class III.
- CSA explosion proof:
  CSA Class I, Division 2, Groups A,B,C, and D.
  CSA Class II, Division 2, Groups E, F, and G.
  CSA Class III.

Detector and converter combination:

LF430/LF600: Combined type for standard specification.
LF430/LF602: Separate type for standard specification.
LF434/LF600: Combined type with Ex approval of Class I, Division 2 (FM & CSA).
LF434/LF602: Separate type with Ex approval of Class I, Division 2 (FM & CSA).

■ Model LF430 Detector

Mounting style: Flange connection type

Fluid pressure: -0.1 to 2.0 MPa (-15 to 300 psi, or -1.0 to 20 bar)

The test pressure is equal to twice the nominal pressure rating of the customer specified flange connection during 15 minutes.

Connection flange standards: ANSI 150, ANSI 300, BS10 and 16, DIN PN10 and PN16, JIS10K, JIS16K and JIS20K

Principal materials:

Case — carbon steel

Flange material — 304 stainless steel: 15mm (1/2") to 200mm (8")
carbon steel: 250mm (10") to 400mm (16")

Linings — 15 to 50mm (1/2" to 2"): Teflon PFA
80 to 400mm (3" to 16"): EPDM rubber (std.) & Teflon PFA (opt.)

Electrodes — 316L stainless steel (std.)

Grounding rings — 316 stainless steel (std.)

Note: See Table 3 for optional materials and other related information.

Measuring tube material — 304 stainless steel

Coating: phthalic acid resin coating (std.), pearl-gray colored

Note: If the optional NEMA 6 (IP 68) structure is specified, the coating is black tar epoxy resin coating 0.5 mm.

Dimensions and weights: See Figure 3 and 4.

Cable connection port: for separate type detectors.
Cable gland —

LF430: Provided as standard, R(PT) 1/2 male screws.

LF434: Not provided, 3/4–14NPT male screws are required.

Applicable diameter — 11 to 13mm (0.433 to 0.512 inch)

■ Model LF600 and LF602 converters

Input signals

Analog signal — the voltage signal from detector, proportional to process flow rate (for LF602 separate type converter).

Digital input DI (opt.)
Signal type: 20 to 30Vdc voltage signal
Input resistance: 2.7kΩ
Number of inputs: one point

DI function — One of the following functions can be assigned to the optional DI signal.

Range switching — Selects either the higher or lower range in the unidirectional or bidirectional 2-range setting.

Totalizer control — Starts and stops the built-in totalizer.

Fixed-value outputs —Outputs fixed-values for current and pulse outputs.

Zero adjustment — Executes zero adjustment (on-stream at zero flow rate).

Output signals

Current output:
4–20mAdc (load resistance 0 to 750Ω)

Digital outputs — One point (std.) and one more point is optionally available as follows.

Digital output DO1 (std.):
Output type: Transistor open collector
Number of outputs: One point
Output capacity: 30Vdc, 200mA maximum

Digital output DO2 (opt.):
Output type: Solidstate relay output (non polarity)
Number of outputs: One point
Output capacity: 150Vdc, 150mA maximum or 150Vac (peak to peak), 100mA maximum

DO1 and DO2 functions — One of the following functions can be assigned to DO1 (std.) and/or DO2 (opt.)

- **Pulse output (available only for DO1)**
  Pulse rate: 3.6 to 3,600,000 pulses/hr
  Pulse width: 0.5 to 500ms (but less than half of the period for 100% flow rate)
- **Multi-range selection outputs (Note 1)**
- **High and/or low limit alarm outputs (Note 2)**
- **Empty pipe alarm output**
- **Digital Output Active Status (DO1 and DO2) (Note 2)**
- **Preset count output**
- **Converter failure alarm output**

Note 1: Two outputs (DO1 and DO2) are needed for 4-range switching and forward/reverse 2-range switching.

Note 2: Normal Open (default set) or Normal Close is selected for alarm outputs when programming.
The status when power failure is kept to Normal Open.

Communications output — Digital signal is superimposed on 4–20mAdc current signal as follows:

- **Conforms to HART protocol**
  Load resistance: 240 to 750Ω
  Load capacitance: 0.25μF maximum
  Load inductance: 4mH maximum
- **ProfibusPA (optional)**

LCD display:
Full dot-matrix 128×128 dot LCD display (back–light provided)
The data on the LCD inside the converter can rotate to 90, 180, and 270 degrees by a software, without rotating the indicator itself. (Combined type only)

Parameter settings — Parameters can be set as follows:

- **IR Switch**: Three key switches are provided to set configuration parameters.
- **Digital communication**: The AF900 hand-held terminal or the Model 375 HART communicator is needed to set parameters.

Zero adjustment:
Zero point adjustment can be started by pressing the switch in the converter.

Damping:
0.5 to 60 seconds (selectable in 1 second increments)

Zero and span calibration:
Built-in calibration signal source allows converter unit check.

Conditions when power fails:
The outputs and display will remain as follows when power fails. Parameter setting values are stored in non–volatile memory and the values will be restored when the power returns to normal condition.

- Current output: 0mAdc
- Digital output: OFF
- LCD display: No display

Power supply:
One of the following can be selected:

- 100 to 240Vac, 50/60Hz (std.) (allowable voltage 80 to 264Vac)
- 24Vdc (allowable voltage 18 to 36Vdc)
- 110Vdc (allowable voltage 90 to 130Vdc)

Surge protection:
Arresters are installed in the power supply, and current signal output circuit.

Case: Aluminum alloy (equivalent of IP 67)

Coating: Acrylic resin-baked coating, pearl–gray colored

Cable connection port:
Cable glands —
LF600 and LF602:
Provided as standard
OD of cable ϕ 11~13mm
Material Nylon 66
G (PF) 1/2 male screws.
LF600 and LF602 for FM Approved:
Not provided, 1/2–14NPT male screws are required.
Applicable diameter —
11 to 13mm (0.433 to 0.512 inch)

Vibration resistance:
No resonance to the following levels of vibration:

- 10 to 150Hz with acceleration of 9.8m/s^2
  No defect in putting vibration to each direction of 30Hz with 29.4 m/s^2 in 4h.

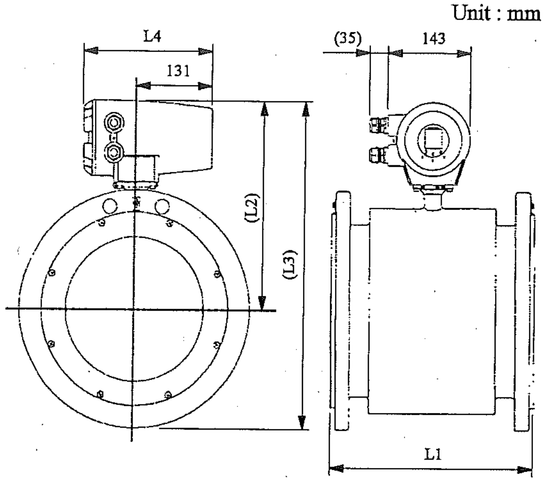
Note: Avoid using the flowmeter in an environment with constant vibration.

Dimensions and Weights:
See Figure 5. (for separate type)

MTBF: 220,000 hours at 25 deg.C (77 deg.F) based on MIL-HDBK-217F

Installation

■ Dimensions



Converter type	L4	
	(mm)	(inch)
With display	225	8.85

Note1: Eye bolts are provided at the top for flowmeters sized 200mm (8") or above, and further, a roll-prevention base is provided for flowmeters sized 250mm (10") or larger.

BS16 and DIN PN16 dimensions:

Meter size (mm)	L1 (mm)	L2 (mm)	L3 (mm)	No. of bolts	Weight (kg)
15	140	220	268	4	approx. 6.0
25	160	223	286	4	approx. 8.0
40	170	231	301	4	approx. 10.0
50	180	240	318	4	approx. 12.0
80	230	254	347	8	approx. 18.0
100	240	272	377	8	approx. 22.0
150	260	302	442	8	approx. 37.0
200	300	328	493	12	approx. 50.0
250	350	351	551	12	approx.106.0
300	400	378	601	12	approx.114.0
350	450	395	640	16	approx.131.0
400	500	416	696	16	approx.174.0
450	550	445	755	20	approx.200.0

ANSI class 150 dimensions:

Meter size (inch)	L1 (inch)	L2 (inch)	L3 (inch)	No. of volts	Weight (lbs)
1/2	5.51	8.46	10.24	4	approx. 13.2
1	6.30	8.58	10.71	4	approx. 16.5
1-1/2	6.69	8.90	11.42	4	approx. 22.0
2	7.09	9.25	12.24	4	approx. 27.6
3	9.06	9.80	13.54	4	approx. 44.1
4	9.45	10.51	15.04	8	approx. 56.2
6	10.24	11.69	17.20	8	approx. 84.9
8	11.81	12.72	19.49	8	approx. 125
10	13.78	13.62	21.61	12	approx. 254
12	15.75	14.69	24.21	12	approx. 302
14	17.72	15.35	25.87	12	approx. 359
16	19.69	16.18	27.95	16	approx. 463
18	21.65	17.51	29.72	16	approx. 423

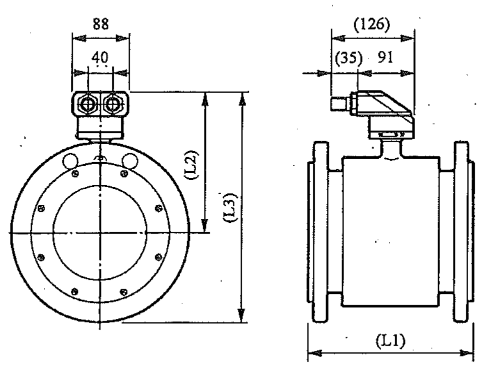
JIS 10K dimensions:

Meter size (mm)	L1 (mm)	L2 (mm)	L3 (mm)	No. of bolts	Weight (kg)
15	140	215	268	4	approx. 6.0
25	160	218	286	4	approx. 8.0
40	170	226	301	4	approx. 10.0
50	180	235	318	4	approx. 12.0
65 (*3)	230 / 200 (*4, *5)	249 / 244 (*4)	336 / 331 (*5)	4	17.0 / 15.0 (*5)
80	230	249	347	8	approx. 18.0
100	240	267	377	8	approx. 22.0
150	260	297	442	8	approx. 37.0
200	300	323	493	12	approx. 50.0
250	350	346	551	12	approx.106.0
300	400	373	601	16	approx.114.0
350	450	390	640	16	approx.131.0
400	500	411	696	16	approx.174.0
450	550	445	755	20	approx.200.0

Note 2: 1 inch = 25.4 mm
Note 3: JIS 10K flange only without any Ex-approvals.
Note 4: EPDM rubber lining / Teflon PFA lining
Note 5: This dimension is changed to "194 mm" when choosing Ta or Pt-Ir grounding ring types in the teflon PFA lining.

