Sitewide Groundwater Monitoring Plan (2006 Through 2010) at RMC-Troutdale

Memorandum WP No. 68

Reynolds Metals Company
TROUTDALE FACILITY

CH2MHILL

October 2005

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Sitewide Groundwater Monitoring Plan (2006 Through 2010) at RMC-Troutdale

TO: Chip Humphrey/EPA
Mavis Kent/DEQ

COPIES: Scott Dethloff/CH2M HILL-PDX

FROM: Mark Stiffler/Alcoa
Steve Shaw/RMC

DATE: October 12, 2005

1.0 Purpose and Scope

This sitewide groundwater monitoring plan (Sitewide Monitoring Plan) provides the procedures and requirements necessary to monitor groundwater at the former Reynolds Metals Company (RMC)/Alcoa aluminum reduction plant in Troutdale, Oregon, following installation and startup of the focused extraction/production well optimization (FE/PWO) groundwater system. The FE/PWO system will be installed starting in July 2005. System startup is expected to occur between November and December 2005.

This memorandum contains the Sitewide Monitoring Plan as envisioned for the next 5 years (2006 through 2010). It is supplemented and supported by two additional plans:

- *Technical Memorandum GW No. 33: Operations Plan – Focused Extraction/Production Well Optimization System for the RMC-Troutdale Facility* (FE/PWO Operations Plan) (CH2M HILL, August 2005)
- *Memorandum WP No. 69: Focused Extraction and Production Well Optimization System Startup Performance Monitoring Plan* (FE/PWO System Startup Performance Monitoring Work Plan) (CH2M HILL, August 2005)

The FE/PWO Operations Plan describes the functional requirements to operate the system. The FE/PWO System Startup Performance Monitoring Work Plan describes the functional requirements for aquifer testing and groundwater monitoring over the first few months of operation.

This Sitewide Monitoring Plan is organized as follows:

- Section 2.0—Background
- Section 3.0—Sitewide Groundwater Monitoring Requirements
- Section 4.0—Performance Monitoring Plan
- Section 5.0—Reporting
- Section 6.0—Schedule

2.0 Background

The Troutdale aluminum reduction plant was constructed in 1941 for the U.S. government in support of wartime operations. RMC first leased the plant from the government in 1946 and purchased it in 1949. RMC operated the plant until 2000, when Alcoa purchased the company. Permanent closure of the Troutdale plant was announced by Alcoa in July 2002. Demolition of the plant is scheduled to occur between 2003 and 2006.

A *Record of Decision for Interim Remedial Action* (Interim ROD) (U.S. Environmental Protection Agency [EPA], 2002) was issued on September 30, 2002. The interim ROD requires that high fluoride in groundwater be addressed by hydraulic containment through production well operation in intermediate- and deep-zone groundwater and enhanced focused extraction of shallow groundwater in the South Plant area.

2.1 Remedial Action Objectives

Remedial action objectives (RAOs) for groundwater at the Troutdale site were developed in the Interim ROD and are provided in Table 1.

TABLE 1
Groundwater Remedial Action Objectives from Interim ROD

RAO-1—Restore and maintain use of the intermediate and deep groundwater as a drinking water source. The goal for restoration is the federal and state safe drinking water standard.
RAO-2a—Reduce fluoride in shallow and intermediate groundwater, RAO-2b— Control migration of contaminant plumes in groundwater.
RAO-3—Control migration of plumes to control the migration of fluoride to the Sandy River.

2.2 Focused Extraction Design and Discharge

Implementation of the groundwater remedy for the Troutdale site is expected to result in a combined pumping rate of about 1,240 gallons per minute (gpm), with discharge of the water through the existing National Pollutant Discharge Elimination System (NPDES) discharge.

The two FE wells, FE-02 and FE-03, were designed to operate at a flow rate of 20 gpm each. The design rate was established from groundwater flow modeling performed to define the hydraulic control requirements of the FE wells. These FE wells will extract groundwater with high fluoride concentrations in the east potliner and scrap yard areas and convey that water through new piping to a common manifold with discharge from production wells PW-3, PW-5, PW-7, and PW-8. From there, new piping will take the blended water to an existing outfall pipe that discharges into the Columbia River.

Additional FE wells may be installed at a future date, depending on the need to contain and extract more groundwater. The operational flow rate of the FE wells will be sufficient to establish hydraulic control of the plume as defined in the RAOs above.

Two production wells, PW-7 and PW-8, will operate at a design flow rate of 600 gpm each (total 1,200 gpm). Depending on capture efficiencies and blending requirements, flow rates

may be increased to a maximum of 800 gpm each (total 1,600 gpm) and/or additional production wells, PW-3 and PW-5, may be brought online to increase the flow rate further. Production wells PW-3 and PW-5 will be piped into the system to provide additional blending water, as appropriate.

EPA has determined that a fluoride concentration standard of 5 milligrams per liter (mg/L) will be applied to combined groundwater discharge to the Columbia River. For other constituents present, EPA will use federal ambient water quality criteria for protection of aquatic organisms in the Columbia River under Section 304 of the Clean Water Act. Water quality sampling requirements for FE/PWO system discharge will be performed as required in the existing facility NPDES Permit.

3.0 Sitewide Groundwater Monitoring Requirements

Groundwater monitoring across the site and especially within the South Plant area, as specified in this Sitewide Monitoring Plan, will be conducted to evaluate the proposed remedial action's effectiveness in achieving compliance with the groundwater RAOs identified in Table 1. This Sitewide Monitoring Plan will be implemented after final approval of this plan is received from EPA and the Oregon Department of Environmental Quality (DEQ) and the components of the remedial action are in place.

Results of the monitoring will be evaluated on an annual basis, and future modifications to the program will be proposed to reflect the conditions observed at the site.

3.1 Groundwater Performance Criteria for Meeting RAOs

The remedial actions taken to remove the source of fluoride to groundwater contribute to improvement of site groundwater on both an individual source area basis and sitewide. Source control actions are most directly related to improvement of groundwater quality near the individual source areas. Production well optimization and focused extraction of groundwater have positive impacts on groundwater quality throughout the aquifer, both near and distant from individual sources.

Monitoring the proposed remedies' effects on mass removal and groundwater quality is complex because of spatial variations in nature and extent, differences in source area impacts on groundwater, the presence of multiple groundwater zones showing varying degrees of impact, and differing timeframes needed to achieve anticipated results. Because of these issues, both capture zone monitoring and water quality criteria will be used to evaluate the effectiveness of site remediation toward achieving the groundwater RAOs. The use of these groundwater performance criteria is summarized in Table 2 for the following areas:

- North Plant (Company Lake and north landfill)
- South Plant (scrap yard and east potliner)
- South landfill
- Intermediate and deep zones
- Other wells

TABLE 2
Groundwater Performance Criteria

Source Area/Remediation	Capture Zone Monitoring		Water Quality Standards	
	Performance Criteria	**Demonstration**	**Performance Criteria**	**Demonstration**
North Plant (Company Lake/ North Landfill) ***Source Control*** Process residue removal ***Groundwater Remediation*** Pore flushing	NA	NA	Source removal and continued groundwater flushing will reduce the extent of groundwater in the upper gray sand (UGS) and intermediate zones with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction based on time/ concentration plots from measured fluoride concentrations.
South Plant (Scrap Yard and East Potliner) ***Source Control*** (1) Waste removal at scrap yard. (2) Waste removal at east potliner is completed. ***Groundwater Remediation*** Focused Extraction (FE)	Focused extraction prevents downward migration of groundwater with fluoride concentrations above the maximum contaminant limit (MCL).	Evaluate capture based on (1) groundwater elevation contour maps constructed from measured water level data from non-pumping wells, and (2) water quality and flow rate measured for the focused extraction wells.	Source removal, focused extraction, and continued groundwater flushing will reduce the extent of groundwater in the UGS with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction based on time/ concentration plots constructed from measured fluoride concentrations.
South Landfill ***Source Control*** Waste removal ***Groundwater Remediation*** Production Well Optimization (PWO)	NA	NA	Source removal and continued groundwater flushing will reduce the extent of groundwater in the UGS with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction based on time/ concentration plots from measured fluoride concentrations.
Intermediate/Deep Zones ***Source Control*** Scrap yard waste removal ***Groundwater Remediation*** PWO	PWO captures groundwater with fluoride concentrations above the MCL.	Evaluate capture based on (1) groundwater elevation contour maps constructed from measured water level data, and (2) water quality and flow rate measured for the production wells.	PWO reduces the extent of groundwater in the intermediate/deep zones with fluoride concentrations greater than the MCL.	Evaluate fluoride concentrations annually based on time/ concentration plots constructed from measured fluoride concentrations.
Other Wells ***Source Control*** NA ***Groundwater Remediation*** Pore Flushing	NA	NA	Source removal and continued groundwater flushing will reduce the extent of groundwater in the UGS and intermediate zones with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction based on time/concentration plots from measured fluoride concentrations.

NA = Not applicable.

Technical Memorandum GW No. 28: Proposed Groundwater Remedial Action Duration and Performance Measurement for the RMC/Alcoa Troutdale Facility (CH2M HILL, July 24, 2002) describes in detail the groundwater conceptual model with respect to groundwater remediation for each of these areas, the performance measurement components for each area, and RAO achievement. Because this information is vital to understanding the components of the proposed monitoring program, it has been included in the Attachment 1 for ease of reference.

3.2 Focused Extraction Performance Duration

The objective of groundwater remedy over a 5-year operational period is to substantially reduce both the mass of fluoride and concentration in groundwater that would be discharged to the adjacent rivers under natural groundwater flow conditions. *Technical Memorandum GW No. 28: Proposed Groundwater Remedial Action Duration and Performance Measurement for the RMC/Alcoa Troutdale Facility* (CH2M HILL, July 24, 2002) provided justification for implementation of groundwater remedial actions at the Troutdale site over a proposed 5-year duration. The 5-year pumping period for the FE system is recommended because it has been predicted to achieve a 50 percent or greater mass removal from the affected portion of the intermediate and deep aquifer systems.

4.0 Performance Monitoring Plan

This section describes the key elements of the sitewide monitoring program presented in Table 3 that RMC/Alcoa will implement at the Troutdale facility under the conditions of the ROD as negotiated with EPA. This plan is consistent with the guidelines established in *Methods for Monitoring Pump-and-Treat Performance* (EPA, 1994). Figure 1 shows the locations of the wells and highlights the well locations as they correspond with Table 3 (see page 7). A thorough discussion of the sitewide groundwater monitoring program presented in Table 3 is provided in Section 4.2.

4.1 Sitewide Groundwater Remedial Action Objectives and Metrics

The effectiveness of the recommended groundwater remedy is measured by its ability to meet the RAOs presented in Table 1. Metrics are used to evaluate the achievement of each RAO and are shown in Table 4.

TABLE 4
Sitewide Remedial Action Objectives and Metrics

Remedial Action Objective	Metric
RAO-1—Restore and maintain use of the intermediate and deep groundwater as a drinking water source. The goal for restoration is the federal and state safe drinking water standard.	1—Reduction in mass of fluoride in affected portions of the intermediate and deep wells identified in Table 3. 1—Reduction in fluoride concentration in affected portions of the intermediate and deep wells identified in Table 3.

TABLE 4
Sitewide Remedial Action Objectives and Metrics

Remedial Action Objective	Metric
RAO-2a—Reduce fluoride in shallow and intermediate groundwater. RAO-2b—Control migration of contaminant plumes in groundwater.	1—Reduction in fluoride concentrations in the upper gray sand (UGS) and intermediate groundwater in South Plant wells identified in Table 3. 2—Capture of UGS and deep groundwater in the South Plant wells identified in Table 3.
RAO-3—Control migration of plumes to control the migration of fluoride to the Sandy River.	1—Hydraulic control of fluoride plume in South Plant area. 2— Reduction in mass of fluoride in the intermediate east and deep east areas.

A detailed discussion of the metrics and how they meet RAOs at a given area and groundwater zone is presented in Appendix G of the *Draft Final Focused Feasibility Study* (CH2M HILL, June 2000).

4.2 Groundwater Monitoring

A summary of the groundwater monitoring program for the first 5 years of FE/PWO system operation, including frequency and type, is presented in Table 3. If groundwater monitoring is needed beyond the fifth year, these monitoring requirements will be proposed to EPA and DEQ and will be based on the first 5 years of monitoring data.

4.2.1 Water Level Monitoring

During the proposed 5-year operational period, water level data will be collected from all available monitoring wells and pumping wells on the site. Groundwater level monitoring will be performed quarterly for the first year and then semiannually for years 2 through 5 for all wells in the North Plant, South Plant, South Landfill, Intermediate/Deep Zones, and Other Wells. Groundwater level monitoring will be performed in the remaining wells at the site (named Water Levels Only) semiannually for all 5 years. Details on the monitoring schedule are provided in Section 6.

4.2.2 Water Quality Monitoring

The predominant constituent of potential concern in groundwater at the site is fluoride because of its distribution and presence above the maximum contaminant level (MCL). Other than fluoride, only a few constituents have exceeded the MCL: amenable cyanide, six metals, and two volatile organic compounds. With few exceptions, all of these constituents exceeding the MCL are co-located with fluoride. Consequently, fluoride has been monitored since 1994 as an indicator parameter to assess potential impacts to groundwater at the site.

A tiered risk assessment, performed for the final baseline risk assessment, confirmed that fluoride is the only constituent of concern in groundwater at the RMC-Troutdale site. This evaluation is documented in *Draft Baseline Risk Assessment, Part 2 – Groundwater* (CH2M HILL, July 1999).

TABLE 3
Sitewide Groundwater Monitoring Program
2006 through 2010

Monitoring Area and Schedule				Frequency Year One				Frequency Year Two				Frequency Year Three				Frequency Year Four				Frequency Year Five			
Monitoring Area	**Well ID**	**Location**	**Zone**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**
North Plant (Company Lake/ North Landfill)	MW23-025	North Landfill	UGS	4	2			2	2			2	2			2	2			2	2		
	MW27-045	Company Lake	UGS	4	2			2	2			2	2			2	2			2	2		
	MW27-081	Company Lake	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW29-090	Plant Interior—Company Lake	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW29-179	Plant Interior—Company Lake	Deep	4	2			2	2			2	2			2	2			2	2		
	MW57-025	North Landfill	UGS	4	2			2	2			2	2			2	2			2	2		
South Plant (Scrap yard/East Potliner)	FE01-046	Scrap Yard	UGS	4	2			2	2			2	2			2	2			2	2		
	FE02-046	Scrap Yard	UGS	4	4	4		2	2	2		2	2	N		2	2	N		2	2	N	
	FE03-045	Scrap Yard	UGS	4	4	4		2	2	2		2	2	N		2	2	N		2	2	N	
	MW02-034	Scrap Yard	UGS	4	2			2	2			2	2			2	2			2	2		
	MW11-017	East Potliner	Silt	4	2			2	2			2	2			2	2			2	2		
	MW13-022	Scrap Yard	Silt	4	2			2	2			2	2			2	2			2	2		
	MW34-038	East Potliner	UGS	4	2			2	2			2	2			2	2			2	2		
	MW35-038	East Potliner	UGS	4	2			2	2			2	2			2	2			2	2		
	MW55-046	Scrap Yard	UGS	4	2			2	2			2	2			2	2			2	2		
	MW56-046	Scrap Yard	UGS	4	2			2	2			2	2			2	2			2	2		
South Landfill	MW19-013	South Landfill	Silt	4	2			2	2			2	2			2	2			2	2		
	MW26-012	South Landfill	Silt	4	2			2	2			2	2			2	2			2	2		
	MW26-050	South Landfill	UGS	4	2			2	2			2	2			2	2			2	2		
Intermediate/Deep Zones	MW10-090	Plant Interior—So. of Dike	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW10-165	Plant Interior—So. of Dike	Deep	4	2			2	2			2	2			2	2			2	2		
	MW32-040	Plant Interior—Rectifier Yard	UGS	4	2		1	2	2		1	2	2		1	2	2		1	2	2		1
	MW32-095	Plant Interior—Rectifier Yard	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW32-165	Plant Interior—Rectifier Yard	Deep	4	2			2	2			2	2			2	2			2	2		
	MW33-033	Plant interior—Scrap Yard	UGS	4	2			2	2			2	2			2	2			2	2		
	MW33-095	Plant interior—Scrap Yard	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW33-165	Plant interior—Scrap Yard	Deep	4	2			2	2			2	2			2	2			2	2		
	MW48-165	Plant Interior	Deep	4	2			2	2			2	2			2	2			2	2		
	PW-3	Plant Interior—Deep	Deep	4	2	2		2	2	2		2	2	N		2	2			2	2		
	PW-5	Plant Interior—Deep	Deep	4	2	2		2	2	2		2	2	N		2	2			2	2		
	PW-7	Plant Interior—Deep	Deep	4	4	4		2	2	N		2	2	N		2	2			2	2		
	PW-8	Plant Interior—Deep	Deep	4	4	4		2	2	N		2	2	N		2	2			2	2		
Other Wells	MW31-034	Fairview Farms	UGS	4	2			2	2			2	2			2	2			2	2		
	MW31-095R	Fairview Farms	Intermediate	4	2			2	2			2	2			2	2			2	2		
	MW52-045	Columbia River	UGS	4	2			2	2			2	2			2	2			2	2		
	MW53-034	Sandy River	UGS	4	2			2	2			2	2			2	2			2	2		

TABLE 3
Sitewide Groundwater Monitoring Program
2006 through 2010

Monitoring Area and Schedule				Frequency Year One				Frequency Year Two				Frequency Year Three				Frequency Year Four				Frequency Year Five			
Monitoring Area	**Well ID**	**Location**	**Zone**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**	**Water Levels**	**Fluoride**	**Cyanide**	**VOCs**
Water levels only (for contouring)	MW01-019	Cryolite Ponds	Silt	2				2				2				2				2	1		
	MW02-012	Scrap Yard	Silt	2				2				2				2				2	1		
	MW03-175	Plant Perimeter—Upgradient	Deep	2				2				2				2				2	1		
	MW04-019	South Wetlands	Silt	2				2				2				2				2	1		
	MW07-024	Plant Interior—South of Dike	Silt	2				2				2				2				2	1		
	MW10-023	Plant Interior—South of Dike	Silt	2				2				2				2				2	1		
	MW12-021	Plant Perimeter—Sundial Road	Silt	2				2				2				2				2	1		
	MW12-092	Plant Perimeter—Sundial Road	Intermediate	2				2				2				2				2	1		
	MW14-015	Scrap Yard	Silt	2				2				2				2				2	1		
	MW16-014	Plant Interior—South landfill	Silt	2				2				2				2				2	1		
	MW17-028	South Wetlands	Silt	2				2				2				2				2	1		
	MW18-016	South Wetlands	Silt	2				2				2				2				2	1		
	MW18-031	South Wetlands	UGS	2				2				2				2				2	1		
	MW24-010	Scrap Yard	Silt	2				2				2				2				2	1		
	MW25-024	Scrap Yard	Silt	2				2				2				2				2	1		
	MW28-160	Plant Interior—Carbon Bakes	Deep	2				2				2				2				2	1		
	MW29-033	Plant Interior—Company Lake	UGS	2				2				2				2				2	1		
	MW30-030	Plant Perimeter—Company Lake	UGS	2				2				2				2				2	1		
	MW30-100	Plant Perimeter—Company Lake	Intermediate	2				2				2				2				2	1		
	MW40-018	Plant Interior—Carbon Bakes	Silt	2				2				2				2				2	1		
	MW42-013	Plant Interior—Carbon Bakes	Silt	2				2				2				2				2	1		
	MW46-018	Plant Interior—Carbon Bakes	Silt	2				2				2				2				2	1		
	MW47-094	South Landfill	Intermediate	2				2				2				2				2	1		
	MW49-095	Plant Interior—East Potliner	Intermediate	2				2				2				2				2	1		
	MW49-145	Plant Interior—East Potliner	Deep	2				2				2				2				2	1		
	MW50-094	Plant Interior	Intermediate	2				2				2				2				2	1		

Notes:

Quarterly monitoring events will occur in February, May, August, and November.
Semiannual monitoring events will occur in February and August.
Annual event is in August.

Abbreviations:
N = as needed.
UGS = Upper Gray Sands.

12-Oct-2005

COMPANY LAKE OUTFALL

COLUMBIA RIVER

MW52-045

OUTFALL ROAD

NORTH LANDFILL

MW30-030
MW30-100

MW27-045
MW27-081

MW23-025

MW57-025

COMPANY LAKE

MW31-034
MW31-095R

EAST LAKE

MW53-034

SANDY RIVER

MW29-033

FACILITY ENTRANCE

MW29-090
MW29-179

MW07-024

BPA SUBSTATION

FAIRVIEW FARMS

MW32-040
MW32-095
MW32-165

POTLINES

PW03

PW05

PW08

MW10-023

MW10-090
MW10-165

U.S. ARMY CORPS OF ENGINEERS DIKE

MW48-165

SUNDIAL ROAD

CASTHOUSE

PW07

MW33-033
MW33-095
MW33-165

FE02-046

MW40-018

MW42-013

MW49-095
MW49-145

MW34-038

SALMON CREEK

CARBON PLANT

MW46-018

MW35-038

WEST DRAINAGE

MW13-022

MW56-046

FE03-045

MW28-160

MW11-017

MW12-021
MW12-092

MW24-010

FE01-046

MW14-015

MW50-094

MW55-046

MW02-012

MW04-019

MW01-019

MW02-034

EAST POTLINER

BUILDING 97 SUBAREA

MW19-013

MW16-014

MW25-024

SOUTH LANDFILL

SOUTH DITCH

SCRAP YARD

WASTEWATER TREATMENT PLANT

MW47-094

MW18-016
MW18-031

MW26-012
MW26-050

SOUTH DITCH

CRYOLITE PONDS

MW03-175

SOUTH WETLANDS

MW17-028

GRAHAM ROAD

SALMON CREEK

LEGEND

MW52	SINGLE MONITORING WELL LOCATION
MW30	WELL GROUP LOCATION
PW01	PRODUCTION WELL LOCATION
MW30	WATER LEVEL ONLY
MW52	NORTH PLANT - WATER LEVEL & WATER QUALITY
MW13	SOUTH PLANT - WATER LEVEL & WATER QUALITY
MW46	INTERMEDIATE / DEEP ZONE - WATER LEVEL & WATER QUALITY
MW19	SOUTH LANDFILL - WATER LEVEL & WATER QUALITY
MW53	OTHER WELLS - WATER LEVEL & WATER QUALITY

N

0 200 600

APPROXIMATE SCALE IN FEET

Figure 1
SITEWIDE GROUNDWATER MONITORING
REYNOLDS METALS COMPANY/ALCOA, INC.
TROUTDALE, OREGON

CH2MHILL

\\rosa\proj\REYNOLDS\39293\CAD\6603464EC_COLOR.DWG

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Fluoride. Water quality will be monitored at the frequency identified in Table 3. In general, fluoride will be monitored semiannually in all wells. The exceptions are the operational FE and PW wells, where fluoride will be monitored quarterly during the first year. Water Level Only wells will be monitored for fluoride during the fifth year of operation, and these data will be included in the 5-year ROD review. The low monitoring frequency in these Water Level Only wells is because fluoride either has not been detected or concentrations have long been stable and below the fluoride MCL of 4 mg/L.

A selective-ion fluoride probe will be used to measure fluoride in the field. If a measured concentration is inconsistent with historical results, a second measure will be taken to verify the first result. Groundwater samples for laboratory fluoride analysis by EPA Method 300.0 will also be collected at well locations exhibiting fluoride concentrations greater than 100 mg/L.

Cyanide. Cyanide will be measured in the operational FE and production wells to evaluate discharges from the FE system.

Groundwater samples will be analyzed for total cyanide analysis (by EPA Method 335.1). If total cyanide results indicate that the NPDES discharge limits may be exceeded (0.05 mg/L daily maximum and 0.025 mg/L monthly maximum), then laboratory analysis (EPA Method SW9015) for metal-complexed cyanide will be performed to determine the amount of iron-cyanide complex (nontoxic) and free cyanide (toxic) present. It is presumed, based on past limited analytical sampling and historical knowledge of the cyanide source, that the cyanide present in groundwater is iron-cyanide complex and not the free cyanide on which the NPDES permit is based.

Volatile Organic Compounds. The FE/PWO system is not intended to remove volatile organic compounds (VOCs). One well, MW32-040, is currently in the annual groundwater monitoring program for VOCs. The sample will be analyzed for VOCs by EPA Method 8260.

4.3 Performance Period

As described in Section 3.2 and evaluated in detail in *Technical Memorandum GW No. 28: Proposed Groundwater Remedial Action Duration and Performance Measurement for the RMC/ Alcoa Troutdale Facility* (CH2M HILL, July 24, 2002), the groundwater remedial actions at the Troutdale site will occur over a proposed 5-year duration. Initial remediation time-to-compliance estimates indicate that reducing the fluoride concentrations in groundwater to the beneficial use criteria will be a long-term process. Therefore, a 5-year initial performance period is proposed to provide adequate time to observe and document the actual effectiveness of the remedial action.