Figure 3. LF430/LF600 and LF434/LF600 combined type flowmeters Meter Sizes 15 (1/2") to 450mm (18")

Unit : mm



Note1: Eye bolts are provided at the top for flowmeters sized 200mm (8") or above, and further, a roll-prevention base is provided for flowmeters sized 250mm (10") or larger.

Note2: Cable glands are not provided for LF434 of FM and CSA approved type. Refer to the part Cable connection port at detector.

BS16 and DIN PN16 dimensions:

Meter size (mm)	L1 (mm)	(L2) (mm)	L3 (mm)	No. of bolts	Weight (kg)
15	140	147	194	4	approx. 4.0
25	160	149	207	4	approx. 6.0
40	170	158	233	4	approx. 9.0
50	180	167	250	4	approx. 11.5
80	230	181	281	8	approx. 17.5
100	240	199	309	8	approx. 22.0
150	260	229	372	8	approx. 37.0
200	300	255	425	12	approx. 52.0
250	350	278	481	12	approx. 108
300	400	305	535	12	approx. 121
350	450	322	582	16	approx. 145
400	500	343	633	16	approx. 188
450	550	372	707	20	approx. 208

JIS 10K dimensions:

Meter size (mm)	L1 (mm)	(L2) (mm)	L3 (mm)	No. of bolts	Weight (kg)
15	140	147	194	4	approx. 4.0
25	160	149	212	4	approx. 6.0
40	170	158	228	4	approx. 8.0
50	180	167	244	4	approx. 10.0
65 (*4)	230 / 200 (*5, *6)	181 / 176 (*5)	269 / 263 (*6)	4	15.0 / 14.0 (*6)
80	230	181	274	8	approx. 15.0
100	240	199	304	8	approx. 20.0
150	260	229	369	8	approx. 35.0
200	300	255	420	12	approx. 48.0
250	350	278	478	12	approx. 106
300	400	305	528	16	approx. 116
350	450	322	567	16	approx. 141
400	500	343	623	16	approx. 176
450	550	372	682	20	approx. 200

ANSI class 150 dimensions:

Meter size (inch)	L1 (inch)	L2 (inch)	L3 (inch)	No. of volts	Weight (lbs)
1/2	5.51	5.79	7.56	4	approx. 8.8
1	6.30	5.87	7.99	4	approx. 12.1
1-1/2	6.69	6.22	8.74	4	approx. 17.6
2	7.09	6.57	9.57	4	approx. 23.1
3	9.06	7.13	10.87	4	approx. 39.7
4	9.45	7.83	12.36	8	approx. 51.8
6	10.24	9.02	14.53	8	approx. 80.5
8	11.81	10.04	16.81	8	approx. 120
10	13.78	10.94	18.94	12	approx. 249
12	15.75	12.01	21.54	12	approx. 298
14	17.72	12.68	23.19	12	approx. 355
16	19.69	13.50	25.28	16	approx. 459
18	21.65	14.64	27.7	16	approx. 507

Note 3: 1 inch = 25.4 mm
Note 4: JIS 10K flange only without any Ex-approvals.
Note 5: EPDM rubber lining / teflon PFA lining
Note 6: This dimesion is changed to “194 mm” when choosing Ta or Pt-Ir grounding ring types in the teflon PFA lining.

Figure 4. Separate type detectors LF430 and LF434 Meter sizes 15 (1/2") to 450mm (18")

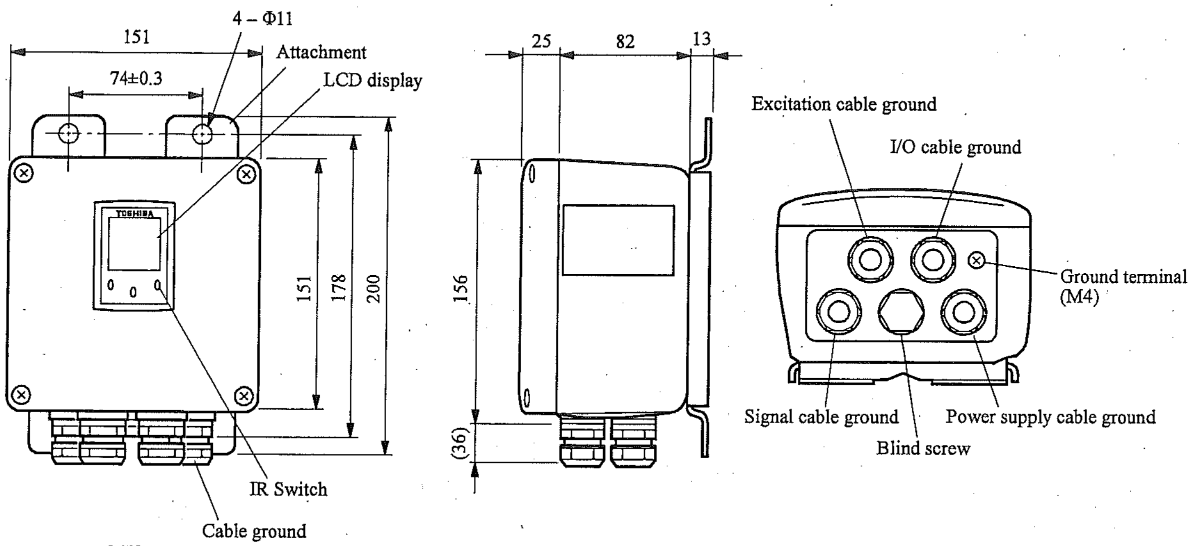
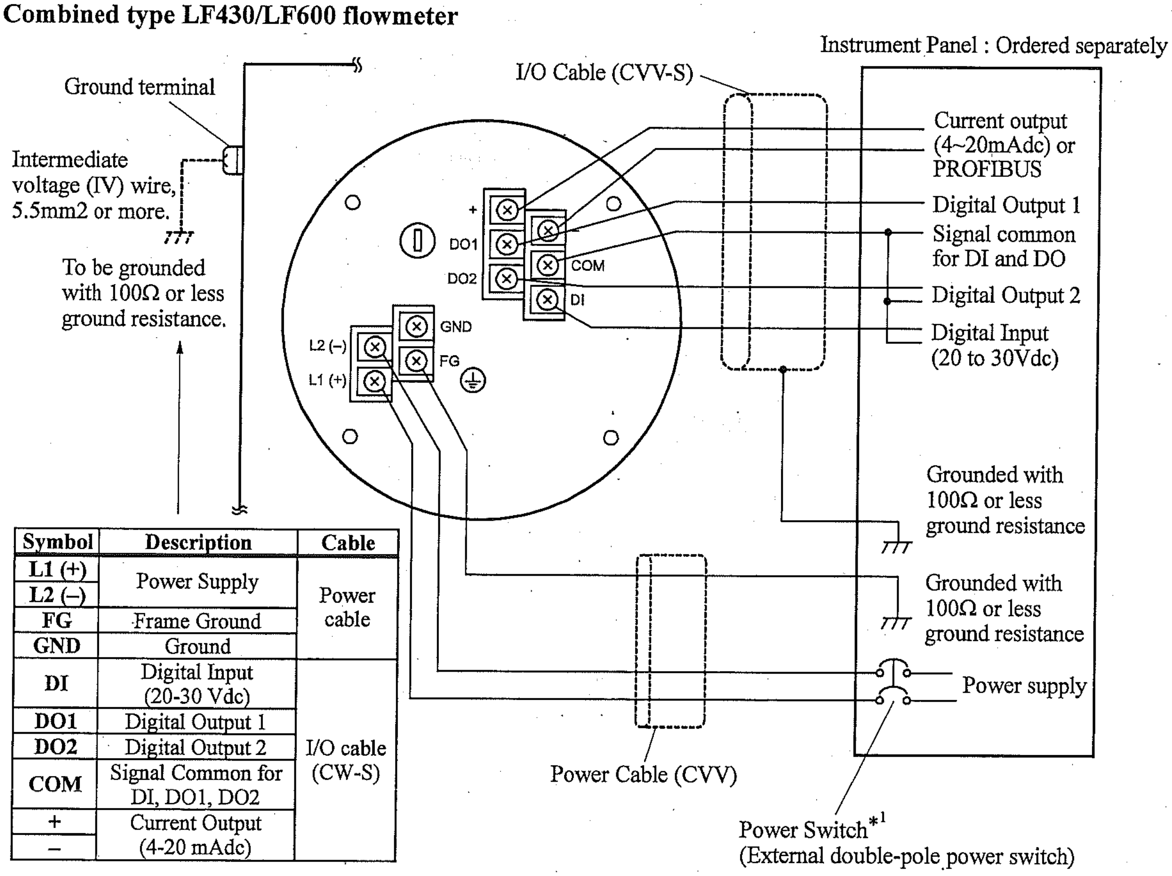


Figure 5. Separate type converter LF602

■ External Connections

• Combined type LF430/LF600 flowmeter

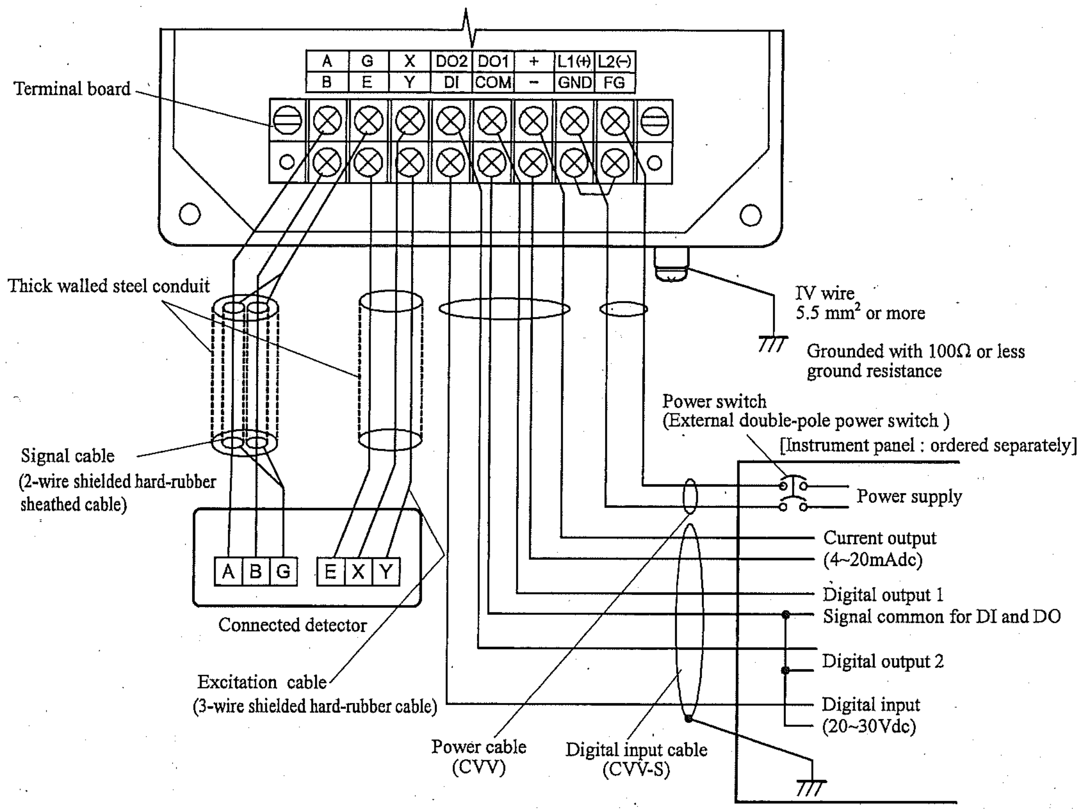


Symbol	Description	Cable
L1 (+)	Power Supply	Power cable
L2 (–)		
FG	Frame Ground	
GND	Ground	
DI	Digital Input (20-30 Vdc)	I/O cable (CW-S)
DO1	Digital Output 1	
DO2	Digital Output 2	
COM	Signal Common for DI, DO1, DO2	
+	Current Output (4-20 mAdc)	
–		