4.4 Performance Evaluation

This performance evaluation has two main elements: evaluating remedial action effectiveness and evaluating progress toward achieving the groundwater RAOs. As described in *Methods for Evaluating the Attainment of Cleanup Standards, Volume 2: Groundwater* (EPA, 1992), the decision to stop corrective action is based on a comparison of monitoring data with the remedial goals. The remedial goals established in the Interim ROD in 2002 were based on project information accumulated to date and presented primarily in the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999) and the *Draft Final*

*Focused Feasibility Study (*FFS*)* (CH2M HILL, June 2000). Included in the FFS were fluoride concentration contour maps and cross-sections showing the distribution of fluoride in the UGS, intermediate, and deep groundwater zones at the site using 1996 through 1998 data. These figures are provided in Attachment 2. Although some water levels and fluoride concentrations depicted on the cross-sections have increased and decreased since they were prepared, the information on these cross-sections is still considered representative of groundwater conditions at the site prior to FE/PWO system operation.

The performance evaluation of the FE/PWO system in developing and maintaining capture of the fluoride plume in the South Plant remediation area will be based on a weight-of-evidence approach using multiple lines of evidence. The degree of hydraulic influence observed across the monitoring well network during the initial startup of the FE system will provide a very good indication of the system's ability to develop and maintain sufficient capture. As the system continues to operate, the development of potentiometric surface contour maps and cross-sections depicting recent fluoride concentrations and water levels in the UGS, intermediate, and deep zones will be used to evaluate capture in three dimensions. Finally, changes in fluoride concentrations or trends, as appropriate, will also be used as evidence of capture.

Two cross-sectional figures, parallel and perpendicular to the natural gradient, will be used in the evaluation to determine the extent of capture and assess changes in the fluoride plume. The cross-sections will visually portray vertical hydraulic gradients. Potentiometric surface contour maps will be developed for the silt, UGS, intermediate, and deep zones; these maps will also include recent fluoride concentration measurements. The differences in water level elevations between strategically located monitoring points depicted on the contour maps will be used to assess capture. These figures will be included in the 2006 annual groundwater report, as described in the next section.

Annually, during performance monitoring, groundwater quality data obtained at the selected monitoring wells will be compared against the agreed-upon remedial goals. The comparison will be made separately for each zone (UGS, intermediate, and deep) by calculating the arithmetic mean of the concentration of fluoride at selected monitoring wells against its remedial goal. A simple arithmetic mean calculation approach is proposed as a preliminary step for assessing compliance to defer use of a more labor-intensive statistical approach until it appears likely that the facility will comply with its remedial goals. When the mean of performance monitoring well concentrations for fluoride appears to meet the remedial goal, or if other factors suggest that it may be appropriate to terminate extraction, a statistical technique that is suitable for the distribution of existing data (parametric or nonparametric) of apparent compliance can be used to document whether extraction will, in fact, be terminated.

5.0 Reporting

Annual reports will be submitted to EPA and DEQ and will include:

- A brief summary (1 to 3 pages) of the number of wells sampled, the dates during which sampling events were conducted, and a discussion of any problems encountered or modifications made to the program during a particular sampling event

- A summary table of validated water quality monitoring results collected during the year compared with remedial goals
- A summary table of the water level elevation measurements
- Water level elevation contour maps for each of the aquifer horizons (Silt, UGS, Intermediate, Deep)
- Hydraulic head data contoured on cross-sections (parallel and normal to original gradient) and containing fluoride concentrations from the previous sampling event
- A table summarizing vertical gradients
- Selected analytical data time-series concentration plots (where necessary to reflect data of interest), similar to the plots included in annual groundwater reports, with the addition of plots for the pumping wells
- A comparison of the post-action fluoride distribution with the 1999 fluoride concentration contour maps to evaluate plume configuration changes and temporal concentration changes near source areas
- Compliance with RAOs
- Compliance with performance standards during the year and responses taken if compliance was not demonstrated
- A summary of NPDES monitoring results

The annual report will be submitted to EPA and DEQ within 90 days after receipt of analytical results from the last sampling event of the year.

6.0 Schedule

The following schedule is proposed:

Task	Date (2005)
FE/PWO System Installation	July through October
Company Lake Dewatering	September/October
Semiannual Sampling Event	August
FE System Operation	November
Aquifer Testing/Performance Monitoring	November through January

The break between system installation and operation results because the system cannot operate while Company Lake is being dewatered. Therefore, an approximately 1-month break is included to perform dewatering. Once the lake is dewatered, the system can be operated. The system is considered operational once the step-rate test is performed during the Aquifer Testing/Performance Monitoring portion of the schedule.

For the first 5 years of FE/PWO system operation (2006 through 2010), wells will be monitored quarterly, semiannually, and annually, depending on the measurement being taken. Quarterly monitoring events will occur in February, May, August, and November. Semiannual monitoring events will occur in February and August. Annual events will occur in August.

ATTACHMENT 1

Technical Memorandum GW No. 28: Proposed Groundwater Remedial Action Duration and Performance Measurement for the RMC/Alcoa Troutdale Facility (CH2M HILL, July 24, 2002)

Proposed Groundwater Remedial Action Duration and Performance Measurement for the RMC/ALCOA Troutdale Facility

PREPARED FOR: Steve Shaw/RMC

PREPARED BY: Ken Trotman/CH2M HILL–SEA

COPIES: Scott Dethloff/CH2M HILL–PDX
RMC/ALCOA File

DATE: July 24, 2002

This memorandum describes the proposed groundwater remedial action duration and performance measurement approach for the Reynolds Metals Company (RMC)/Alcoa Superfund site in Troutdale, Oregon. This information has been developed under the assumption that the following source control and groundwater remedial actions are implemented at the site:

- Source control actions
  - North landfill—Excavation and offsite disposal of debris from the eastern part of the north landfill plus placement of a riprap cap over the western part of the north landfill
  - South landfill—Excavation and offsite disposal of debris from the south landfill
  - Scrap yard—Excavation and offsite disposal of debris from the scrap yard
  - Company Lake—Excavation and offsite disposal of process residue from Company Lake
- Groundwater actions
  - Production well optimization (PWO)—Extraction and offsite discharge of groundwater (through the plant's existing National Pollutant Discharge Elimination System [NPDES] outfall) from the intermediate and deep zones using the existing plant production wells
  - Focused extraction (FE)—Extraction and offsite discharge of groundwater (through the plant's existing NPDES outfall) from new South Plant wells installed in the Upper Gray Sand (UGS) near the scrap yard and east potliner areas

Performance measurement will be conducted to evaluate the proposed remedial actions' effectiveness in achieving compliance with the groundwater remedial action objectives (RAOs) identified in Table 1. RAOs for the Troutdale site were developed in the *Draft Final Focused Feasibility Study* (FFS) (CH2M HILL, June 2000).

Table 1 Groundwater Remedial Action Objectives
No. 1—Reduce or control offsite migration of fluoride plume and other constituents of potential concern (COPCs) in groundwater.
No. 2—Reduce or control mass loading of fluoride and other COPCs in groundwater in the UGS, intermediate, and deep zones.
No. 3—Restore groundwater to beneficial use criteria.

Duration of Groundwater Remedial Actions

The following discussion provides justification for implementation of groundwater remedial actions at the Troutdale site over a proposed 5-year duration, following completion of the source control actions described above. The objective of PWO and FE over this 5-year period is to substantially reduce both the mass of fluoride and concentration in groundwater that would be discharged to the adjacent rivers under natural groundwater flow conditions. The technical discussion below focuses on reducing impacts to the Sandy River because of high agency concern for this river.

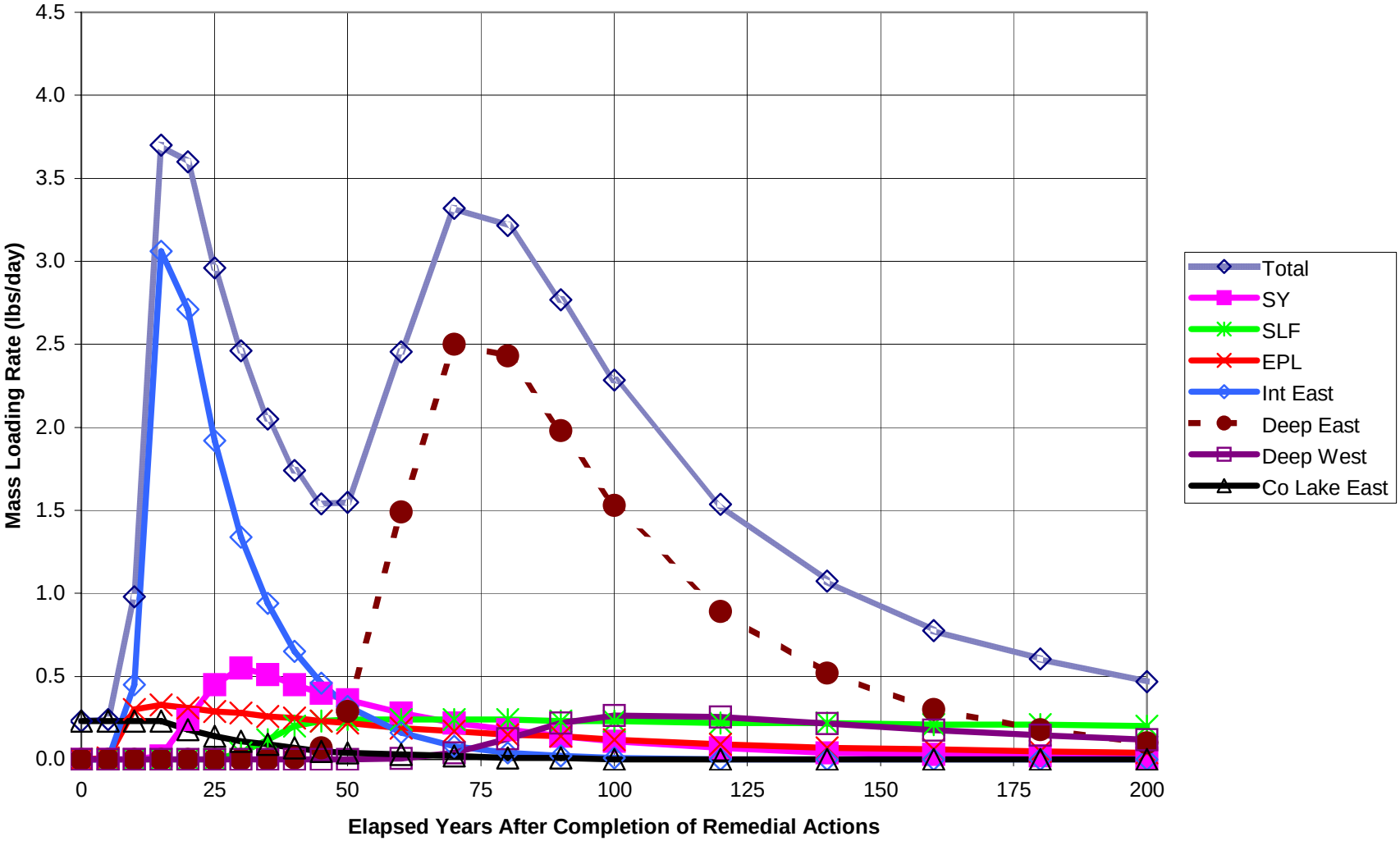
Control of Fluoride Mass Discharge in Groundwater

Control of fluoride mass migration from the Troutdale facility is a key component of the proposed groundwater remedy. As shown in Figure 1, two sources are the primary fluoride contributors to the Sandy River under the assumed no-pumping groundwater alternative; they are the existing fluoride plumes in the intermediate zone (eastern portion) and in the deep zone (eastern portion). The purpose of the PWO action is to reduce the amount of mass currently in the intermediate east and deep east source areas, thereby reducing future mass loading to the Sandy River. The objective of the FE action is prevention of fluoride migration into the intermediate and deep zones during the operation of the production wells.

The effectiveness of PWO on prevention of mass transport to the Sandy River was estimated using groundwater flow model particle tracking. Figure 2 shows the traces of particles that were initiated near the outer edges of the intermediate fluoride plume and traced forward to capture at the production wells. The pumping schedule assumed for this scenario is 400 gallons per minute (gpm) at PW-7 and 800 gpm at PW-8. Model results show that the average travel time for deep-zone particles captured by PW-7 is approximately 1 year; for intermediate-zone particles captured by PW-8, it is approximately 2 years. These results indicate that one pore volume of groundwater will be flushed through the deep zone in approximately one year and through the intermediate zone in approximately 2 years from the start of PWO.

The degree of fluoride mass removal from the intermediate and deep groundwater zones that will arise from PWO can be estimated by using a simple box model (i.e., plug flow pore volume flushing) calculation. In theory, assuming that all fluoride in these zones is dissolved and there is no ongoing source of fluoride to the aquifer, 100 percent of the mass could be removed in one pore volume flush. However, some of the fluoride will actually be retained in the smaller pores within the aquifer soil matrix during the first flush, and these smaller pores will provide a lower concentration secondary source of fluoride to the aquifer

Figure 1 -- Daily Mass Loading Rates to Sandy River from Each Source Area and Plume (No-Pumping Alternative, Reynolds Metals Company, Troutdale, Oregon)



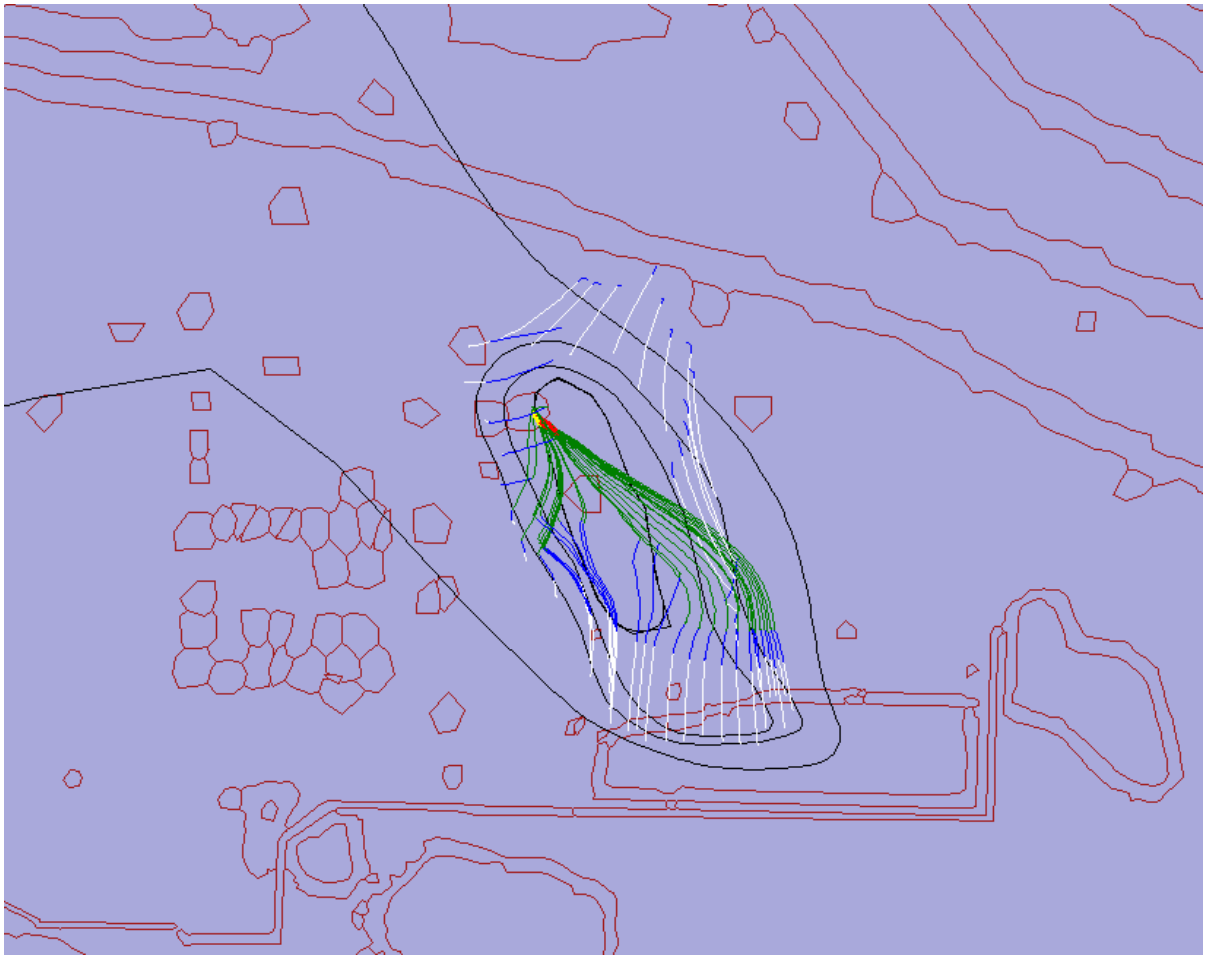


FIGURE 2
Particle Tracking in Run RMC2DB45:
PW-8 at 800 gpm and PW-07 at 400 gpm
Particles tracked forward for 5 years from within the intermediate-zone plume. Effective porosity = 0.20. The black lines are the outlines of the intermediate-zone plume. The white lines are in the lower portion of the intermediate zone (layer 5). Particle traces in blue, green, red, and yellow are in the deep zone (layers 6, 7, 8, and 9, respectively). The figure shows that particles in the southern portion of the plume are captured within 5 years. Particles on the northern edge of the plume are not captured, and some even migrate toward the Sandy River. These particle traces suggest that the eastern edge of the plume may not be as far east as indicated by the black lines.

after one pore volume flush has occurred. Hence, assuming a more modest 50 percent mass removal with each pore volume flush, a box model analysis would predict that about 97 percent of the fluoride mass in the deep zone and 88 percent of the fluoride mass in the intermediate zone would be removed from the aquifer during a 5-year pumping period. However, because of uncertainties in aquifer characteristics such as aquifer flushing efficiency and subsurface geochemistry, a conservative estimate of mass removal would be 50 percent or greater over the entire 5-year pumping period. On the basis of this information, therefore, a 5-year pumping period for PWO and FE is recommended because it achieves 50 percent or greater mass removal from the affected portion of the intermediate and deep aquifer systems.

Recent pumping data suggest that this mass removal estimate is achievable. Between September 2000 and January 2001, PW-8 was pumped at approximately twice the PW-7 rate (see Table 2), and the average blended fluoride concentration from these wells was 1.5 milligrams per liter (mg/L). For the proposed PWO pumping scenario (PW-8 at 800 gpm and PW-7 at 400 gpm), a sustained blended fluoride concentration of 1.5 mg/L would result in removal of approximately 15,800 pounds of fluoride mass from the eastern portion of the intermediate and deep zones during the 5-year PWO pumping period. This is about 50 percent of the fluoride mass that is estimated to be present in the eastern portions of the intermediate- and deep-zone plumes (approximately 30,000 to 35,000 pounds, based on a porosity of 0.25 to 0.30 and the current fluoride concentrations in groundwater as depicted in the FFS [CH2M HILL, June 2000]).

TABLE 2
PRODUCTION WELL MONTHLY VOLUME

Month	PW-3 (million gallons)	PW-7 (million gallons)	PW-8 (million gallons)	PW-10 (million gallons)	Average Fluoride in Tap Water (mg/L)
Dec-99	1.395	19.856	34.8	0	2.05
Jan-00	16.515	34.364	0	0	0.39
Jul-00	8.19	28.272	0	0.135	0.31
Aug-00	8.955	0.326	0	0	0.26
Sep-00	0.004	6.161	11.346	0	2.03
Oct-00	0	18.924	35.626	0	1.9
Nov-00	0	23.782	34.592	0	1.8
Dec-00	19.676	6.351	12.813	0	0.5
Jan-01	1.542	13.029	30.073	0	1.6
Feb-01	0.005	0	27.074	0	2.1
Mar-01	0	0	32.112	0	2.2
Apr-01	0	0.116	6.588	0	2.2
May-01	0	0	2.464	0	2.5
Jun-01	0	0	2.003	0	2.5

TABLE 2
PRODUCTION WELL MONTHLY VOLUME

Month	PW-3 (million gallons)	PW-7 (million gallons)	PW-8 (million gallons)	PW-10 (million gallons)	Average Fluoride in Tap Water (mg/L)
Jul-01	0	0	2.05	0	2.6
Aug-01	0	0	2.161	0	2.7
Sep-01	0	0	2.115	0	2.7
Oct-01	0	0	2.307	0	2.7
Nov-01	0	0	0.795	1.217	1.4
Dec-01	0	0	0	1.514	0.6
Jan-02	0	0	0	1.271	0.3
Feb-02	0.036	0	0.782	0.66	0.9
Mar-02	0	20.057	0	0.861	0.4
Apr-02	0	13.308	16.987	22.921	0.5

In summary, a 5-year pumping period for PWO and FE is recommended because it achieves 50 percent or greater mass removal from the affected portion of the intermediate and deep aquifer systems. This outcome meets the objective of substantially reducing the mass discharge from the intermediate and deep zones to the Sandy River, as shown on Figure 1.

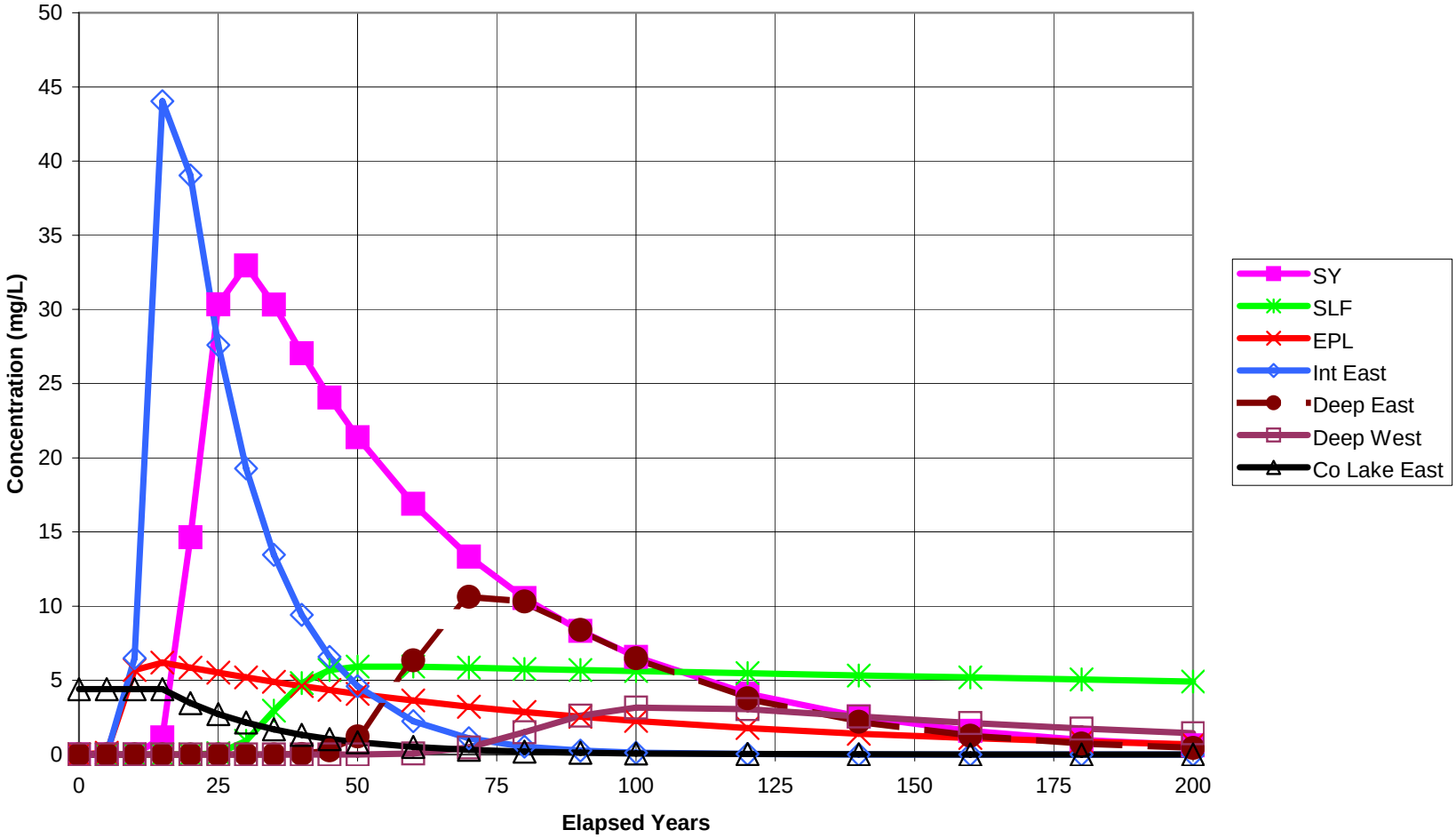
Control of Fluoride Concentration Discharge in Groundwater

Figure 3 shows the predicted fluoride concentrations at the Sandy River that could occur under natural groundwater discharge conditions (that is, the assumed no-pumping groundwater alternative). The scrap yard and intermediate (eastern portion) plume represent the most significant concentration peaks at the river.

In order to achieve a reduction in the concentration of fluoride in groundwater being discharged to the Sandy River, RMC/ALCOA will implement source control actions in the scrap yard (as well as in other locations) in combination with 5 years of PWO and FE. This combination of actions, in conjunction with favorable site conditions, is expected to result in substantial reduction in groundwater fluoride at the river for the following reasons:

- The proposed scrap yard source control action will remove fluoride-containing source material and ultimately reduce the amount of fluoride leaching from the surficial sands and silt into the UGS.
- The proposed FE system will remove dissolved fluoride in the UGS beneath the scrap yard and will increase vertical hydraulic gradients within the surficial sands and silt zones, accelerating flushing/leaching of fluoride from these shallow zones. Note: The current fluoride distribution in the scrap yard, along with the subsurface soil lithology information, indicates that a greater degree of hydraulic connection occurs between the

Figure 3 - Fluoride Concentrations In Groundwater At Sandy River By Source Area and Plume (No-Pumping Alternative, Reynolds Metals Company, Troutdale, Oregon)



shallow and deeper zones beneath the scrap yard than at other locations in the South Plant area. The low-permeability silt unit is as little as 8 feet thick at the scrap yard (thinner than at other locations in the South Plant area), and elevated fluoride concentrations in the UGS correlate to the location of this thin silt area.