*1 Locate an external double-pole power switch on the power line near the flowmeter within easy reach of operation.
Use the appropriate switch rating as shown below:
Switch rating: 250Vac, 6A or more
In rush current: 15A or more

Figure 6. Combined type LF430/LF600 and LF434/LF600 flowmeters Wiring Diagram

<Separate type LF430/LF602 and LF434/LF602 flowmeters>



Symbol	Description	Cable
L1 (+)	Power supply	Power cable (CVV)
L2 (−)		
GND	Ground (for arrester)	
FG	Frame ground	
DI	Digital Input (20～30Vdc)	I/O cable (CVV−S)
DO1	Digital Output 1	
DO2	Digital Output 2	
COM	Signal Common for DI, DO1, DO2	
+	Current Output (4～20mAdc)	
−		
X	Excitation Output	Excitation cable (for only)
Y		
E		
A	Signal Input	Signal cable (for only)
B		
G		

Figure 7. Separate type LF430/LF602 and LF434/LF602 flowmeters wiring Diagram

■ Wiring Precautions

(1) Explosion proof type flowmeters are not provided cable glands. Refer to the part Cable connection port at detector and converter.

(2) Connect the grounding wire (IV wire 5.5mm² or more) to a good earth ground (100Ω or less ground resistance). Make the wire as short as possible. Do not use a common ground shared with other equipment where earth current may flow. An independent earth ground is recommended.

(3) The allowable cable lengths between the detector and converter for the separate type flowmeter depend on the electrical conductivity of the object fluid. See Figure 8 below.

(4) DO1, DO2 (opt.), and DI (opt.) use the same common terminal (COM). This COM can not connect to other equipments which have their own ground terminal. (Power supply for connecting to DI or DO, etc…) Need to wire separately.

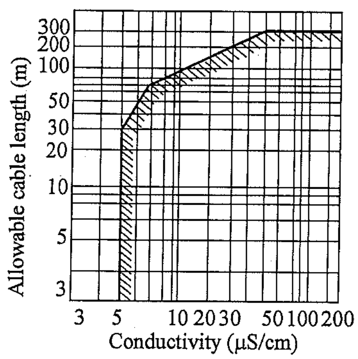


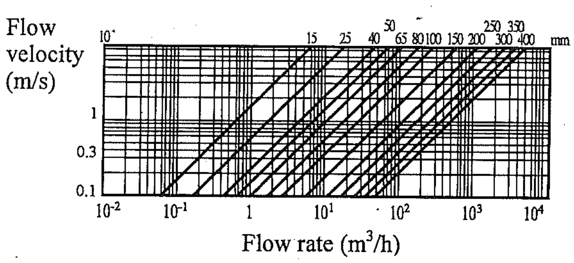
Figure 8. Electrical Conductivity and Cable Length

■ Meter Size

To select the meter size:

See Figure 9 and find meter sizes within the velocity of 0.1 to 10m/s for a specified full-scale (measuring range high limit) flow. Select one that has its full-scale velocity between 1 and 3m/s.

Note: Make sure the full-scale flow rate used for the final planning stage stays within 10m/s in terms of flow velocity.



For SI unit — Unit: m³/h

Meter size (mm)	Flow rate 0.3 m/s	1 m/s	10 m/s
15	0.1908	0.6361	6.361
25	0.5301	1.767	17.67
40	1.357	4.523	45.23
50	2.120	7.067	70.67
65 (*1)	3.584	11.95	119.5
80	5.428	18.09	180.9
100	8.482	28.27	282.7
150	19.08	63.61	636.1
200	33.93	113.1	1131
250	53.01	176.7	1767
300	76.34	254.5	2545
350	103.9	346.4	3464
400	135.7	452.3	4523
450	171.7	572.5	5725

Note 1: JIS 10K flange type only.

For English unit — Unit: gal/min

Meter size (inch)	Flow rate 0.33ft/s	0.98ft/s	32.8ft/s
1/2	0.28148	0.83591	27.977
1	0.78189	2.3220	77.715
1 1/2	2.0016	5.9443	198.95
2	3.1128	9.2879	310.86
3	8.0065	23.777	795.80
4	12.510	37.152	1243.4
6	28.148	83.591	2797.7
8	50.041	148.61	4973.8
10	78.189	232.20	7771.5
12	112.59	334.36	11191
14	153.25	455.11	15232
16	200.16	594.43	19895
18	253.05	752.40	25182

Figure 9. Flow Rate and Flow Velocity

■ Calibration Range

If the calibration range is not specified, the standard range as shown below will be used. If the range is specified, we will use the specified range for calibration.

Table 1. Standard Flow Range

Meter size mm (inch)	Standard flow range: Flow rate (m³/h)	Flow velocity (m/s)	Flow rate (gal/min)
15 (1/2)	2	3.145	25
25 (1)	6	3.395	75
40 (1 1/2)	15	3.315	175
50 (2)	25	3.535	300
65 (2-1/2) (*2)	40	3.348	------
80 (3)	60	3.315	650
100 (4)	100	3.535	1000
150 (6)	200	3.145	2500
200 (8)	300	2.653	4500
250 (10)	600	3.395	7000
300 (12)	900	3.537	10000
350 (14)	1200	3.465	12000
400 (16)	1600	3.537	16000
450 (18)	2500	4.366	25000

Note 1: The unit of "gal/min" is not exchanged (converted) by "m³/h".

Note 2: JIS 10K flange type only.

■ PED matrix in each flange connection.

The following sizes fall under the category for PED in each flange connection when the meter ships to EU. All of them had complied with it from a notified body.

Table 2 PED matrix in each flange standard

Flange standard	Meter size
DIN PN 16 and BS 16	150 to 400mm (6 to 16 inch)
DIN PN 10 and BS 10	250 to 400mm (10 to 16 inch)
ANSI 150 and JIS 10K	6 to 16 inch (150 to 400mm)

Ordering Information

1. When ordering the LF430 series flowmeters, refer to Tables 3 and 4 (Type Specification Codes). An entry must be made for each of the columns in each of these tables.
2. Fluid characteristics:
   (1) Type of fluid to be measured and its characteristics
   (2) Fluid temperature
   (3) Fluid pressure
   (4) Electrical conductivity of the fluid
3. Measuring range
4. I/O function setting
5. Ordering scope:
   Flow calibration data: (required or not)
6. Other items
   Specifications other than standard items

<u>Consult Toshiba before ordering when choose materials of the wetting parts such as lining, electrodes, and grounding rings.</u>

Table 3. Specification Code (Flange type detector LF430 Series)

Model					Specification Code									Description	Detector category			
															Normal type		Ex. type	
1	2	3	4	5	6	7	8	9	10	11	12	13	14		Gr.-A	Gr.-B	Gr.-C	Gr.-D
L	F	4	3	0										Normal specification type	√	√		
L	F	4	3	4										Hazardous location certification type (Note 1)			√	√
														Meter size				
					D									15mm (½")	√		√	
					E									25mm (1")	√		√	
					S									32mm (1¼")	√		√	
					F									40mm (1½")	√		√	
					G									50mm (2")	√		√	
					W									65mm (2½") (Note 7)		√		
					H									80mm (3")		√		√
					J									100mm (4")		√		√
					K									150mm (6")		√		√
					L									200mm (8")		√		√
					M									250mm (10")		√		√
					N									300mm (12")		√		√
					P									350mm (14")		√		√
					Q									400mm (16")		√		√
					R									450mm (18")		√		√
														Mounting Style				
						L								Detector/Converter combined type (LF430/LF600)	√	√		
						M								Detector/Converter separate type (LF430/LF602)	√	√		
						P								Detector/Converter combined type with PED (LF430/LF600) (Note 6)	√	√		
						Q								Detector/Converter separate type with PED (LF430/LF602) (Note 6)	√	√		
														FM and CSA Class I - Division 2 type (Note 1)				
						A								Detector/Converter combined type (LF434/LF600)			√	√
						B								Detector/Converter separate type (LF434/LF602)			√	√
														Connection flange standard				
							C							ANSI 150	●	●	●	●
							D							ANSI 300	○	○	○	○
							E							BS PN 10	●	●	●	●
							F							BS PN 16	●	●	●	●
							G							DIN PN 10	●	●	●	●
							H							DIN PN 16	●	●	●	●
							J							JIS 10K	●	●	●	●
							K							JIS 16K	○	○	○	○
							L							JIS 20K	○	○	○	○
							Z							Other	○	○	—	—
														Electrode Material (Note 5)				
								B						316L stainless steel	●	●	●	●
								C						Ti (titanium)	○	○	○	○
								D						Pt-Ir (platinum/iridium)	○	○	○	○
								E						Ta (tantalum)	○	○	○	○
								F						Hastelloy C(Equivalent)	○	○	○	○
								Z						Other	○	○	—	—
														Lining Materials (Note 5)				
									C					Teflon FPA	●	○	●	○
									D					EPDM rubber	—	●	—	●
														Grounding Ring Material (Note 5)				
										C				316 stainless steel	●	●	●	●
										D				316L stainless steel	○	○	○	○
										E				Ti (titanium)	○	○	○	○
										F				Ta (tantalum)	○	○	○	○
										G				Pt-Ir (platinum/iridium)	○	○	○	○
										H				Hastelloy C (Equivalent)	○	○	○	○
										Z				Other	○	○	—	—
														Flow and calibration velocity range				
											A			0.3 to 10 m/s (standard range calibration)	●	●	●	●
											B			0.3 to 10 m/s (specified range calibration)	○	○	○	○
											C			0.1 to 10 m/s (specified range calibration)	○	○	○	○
														Excitation and Signal Cables				
												A		not provided	●	●	●	●
												B		30m cable, provided (Note 2)	○	○	○	○
												C		other lengths, provided (Note 3)	○	○	○	○
														Coating				
													B	phthalic acid resin coating pearl-gray colored	●	●	●	●
													C	black tar epoxy resin 0.3mm	○	○	○	○
													D	black tar epoxy resin 0.5mm	○	○	○	○
													E	black tar epoxy resin 0.5mm for submersible type (Note 4)	—	○	—	○

Size code explanation: √ : Object ●: Standard ○: Option —: Not available

Note1: Cable glands are not provided. Refer to the part of "Cable connection port" at detector and converter.
Note2: Separate type detector only.
Note3: Separate type detector only. Specifying the code "C", indicate the length of cables from 1 to 300m 1 meter increments.
Note4: EPDM rubber lining is available to choose only in this specification.
Note5: Consult Toshiba before ordering when choose materials at the wetting parts.

Note6: Check the Table 2 whether your chosen meter size meets this directive or not when the meter is shipped to EU. If yes, need to choose this code.
Note7: JIS 10K flange only without any Ex-approvals.

Table 4. Specification Code for converters

Model 1	2	3	4	Specification Code 5	6	7	8	9	10	11	12	13	14	Contents	LF600 type	LF602 type
L	F	6	0											Electromagnetic flowmeter converter		
				0										Integral type	O	—
				2										Separate type	—	O
														Purpose		
					A									Standard	O	O
					F									FM and CSA class I, Division 2 approved	O	O
														Shape		
						A								Integral type with case	O	—
						B								Separate type with case	—	O
														Converter mounting fitting		
							A							None	O	O
							C							Panel, Accessory for wall mounting (BNP material: SUS304)	—	O
							E							Accessory for pipe installation (BNP material: SUS304)	—	O
														I/O and Communication function		
								1	1					Current output + pulse output points 1 (DO1) + HART communication	O	O
								1	2					Pulse output points 1 (DO1) + PROFIBUS communication	O	O
								2	1					Current output + pulse output points 2 (DO1+DO2) + digital input point 1 (DO1) + HART Communication	O	O
								2	2					Pulse output points 2 (DO1+DO2) + digital input point 1 (DI) + PROFIBUS communication	O	O
														Power supply		
										1				100Vac-240Vac, 50/60Hz	O	O
										2				24Vac	O	O
										3				110Vac	O	O
														Instruction manual		
											A			Japanese	O	O
											E			English	O	O

O: Selectable —: Unselectable

ISO9001 and ISO14001 are certified.

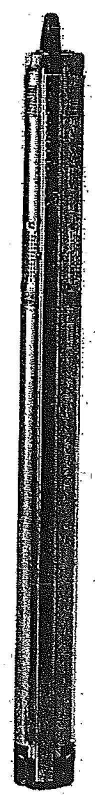
Misuse of this product can result in damages to property or human injury.
Read related manuals carefully before using this product.

Printed in Japan 2006-1 (TDOC)

GRUNDFOS **INSTRUCTIONS**

Redi-Flo3, SQE-NE
Environmental pumps

(US) Installation and operating instructions



BE > THINK > INNOVATE >

GRUNDFOS

LIMITED WARRANTY

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, F.O.B. Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

CONTENTS

		Page
1.	**General description**	3
1.1	Applications	3
2.	**Preinstallation**	3
2.1	Well preparation	3
2.2	Make sure you have the right pump	3
2.3	Pumped liquid requirements	3
2.4	Liquid temperatures/cooling	3
2.5	Motor preparation	4
2.6	Refilling of motor liquid	4
3.	**Installation**	4
3.1	Positional requirements	4
4.	**Electrical connection**	5
4.1	General	5
4.2	Motor protection	5
4.3	Connection of motor	5
5.	**Cable sizing**	6
6.	**Splicing the cable**	6
7.	**Fitting the cable guard**	6
8.	**Piping**	6
9.	**Installing the pump**	7
9.1	Installation depth	7
10.	**Generator operation**	7
11.	**Starting the pump for the first time**	8
11.1	Motor cooling and other considerations	8
11.2	Impurities in the water	8
11.3	Minimum flow rate	8
11.4	Built-in functions	8
11.5	Resetting the pump	8
11.6	MSE 3 motors	8
11.7	Maintenance and service	8
12.	**Assembly of pump and motor**	8
13.	**Troubleshooting**	9
13.1	Instruments not allowed	10
14.	**Checking of motor and cable**	10
15.	**Environment**	10
16.	**Technical data**	11
17.	**Accessories**	11
18.	**Disposal**	11

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

1. General description

The Redi-Flo3 is a 3 inch diameter deep well submersible pump mainly designed for the pumping of raw water in domestic water supply.

This manual is designed to assist in the proper set-up, installation and operation of these pumps.

1.1 Applications

Typical applications are

- industrial applications
- irrigation systems.

WARNING: The use of the pump in swimming pool areas has not been investigated.

2. Preinstallation

2.1 Well preparation

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand.

The construction of the Grundfos Redi-Flo3 submersibles makes them resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

2.2 Make sure you have the right pump

Determine the maximum depth of the well and the drawdown level at the maximum pump capacity. Pump selection and setting depth should be made based on this data.

2.3 Pumped liquid requirements

Submersible well pumps are designed for pumping clear, cold water; free of air or gases. Decreased pump performance and life expectancy can occur if the water is not clear, cold or contains air or gases.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well. The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

CAUTION: This pump has been approved for pumping water of maximum 86°F only.

2.4 Liquid temperatures/cooling

Figure 1 shows a Redi-Flo3 pump installed in a well. With the pump operating, figure 1 illustrates the following:

- Well diameter
- Pump diameter
- Temperature of pumped liquid
- Flow past the motor to the pump suction strainer.

Note: The well diameter must be at least 3 inches. If there is a risk that the motor will be covered with sediment, it is recommended the pump be placed in a flow sleeve. The motor should always be installed above the well screen.

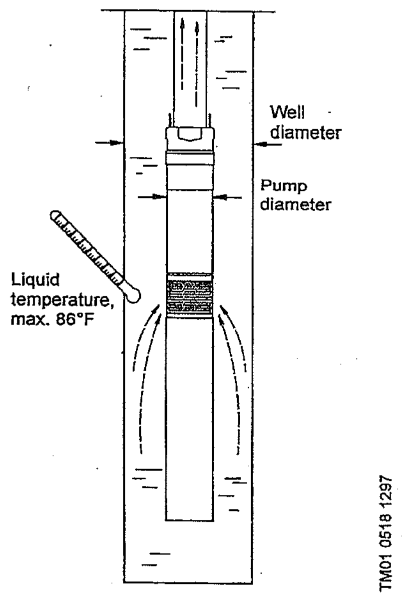


Fig. 1 Pump installed in well

2.5 Motor preparation

Grundfos MSE 3 submersible motors have water-lubricated slide bearings. No additional lubrication is required.

The submersible motors are factory-filled with a special Grundfos motor liquid, type SML 2 or SML 3, which will protect the motor liquid down to 4°F and prevent the growth of bacteria. The level of motor liquid is important for the operating life of the bearings and consequently the life of the motor.

2.6 Refilling of motor liquid

If for any reason the motor liquid has been drained or lost, the motor must be refilled with Grundfos motor liquid SML 2 or SML 3.

To refill the motor, proceed as follows:

1. Remove the cable guard and separate the pump end from the motor.
2. Place the motor in vertical position with an inclination of approximately 10°.
3. Remove the filling plug using a screwdriver or a similar tool.
4. Inject motor liquid into the motor with a filling syringe or similar tool, see fig. 2.
5. To allow possible air to escape, move the motor from side to side and turn the shaft.
6. Replace the filling plug and make sure it is tight.
7. Assemble pump end and motor.
8. Fit the cable guard.

The pump is now ready for installation.

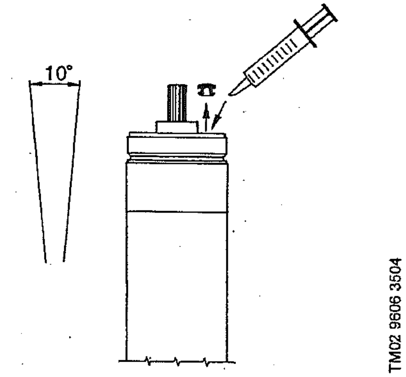


Fig. 2 Injecting motor liquid

3. Installation

3.1 Positional requirements

The pump is suitable for vertical as well as horizontal installation, however, the pump shaft must never fall below the horizontal plane, see fig. 3.

If the pump is to be installed horizontally, e.g. in a tank, and there is a risk that the pump might be covered by mud, it must be installed in a flow sleeve.

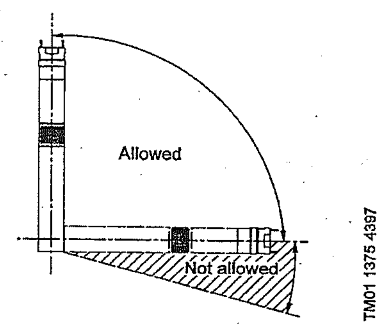


Fig. 3 Pump position

4. Electrical connection

4.1 General

The electrical connection should be carried out by an authorized electrician in accordance with local regulations.

WARNING:

Before starting work on the pump, make sure that the electricity supply has been switched off and that it cannot be accidentally switched on.

This pump is permanent wiring connection only.

Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding.

The grounding connection must be made by a copper conductor at least at the size of the circuit conductors supplying the pump.

The pump must be connected to an external mains switch.

The pump must never be connected to a capacitor or to another type of control box than Redi-Flo3 Status Box, CU 300 or CU 301.

The pump must never be connected to an external frequency converter.

The supply voltage, rated maximum current and power factor (PF) appear on the motor nameplate.

The required voltage for Grundfos submersible MSE 3 motors, measured at the motor terminals, is –10%/+6% of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

If the pump is connected to an installation where a Ground Fault circuit breaker (GFI) is used as additional protection, this circuit breaker must trip out when ground fault currents with DC content (pulsating DC) occur.

Supply voltage

1 x 100-115 V or 1 x 200-240 V, 50/60 Hz.

The current consumption can only be measured accurately by means of a true RMS instrument.
If other instruments are used, the value measured will differ from the actual value.

The Redi-Flo3 pumps can be connected to a Redi-Flo3 Status Box, CU 300 or CU 301 control box.

4.2 Motor protection

The motor has built-in automatic thermal overload protection and requires no additional motor protection.

4.3 Connection of motor

The motor can be connected directly to the main circuit breaker.

Start/stop of the pump will typically be done via a pressure switch, see fig. 4.

Note: The pressure switch must be rated for the maximum amps of the specific pump.

WARNING:

Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump.