- Following termination of PWO activities, pumping influences will no longer induce migration from the UGS into deeper zones, and vertical hydraulic gradients in the shallow zones will be reduced. The smaller vertical gradients will result in lower vertical migration rates within the shallow zones and, ultimately, will result in lower fluoride concentrations in groundwater beneath the scrap yard.

In addition, available data indicate that fluoride concentrations in groundwater downgradient of the scrap yard are higher than those measured in groundwater directly below the scrap yard. This suggests that scrap yard impacts on UGS groundwater have reduced over time. This improvement in UGS groundwater quality may be the result of rapid dissolution of more soluble forms of fluoride (such as sodium fluoride [NaF] and aluminum fluoride [AlF]), leaving less soluble forms behind in the existing waste. Weathering processes that reduce the availability of leachable fluoride may also be contributing to these groundwater quality improvements. Excavation of waste material from the scrap yard will remove soluble fluoride that exists in the waste and will result in further improvement in UGS groundwater quality.

Groundwater Performance Measurement

The proposed monitoring program outlined in this memorandum was designed to be performed for the first 2 years of the groundwater remedy operation. After the first 2 years of pumping, the performance monitoring data will be reviewed. On the basis of the monitoring results, changes to the performance monitoring program for the remaining 3 years of groundwater pumping will be discussed with agency personnel. A long-term monitoring program for evaluation of RAO achievement will be developed after PWO and FE cease.

The remedial actions identified above will contribute to improvement of site groundwater on both an individual source area basis and sitewide. Source control actions are most directly related to improvement of groundwater quality near the individual source areas. Production well optimization and focused extraction of groundwater have positive impacts on groundwater quality throughout the aquifer, both near and distant from individual sources.

Monitoring the proposed remedies' effects on mass removal and groundwater quality is complex because of spatial variations in nature and extent, differences in source area impacts on groundwater, the presence of multiple groundwater zones showing varying degrees of impact, and differing timeframes needed to achieve anticipated results. Because of these issues, it is proposed that both capture zone monitoring and water quality criteria be used to evaluate the effectiveness of site remediation toward achieving the groundwater RAOs. The proposed use of these criteria is summarized in Table 3 for the following areas:

- North Plant (Company Lake and north landfill)
- South Plant (scrap yard and east potliner)

TABLE 3
GROUNDWATER PERFORMANCE CRITERIA

Source Area/Remediation	CAPTURE ZONE MONITORING		WATER QUALITY STANDARDS		RAO Achievement
	Performance Criteria	Demonstration	Performance Criteria	Demonstration	
Company Lake/North Landfill (CL/NLF) Source Control Process residue removal Groundwater Remediation Pore flushing	NA	NA	Source removal and continued groundwater flushing will reduce the extent of groundwater in the UGS and intermediate zones with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction annually based on time/concentration plots from measured fluoride concentrations.	RAO 1 - Process residue removal will reduce/eliminate constituent leaching to groundwater. In the longer term (10 to 15 years), offsite migration will be reduced due to natural flushing of the aquifer. RAO 2 - Process residue removal will eliminate mass loading to the UGS and intermediate groundwater zones. Effects on the deep zone fluoride will occur as entrained fluoride is removed by PWO implementation. RAO 3 - Process residue removal will result in restoration of groundwater north of the dike to the MCL.
South Plant (Scrap Yard and East Potliner) Source Control 1) Waste removal at scrap yard. 2) Waste removal at east potliner is completed. Groundwater Remediation Focused Extraction	Focused extraction prevents downward migration of groundwater with fluoride concentrations above the MCL.	Evaluate capture based on (1) groundwater elevation contour maps constructed from measured water level data, and (2) water quality and flow rate measured for the FE wells.	Source removal, focused extraction, and continued groundwater flushing will reduce the extent of groundwater in the UGS with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction semiannually based on time/concentration plots constructed from measured fluoride concentrations.	RAO 1 - Waste removal will reduce/eliminate constituent leaching to groundwater and subsequent offsite migration of constituents to the Sandy River. RAO 2 - Waste removal at SY and EPL will reduce mass loading to the UGS. Operation of the FE system prevents downward mass loading of fluoride from the UGS to the intermediate and deep zones during implementation of PWO. RAO 3 - Waste removal reduces COPC extent and concentration (restores beneficial use).

TABLE 3
GROUNDWATER PERFORMANCE CRITERIA

Source Area/Remediation	CAPTURE ZONE MONITORING		WATER QUALITY STANDARDS		RAO Achievement
	Performance Criteria	Demonstration	Performance Criteria	Demonstration	
South Landfill Source Control Waste removal Groundwater Remediation Production Well Optimization (PWO)	NA	NA	Source removal and continued groundwater flushing will reduce the extent of groundwater in the UGS with fluoride concentrations greater than the MCL.	Evaluate fluoride concentration reduction annually based on time/concentration plots from measured fluoride concentrations.	RAO 1 - Waste removal will reduce/eliminate constituent leaching to groundwater and subsequent offsite migration of constituents to the rivers. RAO 2 - Waste removal at SLF will reduce mass loading to the UGS. RAO 3 - Waste removal reduces COPC extent and concentration (restores beneficial use).
Intermediate/Deep Zones Source Control Scrap yard waste removal Groundwater Remediation PWO	PWO captures groundwater with fluoride concentrations above the MCL.	Evaluate capture based on (1) groundwater elevation contour maps constructed from measured water level data, and (2) water quality and flow rate measured for the production wells.	PWO reduces the extent of groundwater in the intermediate/deep zones with fluoride concentrations greater than the MCL.	Evaluate fluoride concentrations annually based on time/concentration plots constructed from measured fluoride concentrations.	RAO 1 - PWO removes fluoride mass from the intermediate and deep groundwater zones, preventing horizontal migration to the rivers. RAO 2 - Waste removal at the scrap yard and operation of the focused extraction system while PWO is being implemented will reduce mass loading to the intermediate and deep zones. RAO 3 - PWO reduces COPC extent and concentration (restores beneficial use).

RAO No. 1 - Reduce/control offsite migration.
RAO No. 2 - Reduce mass loading to UGS, intermediate, and deep zones.
RAO No. 3 - Restore groundwater beneficial use.

- South landfill
- Intermediate and deep groundwater

The ability of remedy implementation to achieve each of the three groundwater RAOs is summarized in Table 3 and discussed below.

North Plant

The North Plant is defined as the area of affected groundwater north of the U.S. Army Corps of Engineers (COE) dike near Company Lake and north landfill. Although groundwater affected by the leaching of fluoride from Company Lake flows both north and south from the lake, this section focuses only on the northerly component of this flow. The southerly component of this flow is addressed below under Intermediate and Deep Groundwater. This distinction has been made because the southerly flow component affects primarily the intermediate and deep groundwater zones and will be addressed, in large part, by implementation of PWO.

The northerly component of groundwater flow from Company Lake and north landfill will not be affected by either PWO or FE. The combination of source control actions planned for Company Lake/north landfill and the natural flushing of the fluoride plume will achieve groundwater remediation in the North Plant area. As noted in *Baseline Risk Assessment: Part 2–Groundwater* (CH2M HILL, July 1999), offsite migration of groundwater from the plant site is not expected to pose a risk to ecological receptors in either the Columbia or the Sandy River.

Capture Zone Performance Criteria

Groundwater remediation in the North Plant will be achieved through implementation of source control actions only. Operation of the PWO and FE well system will not greatly influence groundwater response in this portion of the site. As a result, capture zone criteria are not proposed for use in the North Plant area.

Water Quality Performance Criteria

Water quality performance criteria for the North Plant are dependent on the expected effectiveness of the proposed source control actions for Company Lake and north landfill. As discussed in the FFS, Appendix A, Section A.6.2, following removal of process residue from Company Lake and removal of debris from the east side of north landfill, groundwater in a substantial portion of the area occupied by the fluoride plume north of the dike (including the offsite areas) will be flushed with clean water within a 10-year period. Although it is possible that the soil forming the aquifer matrix could leach fluoride into the clean water, it is currently anticipated that this process will not substantially prolong the groundwater cleanup times north and west of Company Lake. This means that wells closest to the source areas should show fairly rapid response to the source control actions and that more distant wells would be expected to respond in a similar manner but at a later date. The following wells are proposed to be used for North Plant performance monitoring and compliance with water quality criteria:

- MW09-030
- MW27-045

- MW27-081
- MW31-095
- MW52-045
- MW53-034

Demonstration of compliance with this metric will involve plotting fluoride time concentration trends for these monitoring wells. Groundwater elevation data will also be collected during sampling (at these and other wells onsite) to prepare water level contour maps and to verify groundwater flow toward these monitoring wells. On the basis of this information, only limited water quality monitoring is needed to measure the performance of the source control actions. Annual groundwater sampling for fluoride in selected monitoring wells is proposed as the water quality criterion.

RAO Achievement

Source control actions in Company Lake and north landfill achieve RAO 1 by eliminating the process residue that originally caused fluoride migration into the UGS and intermediate groundwater zones. It is expected that substantial reduction in offsite constituent migration in groundwater will be achieved as a result of these actions in about 10 to 15 years after implementation. Removal of the process residue also satisfies RAO 2 by eliminating the mass loading from these source areas to groundwater. Satisfying RAO 1 and 2 is expected to achieve RAO 3 and, ultimately, to restore groundwater to its beneficial use criteria.

South Plant

The South Plant is defined as the area of affected groundwater near the scrap yard and east potliner areas. An early action was completed in east potliner in 1996. As a result, only scrap yard (SY) source control actions are proposed for the South Plant.

Focused extraction is the proposed groundwater remedy for the South Plant area. Groundwater model simulations predict that FE will capture fluoride containing groundwater in the South Plant UGS, effectively preventing offsite downward migration into the intermediate and deep groundwater zones during the period of PWO operation. Groundwater modeling suggests that affected groundwater beneath the SLF is not directly influenced by FE (in the short term); therefore, performance measurement for the SLF is discussed separately in a later subsection of this memorandum, under South Landfill.

Capture Zone Performance Criteria

Capture zone performance criteria for the South Plant focus on preventing groundwater with fluoride concentrations above the maximum contaminant level (MCL) from migrating into the intermediate and deep groundwater zones during implementation of PWO. Achievement of groundwater capture will be demonstrated through the use of contour maps, site groundwater flow modeling results, and water quality sampling in the FE wells.

Groundwater contour maps will be constructed using measured water elevation data. In conjunction with the site groundwater flow model results, these contour maps will demonstrate that the FE system is capturing affected groundwater. Groundwater elevation data will be obtained from all existing UGS monitoring wells and piezometers in the South Plant area on a quarterly basis for the first 2 years of operation in order to develop the

contour maps. The frequency of water level monitoring will be reassessed after the initial 2-year period.

Fluoride capture and mass removal will be determined through periodic water quality sampling and flow measurement. Water quality samples will be collected from each FE well at least twice yearly in conjunction with other water quality data being collected at the plant. The specific method to be used for flow rate measurement will be determined during FE system design. A likely outcome in system design would be continuous flow rate measurement of the combined output of both FE wells supplemented by record of the pump motor operation (in hours) at each well.

Water Quality Performance Criteria

The objective of the proposed water quality performance criteria is the reduction of the extent of groundwater in the UGS with fluoride concentrations greater than the MCL. To demonstrate compliance with the water quality criteria, fluoride concentration trends at selected wells will be constructed from groundwater sampling results. The proposed groundwater sampling frequency is semiannual for the first two years. After the initial 2-year period, the groundwater sampling frequency will be reassessed. Adjustments to the sampling frequency may be required to better match the adjusted FE pumping schedule and the resulting concentration responses observed in groundwater. Groundwater elevation data will also be collected during sampling (at these and other wells onsite) to prepare water level contour maps and to verify groundwater flow toward these monitoring wells.

The following wells are proposed to be used for performance monitoring and compliance with the water quality criteria:

- Install two new monitoring wells
- MW11-017
- MW13-022
- MW25-035
- MW33-033
- MW34-038
- MW35-038

RAO Achievement

Source control and the operation of the FE groundwater remedy in the South Plant area will ultimately meet all three groundwater RAOs. Waste removal will reduce and eventually eliminate constituent leaching and subsequent migration of constituents to the Sandy River (RAO 1). Waste removal in combination with FE will reduce mass loading to the UGS, intermediate, and deep groundwater zones (RAO 2). Satisfying RAO 1 and 2 is expected to achieve RAO 3 and, ultimately, to restore groundwater to its beneficial use criteria.