2-wire Grundfos motors 200-240 V

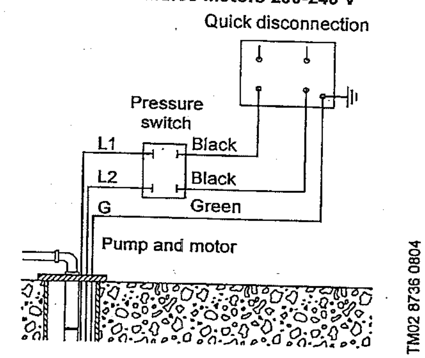


Fig. 4 Wiring diagram, 2-wire (200-240 V)

Single-phase Grundfos motors

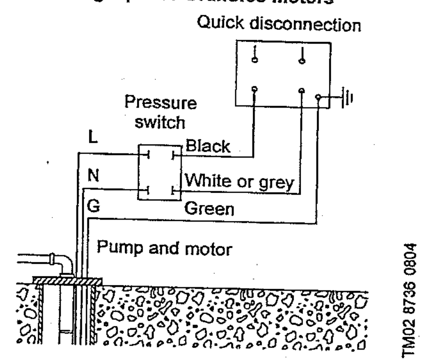


Fig. 5 Wiring diagram, single-phase (100-115 V)

5. Cable sizing

Single-phase 60 Hz maximum cable length (feet) motor service to entrance:

Motor rating			Maximum lengths of copper wire in feet (9% voltage drop)						
Volts	hp	amps	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	2 AWG
115	0.5	12	140	220	360	550	880	1390	2260
230	0.5	5.2	640	1000	1660	2250	4060		
230	0.75	8.4	400	620	1030	1580	2510	3970	
230	1.0	11.2	300	460	770	1190	1890	2980	4850
230	1.5	12	280	430	720	1110	1760	2780	4530

Note: The values apply to 230 V, 60 Hz, and conform to the requirements stated in the National Electrical Code Book.

Note: Recommended maximum cable length between the Redi-Flo3 Status Box, CU 300 or CU 301 and the SQE = 650 ft.

6. Splicing the cable

The submersible drop cable can be ordered separately in lengths of 25 to 300 ft, see section *17. Accessories.*

The submersible drop cable available for Redi-Flo3 pumps is a 12 AWG ETFE cable with end cover and socket. It is not recommended to splice this type of cable.

7. Fitting the cable guard

To fit the cable guard, proceed as follows:

1. Make sure that the motor lead lies flat in the cable guard.
2. Place the cable guard in the groove in the cable plug. The two flaps must engage with the upper edge of the pump sleeve, see fig. 6.

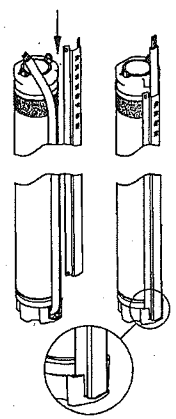

TM02 9613 3504

Fig. 6 Placing the cable guard

3. Fasten the cable guard to the pump suction strainer with the two self-tapping screws supplied, see fig. 7.

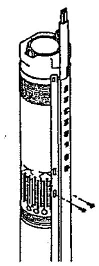

TM01 4427 0299

Fig. 7 Fitting the cable guard to the pump suction strainer

8. Piping

- The pump should only be gripped by the two flats at the top of the pump, see fig. 8.
- The pump can be installed vertically or horizontally. During operation, the pump must always be completely submerged in water.
- When plastic pipe is used, a stainless steel safety wire is recommended for lowering and lifting the pump. Fasten the wire to the eyelet on the pump, see fig. 9.
- The threaded joints must be well cut and fit together tightly to ensure that they do not work loose.

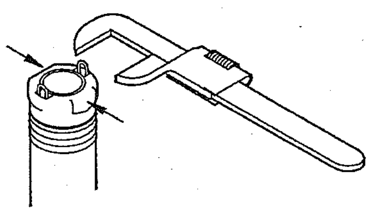

TM02 8739 0804

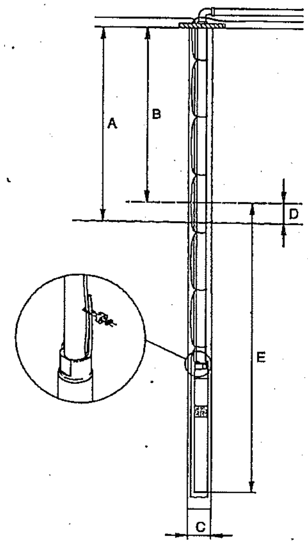
Fig. 8 Gripping the pump

9. Installing the pump

9.1 Installation depth

The dynamic water level should always be above the pump, see fig. 9.

A = Dynamic water level
B = Static water level
C = Minimum 3 inch well diameter
D = Drawdown
E = Installation depth below static water level. Maximum 500 feet.



TM02 8740 0804

Fig. 9 Installation depth

Procedure

To install the pump, proceed as follows:

1. Attach the enclosed data plate sticker at the well head.
2. Check the well for proper clearance. The well must be at least 3 inches in diameter. It is a good idea to check the well for clearance using a plumb ring (2.95 ø x 10 in.).
3. Attach the first section of riser pipe to the pump.
4. Lower the pump into the well. Make sure the motor cable is not damaged when the pump is lifted or lowered into the well, especially in 3 inch wells.
   Note: Do not lower or lift the pump using the motor cable.
5. When the pump has been installed to the required depth, the installation should be finished by means of a well seal.
   Note that the dynamic water level should always be above the pump.
6. Loosen the safety wire so that it becomes unloaded and lock it to the well seal using a cable clamp.
7. Complete the electrical connections.

Note: The pump must never be connected to a capacitor or to another type of control box than Redi-Flo3 Status Box, CU 300 or CU 301.

Installation depths

Maximum installation depth:
500 feet below the static water level.

Minimum installation depth:
1.75 feet below the dynamic water level.

Vertical installation

During start-up and operation, the pump must always be completely submerged in water.

Horizontal installation

The pump must be installed at least 1.75 feet below the dynamic water level.

If there is a risk that the pump might be covered by mud, the pump must always be placed in a flow sleeve.

Note: Do not lower or lift the pump using the motor cable.

10. Generator operation

It is safe to operate the Redi-Flo3 with a generator.

The generator must be sized 50% above the P_1 (input power) values of the pump. See the following table.

Motor [hp]	Minimum generator size [W]	Recommended generator output [W]
0.5	1200	1500
0.75	1900	2500
1.0	2600	3200
1.5	2800	3500

11. Starting the pump for the first time

When the pump has been connected correctly, the pump should be started with the discharge valve closed approximately one third.

Due to the soft start feature, the pump takes approximately 2 seconds to develop full pressure.

11.1 Motor cooling and other considerations

- Make sure the well is capable of yielding a minimum quantity of water corresponding to the pump capacity.
- Do not start the pump until it is completely submerged in the liquid.
- As the valve is being opened, the drawdown should be checked to ensure that the pump always remains submerged.
- To ensure the necessary cooling of the motor, the pump should never be set so low that it gives no water.
  If the flow rate suddenly falls, the reason might be that the pump is pumping more water than the well can yield. The pump must immediately be stopped and the fault corrected.

11.2 Impurities in the water

If there are impurities in the water, the valve should be opened gradually as the water becomes clearer. The pump should not be stopped until the water is clean, otherwise the pump parts and the check valve may become clogged.

When the water is clean, the valve should be fully opened.

11.3 Minimum flow rate

To ensure the necessary cooling of the motor, the pump flow rate should never be set to a value lower than 0.2 gpm.

If the flow rate suddenly falls, the reason might be that the pump is pumping more water than the well can yield. The pump must immediately be stopped and the fault corrected.

WARNING: The pump's dry-running protection is effective only within the recommended duty range of the pump.

Note: Do not let the pump run against a closed discharge valve for more than 5 minutes. When the discharge valve is closed, there is no cooling flow and there is a risk of overheating in motor and pump.

11.4 Built-in functions

The motor incorporates an electronic unit which functions as follows:

- In case of overload, the built-in overload protection will stop the pump for 5 minutes. After that period, the pump will attempt to restart.
- If the pump has been stopped as a result of dry running, it will start automatically after 5 minutes.
- If the pump is restarted and the well has not recovered, the pump will stop after 30 seconds.

11.5 Resetting the pump

Switch off the electricity supply for 1 minute.

11.6 MSE 3 motors

Note: All motors are factory-set to detect dry-running conditions. However, if the maximum pump speed setting is changed, the dry running stop value must also be changed. Please refer to either the Redi-Flo3 Status Box, CU 301 or CU 300 I&O for instructions on this procedure.

11.7 Maintenance and service

The pumps are normally maintenance-free.

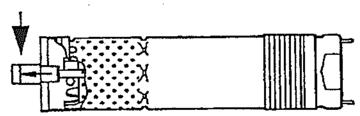
Deposits and wear may occur. For that purpose, service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service center.

12. Assembly of pump and motor

To assemble pump end and motor, proceed as follows:

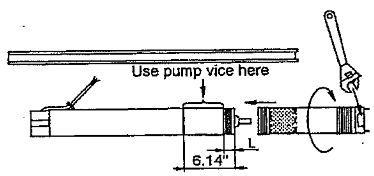
1. Place the motor horizontally in a vice and tighten it, see fig. 11.
2. Pull the pump shaft out to the position shown in fig. 10.



TM02 8425 5203

Fig. 10 Pump shaft position

3. Grease the motor shaft end with the grease supplied with the motor.
4. Screw the pump end on the motor (55 Nm).
   Note: The pump shaft must engage with the motor shaft.
   A spanner may be used on the clamping faces of the pump end, see fig. 11.
5. Fit the cable guard as described in section 7.



TM01 2854 3804

Fig. 11 Pump in vice

0.5 hp: L = 4.7".
0.75 hp: L = 4.0".
1.0 hp: L = 2.6".
1.5 hp: L = 2.6".

When pump end and motor have been assembled correctly, there must be no clearance between pump end and motor.

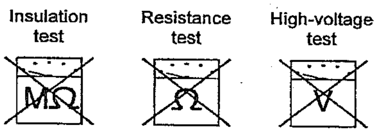
To disassemble, reverse procedure.

13. Troubleshooting

Fault	Cause	Remedy
1. The pump does not run.	a) The fuses are blown.	Replace the blown fuses. If the new fuses blow too, check the electrical installation and the drop cable.
	b) The GFI circuit breaker has tripped.	Reset the circuit breaker.
	c) No electricity supply.	Contact the electricity provider.
	d) The motor protection has cut off the electricity supply due to overload.	Check for motor/pump blockage.
	e) The drop cable is defective.	Repair or replace the pump/cable.
	f) Overvoltage has occurred.	Check the electricity supply.
2. The pump runs but gives no water.	a) The discharge valve is closed.	Open the valve.
	b) No water or too low water level in well.	Increase the installation depth of the pump, throttle the pump or replace it with a smaller capacity model.
	c) The check valve is stuck in its closed position.	Pull the pump and clean or replace the valve.
	d) The suction strainer is closed.	Pull the pump and clean the strainer.
	e) The pump is defective.	Repair or replace the pump.
3. The pump runs at reduced capacity.	a) The drawdown is larger than anticipated.	Increase the installation depth of the pump, throttle the pump or replace it with a smaller capacity model.
	b) The valves in the discharge pipe are partly closed/blocked.	Check and clean or replace the valves as necessary.
	c) The discharge pipe is partly choked by impurities (iron bacteria).	Clean or replace the discharge pipe.
	d) The check valve of the pump is blocked.	Pull the pump and clean or replace the valve.
	e) The pump and the riser pipe are partly choked by impurities (iron bacteria).	Pull the pump. Check and clean or replace the pump, if necessary. Clean the pipes.
	f) The pump is defective.	Repair or replace the pump.
	g) Hole in discharge pipe.	Check and repair the piping.
	h) The riser pipe is defective.	Replace the riser pipe.
	i) Undervoltage has occurred.	Check the electricity supply.
4. Frequent starts and stops.	a) The differential of the pressure switch between the start and stop pressures is too small.	Increase the differential. However, the stop pressure must not exceed the operating pressure of the pressure tank and the start pressure should be high enough to ensure sufficient water supply.
	b) The water level electrodes or level switches in the reservoir have not been installed correctly.	Adjust the intervals of the electrodes/level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See installation and operating instructions for the automatic devices used. If the intervals between start/stop cannot be changed via the automatics, the pump capacity may be reduced by throttling the discharge valve.
	c) The check valve is leaking or stuck half-open.	Pull the pump and clean or replace the check valve.
	d) The supply voltage is unstable.	Check the electricity supply.
	e) The motor temperature is too high.	Check the water temperature.

13.1 Instruments not allowed

Note: The use of the following instruments is not allowed during troubleshooting.

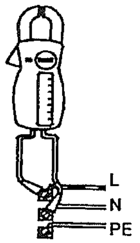
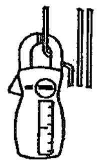


TM01 2072 1098

Fig. 12 Instruments not allowed

Note: When measuring, use RMS instruments.

14. Checking of motor and cable

1. Supply voltage  TM00 1371 5092	Measure the voltage L1 (RMS) between phase and L2. Connect the voltmeter to the terminals at the connections.	The voltage should, when the motor is loaded, be within the range specified in section *4. Electrical connection.* Large variations in supply voltage indicate poor electricity supply, and the pump should be stopped until the problem has been corrected.
2. Current consumption  TM00 1372 5082	Measure the current (RMS) while the pump is operating at a constant discharge head (if possible, at the capacity where the motor is most heavily loaded). For maximum current, see motor nameplate.	If the current exceeds the full-load current, there are the following possible faults: • Poor connection in the leads, possibly in the cable joint. • Too low supply voltage, see item 1.

15. Environment

During handling, operation, storage and transport, all environment regulations dealing with the handling of hazardous materials must be observed.

WARNING:
When the pump is taken out of operation, it must be ensured that no hazardous material is left in the pump and in the riser pipe, which can be injurious to persons and the environment.

16. Technical data

Supply voltage
1 x 100-115 V, 50/60 Hz, PE.
1 x 200-240 V, 50/60 Hz, PE.

Operation via generator
Recommended generator output must be equal to P_1 [kW] + 50% and minimum P_1 + 10%.

Starting current
The motor starting current is equal to the highest value stated on the motor nameplate.

Starting
Soft starting.

Run-up time
Maximum 2 seconds.

Motor protection
Motor overload protection against locked rotor and running-overload protection must be provided by the installer.

Power factor
PF = 1.

Service factor
0.5 hp: 1.85 at 115 V/240 V.
0.75 hp: 2.05 at 240 V.
1.0 hp: 2.25 at 240 V.
1.5 hp: 1.65 at 240 V.

Motor cable
3-wire, RHW-2, 12 AWG ETFE.
Length: 5 feet.

Motor liquid
Type SML 2 or SML 3.

pH values
5 to 9.

Liquid temperature
The temperature of the pumped liquid must not exceed 86°F.

Discharge port
10 SQE-NE: 1¼" NPT.
22 SQE-NE: 1½" NPT.

Storage conditions
Minimum ambient temperature: 4°F.
Maximum ambient temperature: 140°F.

Freeze protection
Note: The motor must not be stored without being filled with motor liquid.

If the pump has to be stored after use, it must be stored on a frost-free location or it must be ensured that the motor liquid is frost-proof.

Operating conditions
Maximum ambient liquid temperature: 86°F.

Motor dimensions
0.5 hp: 20.9" length x 2.68" diameter.
0.75 hp: 20.9" length x 2.68" diameter.
1.0 hp: 22.3" length x 2.68" diameter.
1.5 hp: 22.3" length x 2.68" diameter.

Motor weights
0.5 hp: 6.0 lbs.
0.75 hp: 7.1 lbs.
1.0 hp: 8.2 lbs.
1.5 hp: 8.2 lbs.

Pump end dimensions
Pump diameter: 2.68".
Pump diameter, incl. cable guard: 2.91".

Pump end dimensions (min. and max.)
10 SQE-NE: 10.6" to 14.8".
22 SQE-NE: 10.6" to 16.9".

Pump end weights (min. and max.)
All SQE-NE models: 2.2 lbs to 3.5 lbs.

Well diameter
Minimum 3".

Installation depth
Maximum 500 feet below static water level.

17. Accessories

Product	Product number
Redi-Flo3 Status Box	96440289
Flow sleeve	96037505
Grease	96037562
Grundfos SPP 1 potentiometer	625468
R100 remote control	625333
Submersible drop cable. 12 AWG ETFE with end cover and socket in lengths of	
25 ft	96160895
50 ft 75 ft	96160896 96160897
100 ft 125 ft	96160898 96160899
150 ft 175 ft	96160900 96160901
200 ft 225 ft	96160902 96160903
250 ft 300 ft	96160904 96160905

18. Disposal

This product or parts of it must be disposed of in an environmentally sound way:

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Subject to alterations.

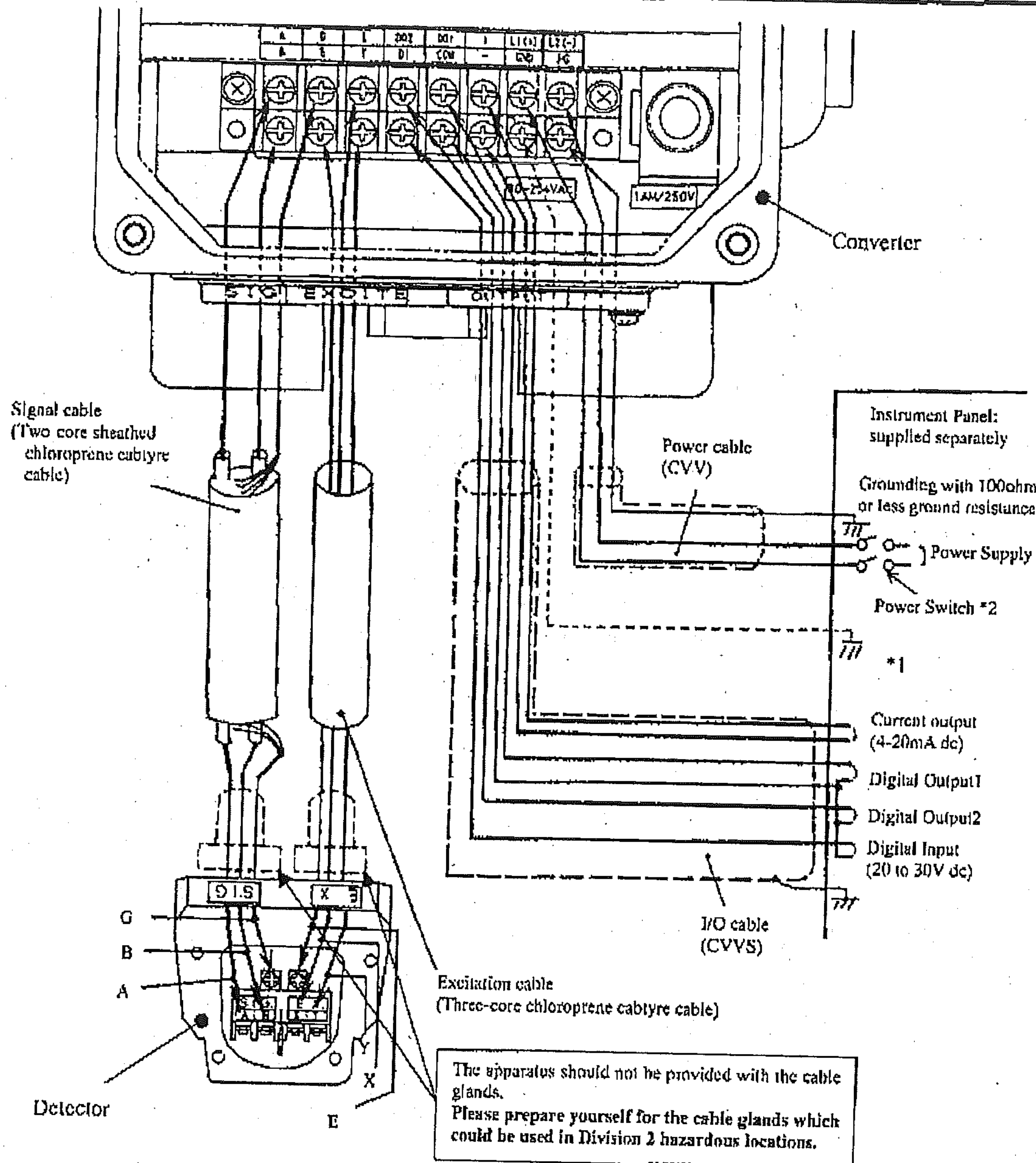
BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