South Landfill

The south landfill is discussed separately from the South Plant area because of the different groundwater remedies involved. As discussed in the FFS, available data indicate that the south landfill is not a significant source of constituent migration to the UGS, intermediate, or deep groundwater zone. Low soil permeability in the silt unit limits the ability of fluoride

to migrate from the silt to the underlying UGS. The primary remedial emphasis in the south landfill area, therefore, is source removal.

Capture Zone Performance Criteria

Groundwater remediation in the south landfill area will be achieved through implementation of source control actions only. Operation of the PWO and FE well system will not greatly influence groundwater response in this portion of the site. As a result, capture zone criteria are not proposed for use in the south landfill area.

Water Quality Performance Criteria

The objective of the proposed SLF quality performance criteria is the reduction of the extent of groundwater in the UGS with fluoride concentrations greater than the MCL. To demonstrate compliance with the water quality criteria, fluoride concentration trends at selected wells will be constructed from groundwater sampling results. The proposed groundwater sampling frequency is annually.

The following wells are proposed to be used for performance monitoring and compliance with the water quality criteria:

- MW19-013
- MW26-012
- MW26-050
- MW54-050

RAO Achievement

As previously noted, SLF is not a groundwater remediation focus area. However, waste removal will reduce and eventually eliminate constituent leaching to groundwater and subsequent offsite constituent (RAO 1). Waste removal will also reduce mass loading to the UGS, intermediate, and deep groundwater zones (RAO 2). Satisfying RAO 1 and 2 is expected to achieve RAO 3 and, ultimately, to restore groundwater to its beneficial use criteria.

Intermediate and Deep Groundwater

The intermediate and deep groundwater zones are defined as areas of affected groundwater in the central portion of the site where fluoride concentrations exceed the MCL. This area includes the southerly component of groundwater flow from Company Lake (see North Plant discussion, above). As discussed in the FFS, the primary source of fluoride to intermediate and deep zone groundwater is the UGS located beneath the scrap yard and south of Company Lake. The migration of dissolved fluoride from these areas into the intermediate and deep zones is thought to be the result of historical production well pumping influences. The PWO groundwater remedy is intended to remove fluoride mass and prevent offsite migration of the fluoride currently in the intermediate and deep zones.

Capture Zone Performance Criteria

The capture zone performance criteria for the intermediate and deep zones focus on preventing groundwater with fluoride concentrations above the MCL from migrating offsite to the rivers. Capture of affected groundwater will be accomplished through the operation

of the production wells. Achievement of groundwater capture will be demonstrated through the use of contour maps, site groundwater flow modeling results, and water quality sampling in production wells PW-07 and PW-08.

Groundwater elevation data will be obtained from all existing UGS, intermediate, and deep monitoring wells and piezometers in the central plant area on a semiannual basis for the first two years of operation in order to develop the contour maps and assess compliance. The frequency of water level monitoring will be reassessed after the initial 2-year period.

Fluoride capture and mass removal will be determined through periodic water quality sampling and flow measurement. Water quality samples will be collected from plant process water supply system in a manner that is representative of the total production well output. The exact measurement location will be determined by RMC/ALCOA consistent with plant requirements for NPDES monitoring. Combined production well water quality samples will be obtained at least twice yearly in conjunction with other water quality data being collected at the plant. Flow measurement data will also be obtained consistent with plant NPDES monitoring requirements. The approach to be used for production well flow rate measurement will be determined during remedial design of the PWO system.

Water Quality Performance Criteria

The objective of the proposed intermediate and deep zone water quality performance criteria is the reduction of the extent of groundwater in these zones with fluoride concentrations greater than the MCL. Similar to the water quality performance criteria discussed previously, compliance will be assessed using fluoride concentration trend plots developed for selected wells. The proposed groundwater sampling frequency at these wells is annually.

The following wells are proposed to be used for performance monitoring and compliance with the water quality criteria:

- MW29-090
- MW29-179
- MW31-095
- MW33-095
- MW33-165
- MW48-165

RAO Achievement

The operation of the PWO groundwater remedy will achieve groundwater RAOs 1 and 3 in the intermediate and deep zones. Achievement of groundwater RAO 2 will be accomplished through the waste removal activities at the scrap yard.

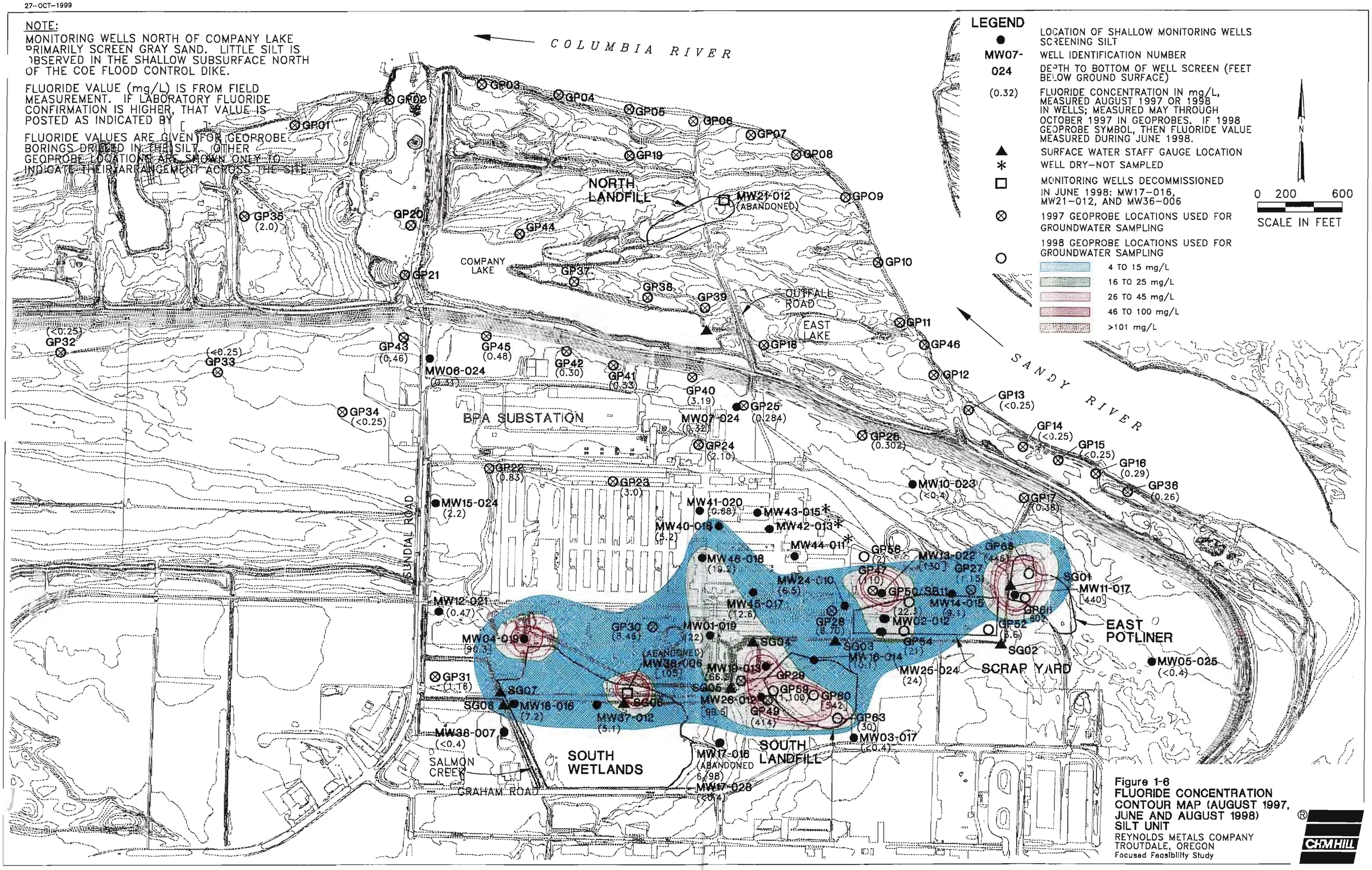
ATTACHMENT 2
Fluoride in Groundwater Figures

ALR COLOR6D.DWG
27-OCT-1999

NOTE:
MONITORING WELLS NORTH OF COMPANY LAKE PRIMARILY SCREEN GRAY SAND. LITTLE SILT IS OBSERVED IN THE SHALLOW SUBSURFACE NORTH OF THE COE FLOOD CONTROL DIKE.

FLUORIDE VALUE (mg/L) IS FROM FIELD MEASUREMENT. IF LABORATORY FLUORIDE CONFIRMATION IS HIGHER, THAT VALUE IS POSTED AS INDICATED BY [ ].

FLUORIDE VALUES ARE GIVEN FOR GEOPROBE BORINGS DRILLED IN THE SILT. OTHER GEOPROBE LOCATIONS ARE SHOWN ONLY TO INDICATE THEIR ARRANGEMENT ACROSS THE SITE.



LEGEND

- ● LOCATION OF SHALLOW MONITORING WELLS SCREENING SILT
- MW07-024 WELL IDENTIFICATION NUMBER
- 024 DEPTH TO BOTTOM OF WELL SCREEN (FEET BELOW GROUND SURFACE)
- (0.32) FLUORIDE CONCENTRATION IN mg/L, MEASURED AUGUST 1997 OR 1998 IN WELLS; MEASURED MAY THROUGH OCTOBER 1997 IN GEOPROBES. IF 1998 GEOPROBE SYMBOL, THEN FLUORIDE VALUE MEASURED DURING JUNE 1998.
- ▲ SURFACE WATER STAFF GAUGE LOCATION
- * WELL DRY–NOT SAMPLED
- □ MONITORING WELLS DECOMMISSIONED IN JUNE 1998: MW17–016, MW21–012, AND MW36–006
- ⊗ 1997 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING
- ○ 1998 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING

4 TO 15 mg/L
16 TO 25 mg/L
26 TO 45 mg/L
46 TO 100 mg/L
>101 mg/L

N

0 200 600
SCALE IN FEET

Figure 1-6
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998) SILT UNIT
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2M HILL

COLOR6D.DWG

ALR COLOR2D.DWG
27-OCT-1999

NOTE:
FLUORIDE VALUE (mg/L) IS FROM FIELD MEASUREMENT. IF LABORATORY FLUORIDE CONFIRMATION IS HIGHER, THAT VALUE IS POSTED AS INDICATED BY [ ].

FLUORIDE VALUES ARE GIVEN FOR GEOPROBE BORINGS DRILLED IN THE UPPER GRAY SAND. OTHER GEOPROBE LOCATIONS ARE SHOWN ONLY TO INDICATE THEIR ARRANGEMENT ACROSS THE SITE.

COLUMBIA RIVER

SANDY RIVER

NORTH LANDFILL

COMPANY LAKE

BPA SUBSTATION

OUTFALL ROAD

EAST LAKE

DIKE

LINDIAL ROAD

SOUTH WETLANDS

GRAHAM ROAD

EAST POTLINER

SCRAPYARD

SOUTH LANDFILL

GP02 (3.09)
GP03 (12.0)
MW52-045 (19.3)
GP04 (13.0)
MW08-027 (2.8)
GP05 (0.77)
GP06 (0.48)
GP07 (0.64)
GP08 (0.29)
GP01 (1.24)
GP19 (4.60)
MW30-030 (0.85)
MW09-030 (31.50)
MW27-045 (20.2)
MW23-025 (3.1)
MW21-026 (12.1)
GP09 (0.35)
(18.60) GP20
(15.90) GP44
GP35 (2.8)
MW22-027 (13.6)
GP10 (0.27)
GP21 (12.40)
(24.40) GP37
MW20-026 (5.0)
(16.80) GP38
(24.50) GP39
GP11 (4.36)
(<0.25) GP32
MW31-034 (<0.4)
GP43 (0.70)
(<0.25) GP33
MW06-025
GP45
GP42 (0.30)
GP41 (1.27)
GP18 (2.50)
MW53-034 (3.04)
GP46 (2.49)
GP12 (<0.25)
MW29-033 (0.54)
GP40 (9.45)
MW07-024
GP25 (0.625)
GP34 (<0.25)
GP13 (<0.25)
GP14 (<0.25)
GP15 (<0.25)
GP26 (0.207)
GP16 (0.39)
GP24 (0.66)
GP22 (0.35)
MW32-040
GP23 (0.84) (0.30)
GP36 (0.3)
MW10-023
GP17 (0.39)
MW15-024
MW41-033 (0.59)
MW33-033 (0.25)
MW43-027 (4.2)
MW40-030 (1.4)
MW42-027 (22.0)
MW34-038 (5.4)
MW46-043 (0.84)
MW44-027 (3.1)
GP56 (1.31)
MW35-038 (<0.4)
GP65 (3.13)
MW24-010
GP50/56 (50.8)
GP27 (1.05)
GP66 (0.70)
MW16-042 (0.7)
GP28 (1.8)
MW12-021
GP47 (0.66)
MW02-034 (6.0)
MW25-024
GP52 (<0.4)
MW25-035 (0.25)
GP54 (0.54)
MW05-025
MW18-014
MW19-013
GP31 (0.256)
GP29
GP59 (61)
GP60 (2)
MW36-026
MW18-031
MW18-016 (6.34)
MW37-030
MW37-012 (0.33)
GP49 (0.51)
GP63 (1.6)
MW03-017
MW38-035
MW38-007 (<0.40)
MW17-016
MW17-028

LEGEND
- LOCATION OF SHALLOW MONITORING WELLS SCREENING UPPER GRAY SAND
- MW08- WELL IDENTIFICATION NUMBER
- 027 DEPTH TO BOTTOM OF WELL SCREEN (FEET BELOW GROUND SURFACE)
- (2.8) FLUORIDE CONCENTRATION IN mg/L, MEASURED AUGUST 1997 OR 1998 IN WELLS; MEASURED MAY – OCTOBER 1997 IN GEOPROBES; FOR 1998 GEOPROBE LOCATIONS FLUORIDE MEASURED DURING JUNE 1998.
- 1997 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING
- 1998 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING
- 4 TO 15 mg/L
- 16 TO 25 mg/L
- 26 TO 45 mg/L
- 46 TO 100 mg/L
- >101 mg/L

N

0 200 600
SCALE IN FEET

Figure 1-7
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998) UPPER GRAY SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2M HILL

COLOR2D.DWG

ALR COLOR5E.DWG
27-OCT-1999

NOTE:
INTERMEDIATE-DEPTH MONITORING WELLS ARE GENERALLY SCREENED IN GRAY UNCONSOLIDATED SAND 80 TO 100 FEET BELOW GROUND SURFACE.

FLUORIDE VALUE (mg/L) IS FROM FIELD MEASUREMENT. IF LABORATORY FLUORIDE CONFIRMATION IS HIGHER, THAT VALUE IS POSTED AS INDICATED BY [ ].

FLUORIDE VALUES ARE GIVEN FOR GEOPROBE BORINGS DRILLED IN INTERMEDIATE-DEPTH SAND. OTHER GEOPROBE LOCATIONS ARE SHOWN ONLY TO INDICATE THEIR ARRANGEMENT ACROSS THE SITE.

* TO TARGET AN INTERVAL SUSPECTED OF BEING CONTAMINATED, MW08-127 WAS SCREENED APPROXIMATELY 50 FEET DEEPER THAN NEARBY INTERMEDIATE-DEPTH WELLS. THEREFORE, WATER LEVEL ELEVATIONS AND CONCENTRATIONS AT THIS LOCATION MAY NOT BE COMPARABLE WITH THOSE AT NEARBY LOCATIONS.

LEGEND

- ● INTERMEDIATE-DEPTH MONITORING WELL LOCATION
- MW08- WELL IDENTIFICATION NUMBER
- 127 DEPTH TO BOTTOM OF WELL SCREEN (FEET BELOW GROUND SURFACE)
- (0.32) FLUORIDE CONCENTRATION IN mg/L, MEASURED AUGUST 1997 OR 1998 IN WELLS; MEASURED MAY – OCTOBER 1997 IN GEOPROBES. FOR 1998 GEOPROBE LOCATIONS, FLUORIDE MEASURED DURING JUNE 1998.
- ⊗ 1997 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING
- ○ 1998 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING

4 TO 15 mg/L
16 TO 25 mg/L
26 TO 45 mg/L
46 TO 100 mg/L
>101 mg/L

N

0 200 600
SCALE IN FEET

COLUMBIA RIVER
SANDY RIVER
NORTH LANDFILL
COMPANY LAKE
EAST LAKE
OUTFALL ROAD
DIKE
BPA SUBSTATION
SUNDIAL ROAD
SOUTH WETLANDS
GRAHAM ROAD
SCRAPYARD
EAST POTLINER
SOUTH LANDFILL

GP03 (4.00)
GP04 (2.40)
GP05
GP06
GP07
GP08 (0.33)
GP09 (0.25)
GP10
GP11 (2.61)
GP12 (<0.25)
GP13 (<0.25)
GP14 (<0.25)
GP15 (<0.25)
GP16 (0.36)
GP17 (0.38)
GP18 (7.35)
GP19 (0.95)
GP20 (15.10)
GP21 (8.94)
GP22 (0.88)
GP23 (6.76)
GP24 (4.71)
GP25 (8.50)
GP26 (1.03)
GP27 (.27)
GP28 (1.09)
GP29
GP30 (1.54)
GP31
GP32 (<0.25)
GP33 (<0.25)
GP34 (<0.25)
GP35 (2.0)
GP36 (0.39)
GP37
GP38
GP39
GP40 (4.64)
GP41 (3.14)
GP42 (5.22)
GP43
GP44
GP45 (20.5)
GP46
GP47 (41.2)
GP48
GP49
GP50/SB11 (31.4)

MW01-089 (<0.4)
MW02-127 (0.32) *
MW03-098 (0.57)
MW06-094 (4.6)
MW10-090 (<0.4)
MW12-092 (<0.4)
MW15-086 (<0.4)
MW21-063 (0.27)
MW27-081 (22.5)
MW28-090 (15)
MW30-100 (0.85)
MW31-095 (21)
MW32-095 (0.61)
MW33-095 (87.4)
MW39-095 (<0.4)
MW47-094 (0.26)
MW48-055 (<0.4)
MW49-096 (<0.4)
MW50-094 (<0.4)

Figure 1-8
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998), INTERMEDIATE-DEPTH SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL

COLOR5E.DWG

ALR COLOR4D.DWG
27-OCT-1999

NOTE:
DEEP MONITORING WELLS ARE SCREENED 150 TO 180 FEET BELOW GROUND SURFACE. SCREENED MATERIALS ARE PRIMARILY GRAY SAND TO THE SOUTH, SAND AND GRAVEL TO THE NORTH.

FLUORIDE VALUE (mg/L) IS FROM FIELD MEASUREMENT. IF LABORATORY FLUORIDE CONFIRMATION IS HIGHER, THAT VALUE IS POSTED AS INDICATED BY [ ].

FLUORIDE VALUES ARE GIVEN FOR GEOPROBE BORINGS DRILLED IN THE DEEP SAND. OTHER GEOPROBE LOCATIONS ARE SHOWN ONLY TO INDICATE THEIR ARRANGEMENT ACROSS THE SITE.

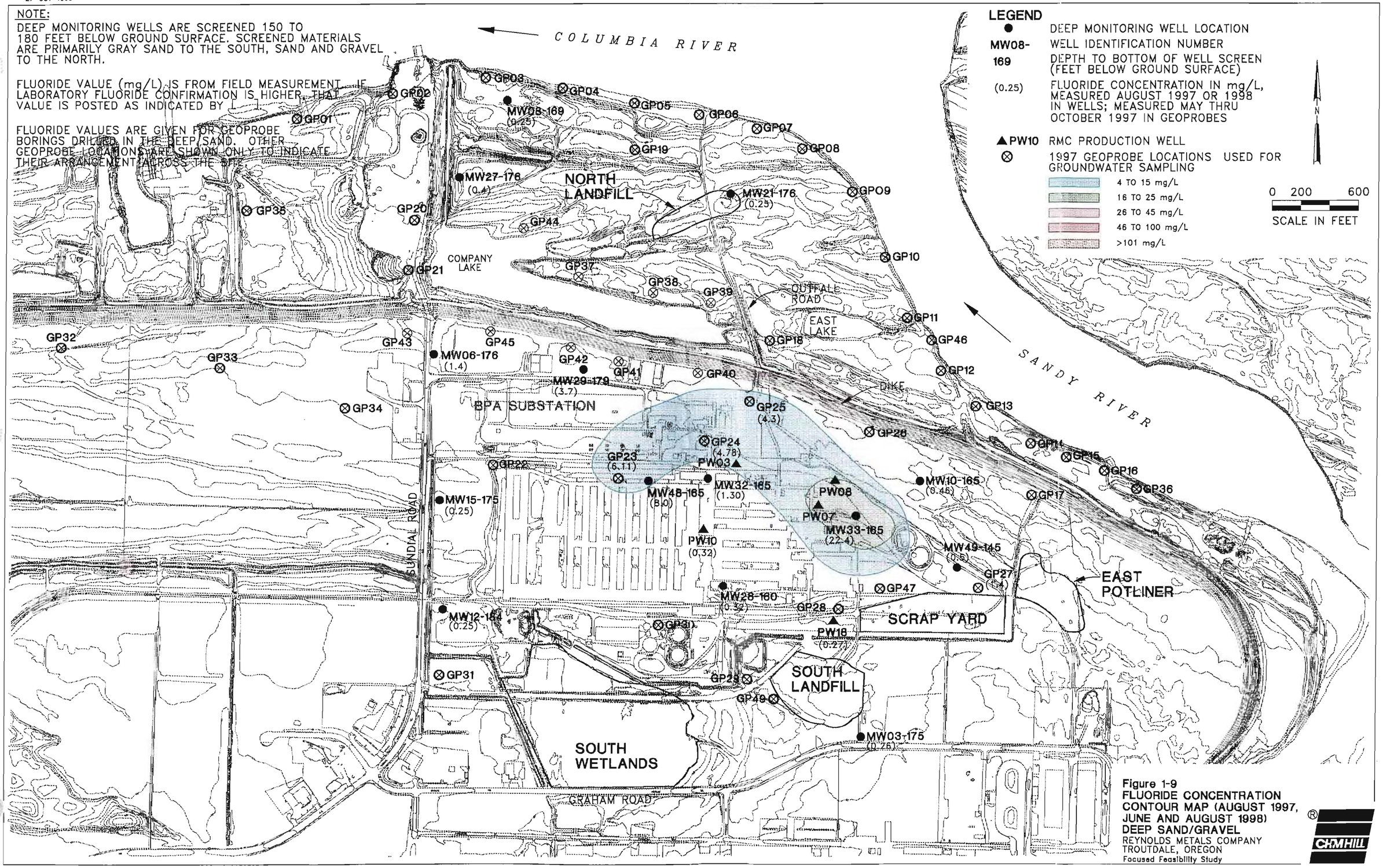


Figure 1-9
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998) DEEP SAND/GRAVEL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL

COLOR4D.DWG

27-OCT-1999

COMPANY LAKE OUTFALL

COLUMBIA RIVER

GRESHAM SAND AND GRAVEL WELL

SUNDIAL MARINE WELL

NORTH LANDFILL

OUTFALL ROAD

COMPANY LAKE

EAST LAKE

MW53-034

SANDY RIVER

FACILITY ENTRANCE

FAIRVIEW FARMS

POTLINES

MINERAL OIL SPILL

U.S. ARMY CORPS OF ENGINEERS

BAKEHOUSE

PW08

MW10

BAKEHOUSE SUMPS

PW07

DIKE

SUNDIAL ROAD

CASTHOUSE

PW03

PW10

GARBON PLANT

SALMON CREEK

PCB SPILL AREA

WEST DRAINAGE

SOUTH DITCH

SCRAP YARD

EAST POTLINER

BUILDING 97 SUBAREA

WASTEWATER TREATMENT PLANT

SOUTH LANDFILL

SOUTH DITCH

CRYOLITE PONDS

SALMON CREEK

SOUTH WETLANDS

GRAHAM ROAD

LEGEND

- ●MW08 SINGLE GROUNDWATER MONITORING WELL LOCATION
- ■MW21 GROUNDWATER MONITORING WELL LOCATION CLUSTER
- —— 8 CROSS SECTION LOCATION FOR SOIL
- ---8 CROSS SECTION LOCATION FOR GROUNDWATER

NOTE: FAIRVIEW FARMS AREA EXTENDS FARTHER TO THE WEST THAN IS SHOWN HERE.