96160911 0806	US
Repl. 96048931 0302	

www.grundfos.com

GRUNDFOS



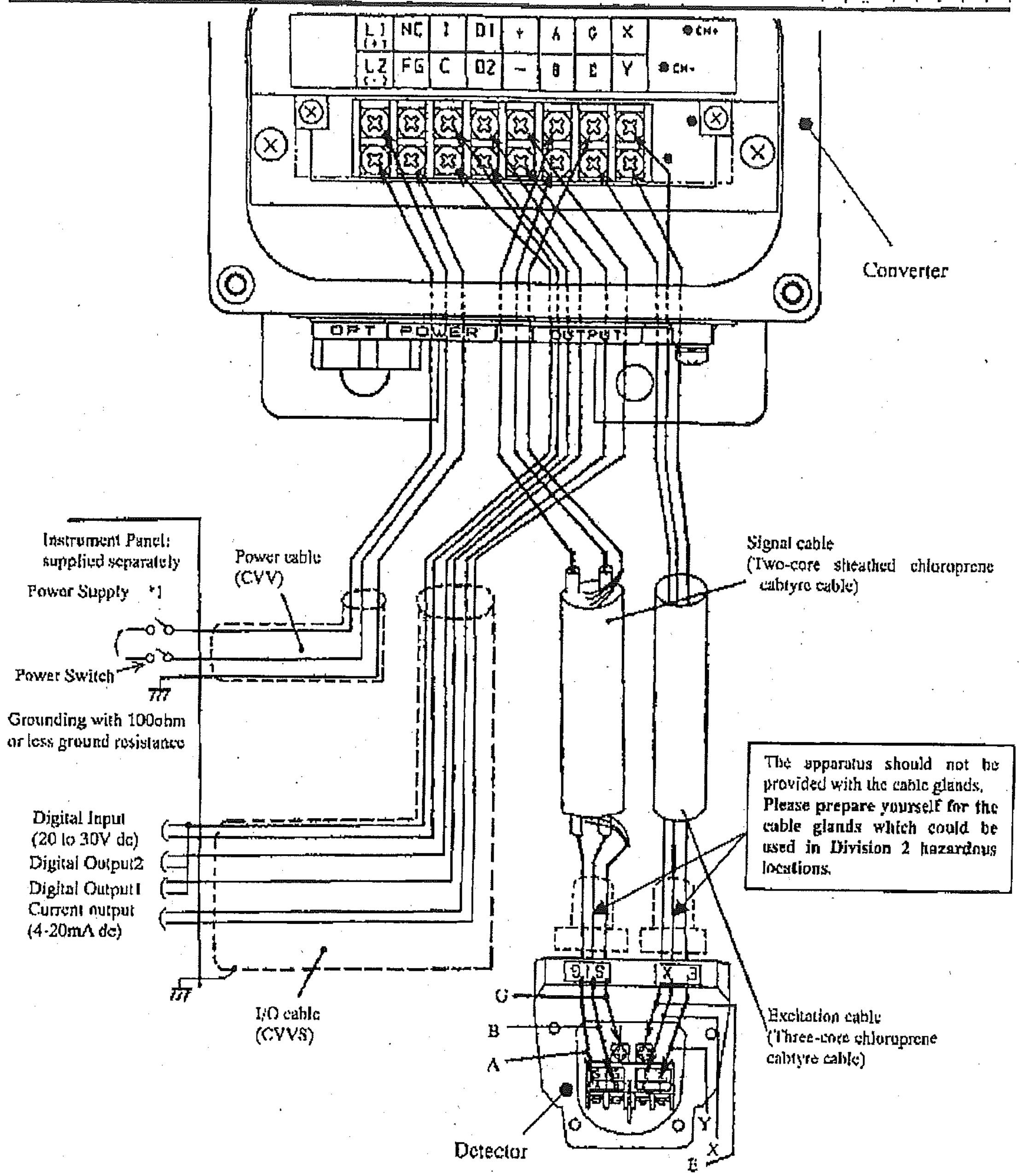
*[1] To use the arresters, ground the GND terminal using a wire shown in broken line.

*[2] Locate an external double-pole power switch on the power line near the flowmeter and within easy operation. Mark on the switch as the disconnecting device for the flowmeter.

Use the proper switch as follows.

Recommended switch rating;	Rating	AC250V 6A or more
	Inrush current	15A or more

Figure 5.1 In Case Of LF424 Terminal Board Connections



*1 Locate an external double-pole power switch on the power line near the flowmeter and within easy operation. Mark on the switch as the disconnecting device for the flowmeter. Use the proper switch as follows.

Recommended switch rating; Rating AC250V 6A or more
Inrush current 15A or more

Figure 5.2 In Case Of LF424 With Terminal Box Terminal Board Connections

■ Excitation Cable

Remove each core coating for cable as shown in Figure 5.6. Next, attach the M3.5 insulating sleeve crimp-style terminals. Then, connect to terminal block X and Y. Also, connect the red cable core to terminal block E

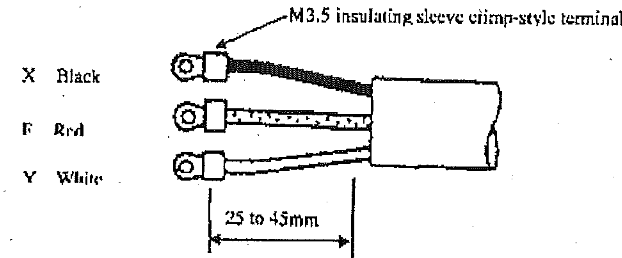


Figure5.6 Excitation cable and processing

■ Power and communication signal Cable

The contractor should prepare the necessary cables.
Remove each core coating for cable. Next, attach the M3.5 insulating sleeve crimp-style terminals. Then, connect to terminal block L1 and L2, and connect the communication signal cable to terminal block + and -.

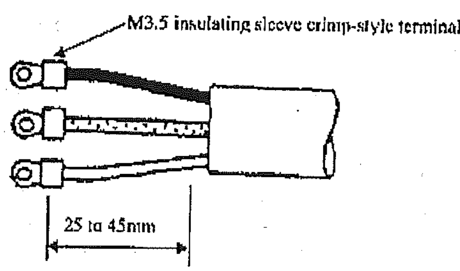
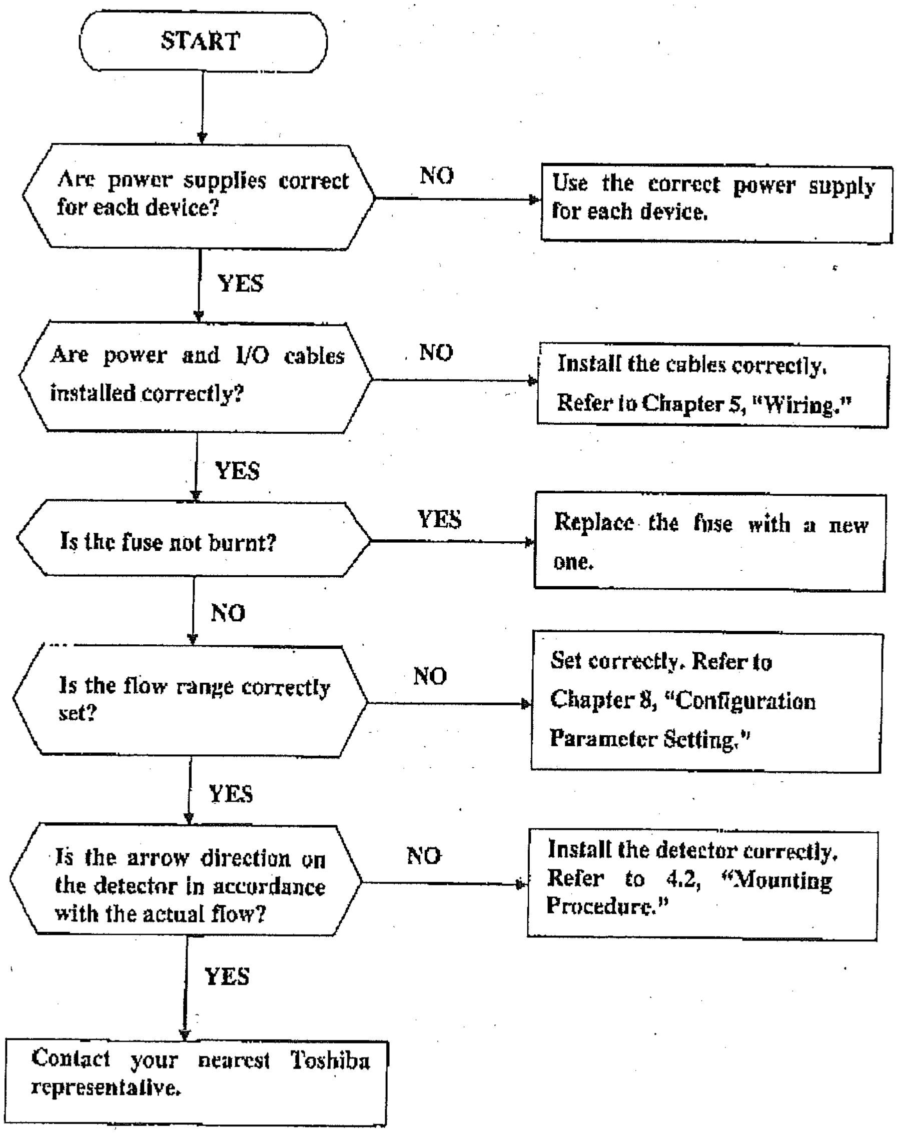


Figure 5.7 Termination of cables

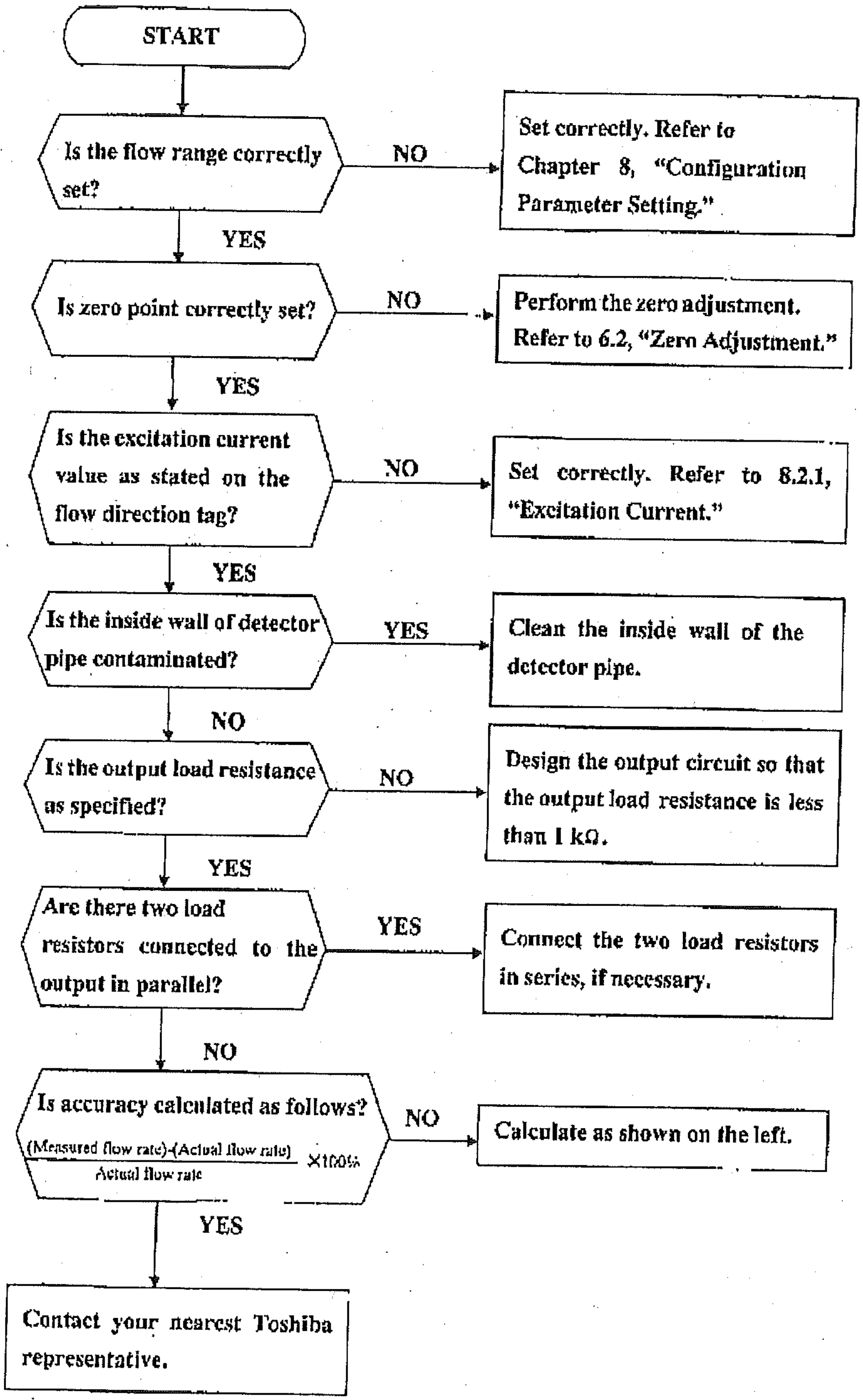
13.2 Troubleshooting

If a problem occurs while using the LF424, follow the flowcharts described below. You may find a way to solve the problem. The flowcharts are based on three symptoms (1) to (3). If you cannot solve the problem, contact your nearest Toshiba representative.