N

0 200 600 1000

APPROXIMATE SCALE IN FEET

Figure 1-13
CROSS SECTION LOCATIONS FOR SCRAP YARD, EAST POTLINER, AND SOUTH LANDFILL GROUNDWATER AND SOIL DATA
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL

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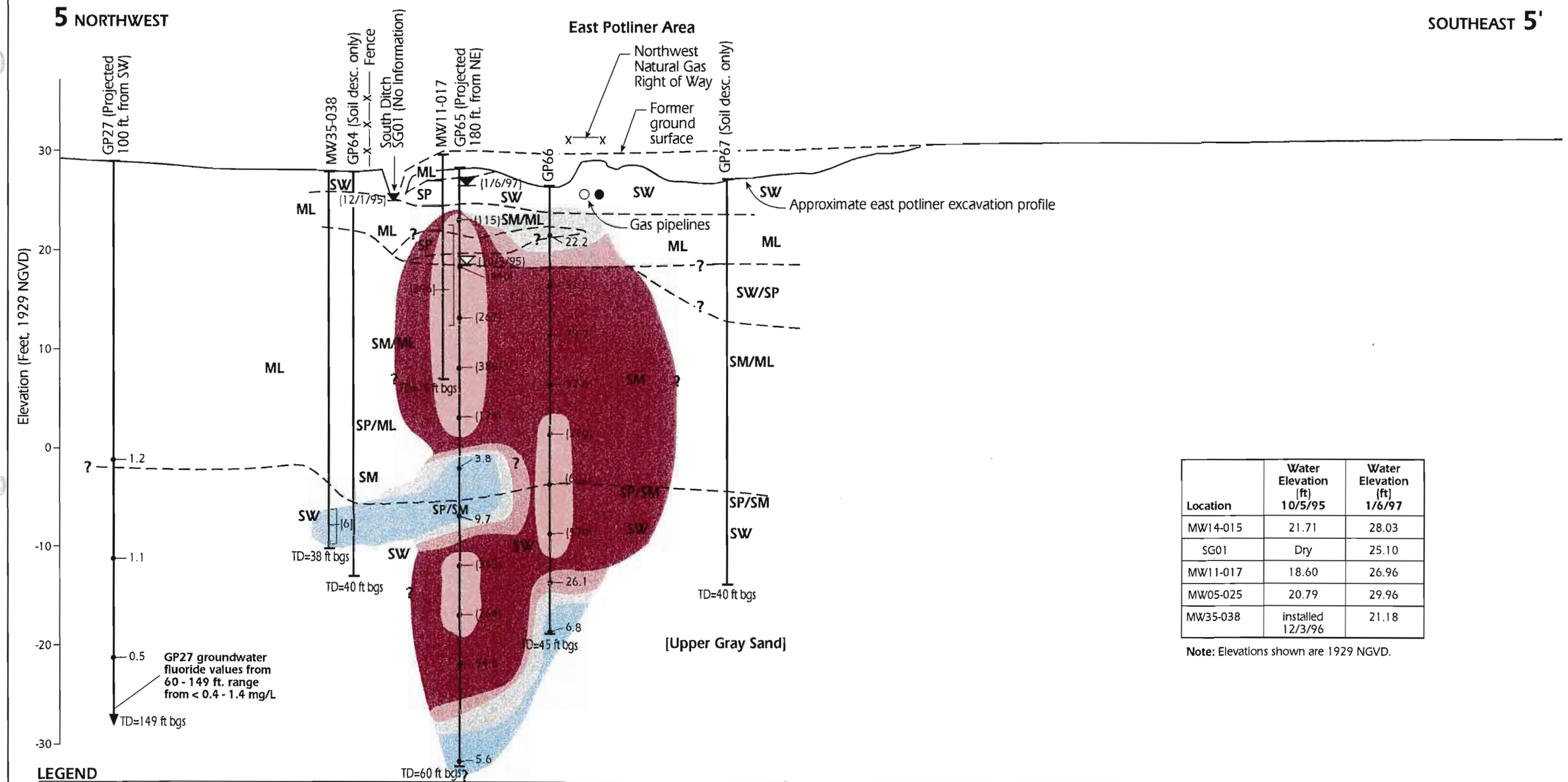

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW14-015	21.71	28.03
SG01	Dry	25.10
MW11-017	18.60	26.96
MW05-025	20.79	29.96
MW35-038	installed 12/3/96	21.18

Note: Elevations shown are 1929 NGVD.

LEGEND

- MW09 ← Monitoring well number
- Cased interval
- Screened interval
- TD=16 ft bgs ← Total depth
- GP66 ← Geoprobe ID number (Locations are approximate)
- (440) Field fluoride value, mg/L
- TD=45 ft bgs ← Total Geoprobe depth in feet below (approx.) ground surface elevation
- 12/1/95 or 1/6/97 water level elevation
- 10/5/95 water level elevation
- [ ] Laboratory fluoride values (mg/L) (August 1997 quarterly sampling)
- ( ) Laboratory fluoride value (mg/L) (June 1998 field sampling)
- **ML** = Silt
- **SP** = Poorly graded sand
- **SW** = Well-graded sand
- **SM** = Silty sand

0 50 100 Feet
Approximate Horizontal Scale

0 5 10 Feet
Approximate Vertical Scale

Vertical exaggeration = 10x

Fluoride Concentration Ranges

- 4-15 mg/L
- 16-25 mg/L
- 26-45 mg/L
- 46-100 mg/L
- 101-500 mg/L
- 501-1,100 mg/L

Figure 1-16
EAST POTLINER AREA CROSS SECTION 5-5' VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL

WEST **6** — **6'** EAST

Elevation (Feet, 1929 NGVD)

MW24-010 (Projected 40 ft. from N) | GP47 (Projected 140 ft. from N) | MW13 -022(Projected 120 ft. from N) | GP55* | GP50/SB11 (Projected 60 ft. from N) | Scrap Yard | MW14-015 (Projected 120 ft. from N) | GP27 (Projected 160 ft. from N) | GP51* | MW35-038 (Projected 180 ft. from N) | Fence | South Ditch SG02 | MW11-017 (Projected 120 ft. from N)

SP | ML | SW | Fill | SW/SM | ML | SP/SM | SP/ML | SM | SP/SW

(1/6/97) (10/5/95) [6.5] [396] [9.1] [1.2]

No Sample

dry | 10.1 | 22.3 | 20.6 | 45 | 38.1 | 23 | 45.7 | 1.2 | 1.1 | 0.5 | 6

Estimated elevation

[Upper Gray Sand]

TD=11 ft bgs | TD=16 ft bgs | TD=19 ft bgs | TD=36 ft bgs | TD=38 ft bgs | TD=40 ft bgs | TD=80 ft bgs | TD=82 ft bgs | TD=149 ft bgs

GP47 groundwater fluoride values beyond 50 ft. bgs:	
62 ft.	28.6 mg/L
72 ft.	25.3 mg/L
82 ft.	41.2 mg/L

GP50 groundwater fluoride values beyond 50 ft. bgs:	
60 ft.	35.4 mg/L
70 ft.	31.4 mg/L
80 ft.	24.5 mg/L

GP27 groundwater fluoride values from 60-149 ft. range from < 0.4-1.4 mg/L

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW24-010	18.99	25.26
MW13-022	9.35	25.23
MW14-015	21.71	28.03
South Ditch (SG02)	Dry	26.52
MW11-017	18.60	26.96
MW25-35	8.77	21.97
MW02-34	—	—
MW35-038	Installed 12/3/96	21.18

Note: Elevations shown are 1929 NGVD.

LEGEND

MW09 ← Monitoring well number; Cased interval; Screened interval; TD=95 ft bgs ← Total depth

GP54 ← Geoprobe ID number (Locations are approximate); 1.5 ← Field fluoride value, mg/L; TD=80 ft bgs ← Total Geoprobe depth in feet below (approx.) ground surface elevation

1/6/97 water level elevation

10/5/95 water level elevation

Waste material

ML = Silt

SP = Poorly graded sand

SW = Well-graded sand

[ ] = Laboratory fluoride values (mg/L) (August '97 quarterly sampling)

*GP51 and GP55 included for geology only. No groundwater data available.

0 50 100 Feet
Approximate Horizontal Scale

0 5 10 Feet
Approximate Vertical Scale

Vertical exaggeration = 10x

Fluoride Concentration Ranges

- 4-15 mg/L
- 16-25 mg/L
- 26-45 mg/L
- 46-100 mg/L
- 101-500 mg/L
- 501-1,100 mg/L

Figure 1-17
SCRAP YARD
CROSS SECTION 6-6'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL

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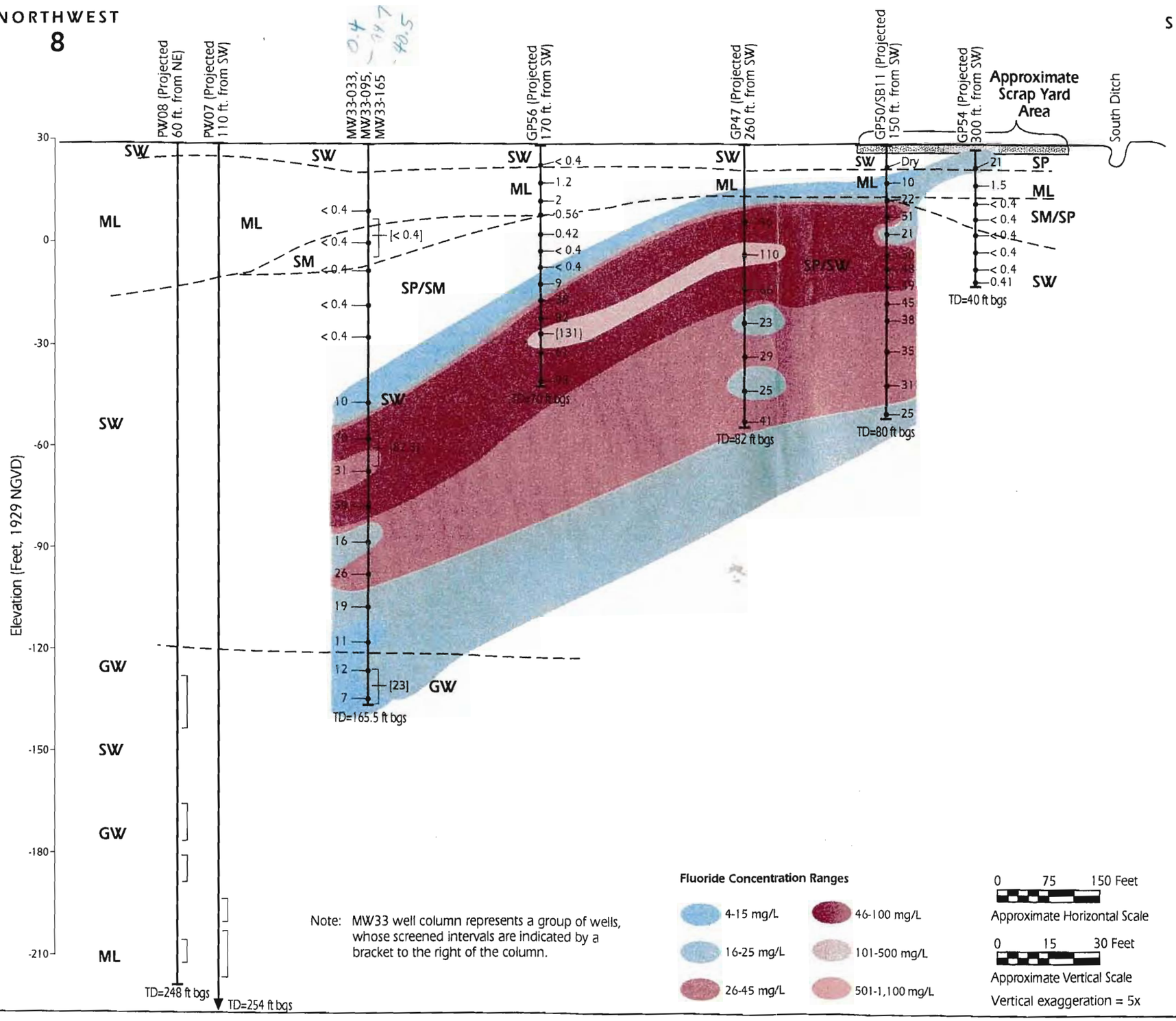
NORTHWEST 8 — SOUTHEAST 8'



Note: MW33 well column represents a group of wells, whose screened intervals are indicated by a bracket to the right of the column.

Fluoride Concentration Ranges

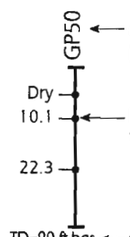
- 4-15 mg/L
- 16-25 mg/L
- 26-45 mg/L
- 46-100 mg/L
- 101-500 mg/L
- 501-1,100 mg/L

0 75 150 Feet
Approximate Horizontal Scale

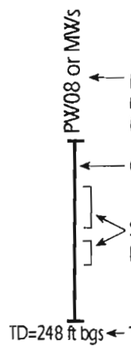
0 15 30 Feet
Approximate Vertical Scale

Vertical exaggeration = 5x

LEGEND



- GP50 ← Geoprobe ID number (Locations are approximate)
- Dry / 10.1 / 22.3 ← Field fluoride value, mg/L
- TD=80 ft bgs ← Total Geoprobe depth in feet below (approx.) ground surface elevation



- PW08 or MWs ← Production well or monitoring well number (Locations are approximate)
- Cased interval
- Screened or perforated interval(s)
- TD=248 ft bgs ← Total depth

ML = Silt
SP = Poorly graded sand
SW = Well-graded sand
SM = Silty sand
GW = Well-graded gravel