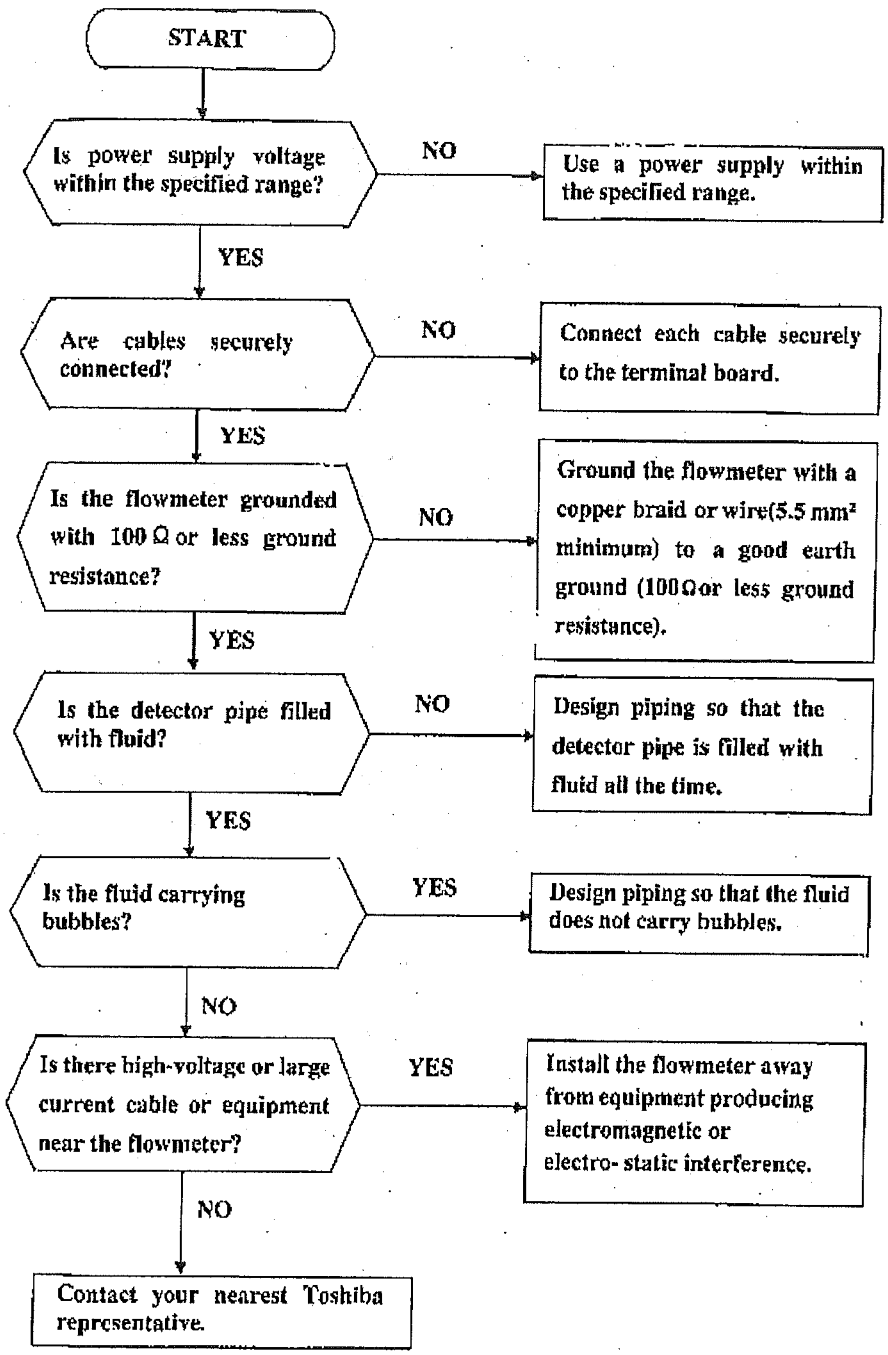
(1) Flow rate is not indicated.



(2) Flow rate indication is not correct.

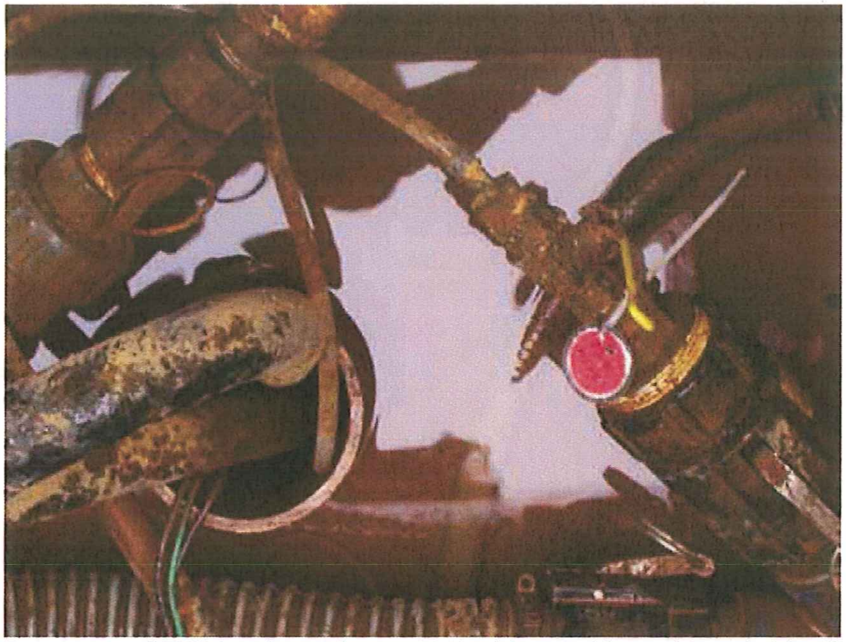


(3) Flow rate indication is not stable.



Appendix C

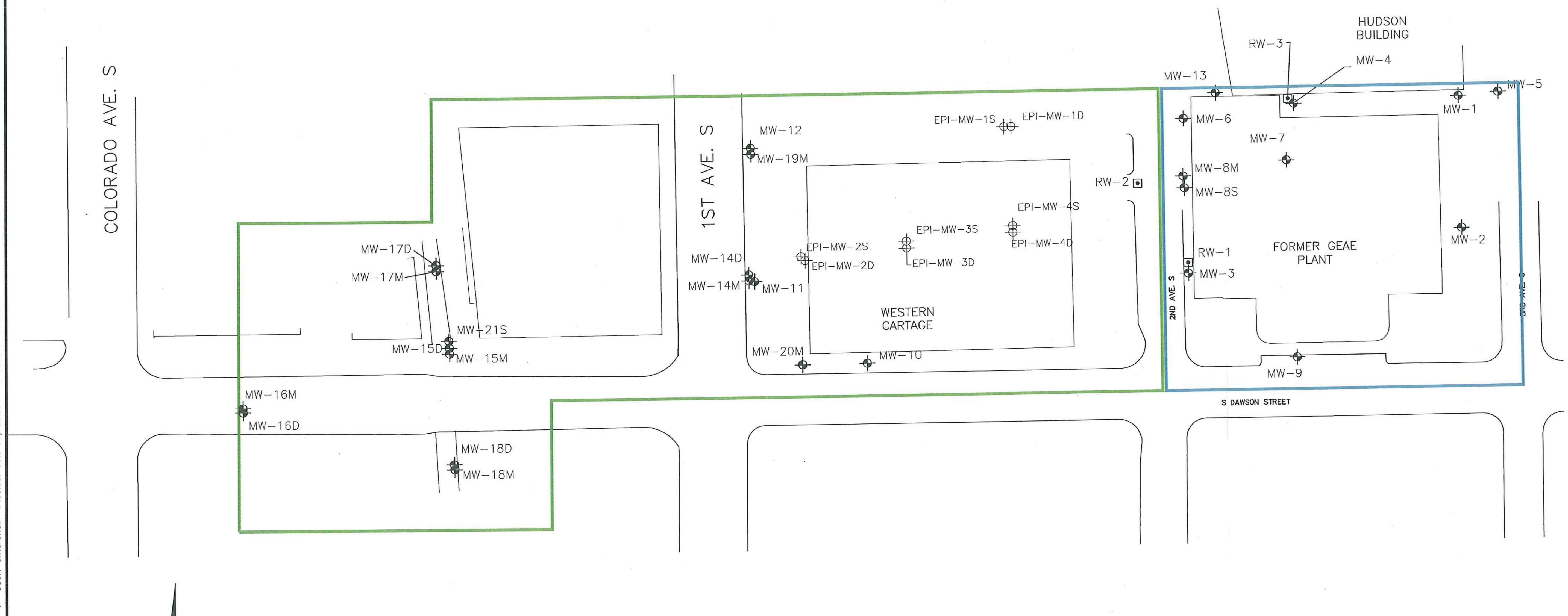
Photographic Log of Recovery Well RW-1



Recovery well RW-1 and sample port A4487 (shown with a red sample identification tag).

Recovery well RW-1.

Figures



50 0 100

SCALE IN FEET

LEGEND

- MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- ON-SITE AREA
- OFF-SITE AREA

NOTES:

1. MONITORING WELLS MW-8, MW-14S, MW-15S, AND MW-16S HAVE BEEN RENAMED MW-8S, MW-14M, MW-15M, AND MW-16M.

ENSR | AECOM

Merged with ENSR in 2007 RETEC

GEAE - S. DAWSON STREET

GE001-19314-735

DATE: 06/04/07 DRWN: E.M./SEA

SITE LOCATION MAP

FIGURE 1-1

File: H:\19314\19314S125.dwg Layout: FIGURE 1-1 User: emarshall Plotted: Jun 04, 2007 - 11:22am Xref's: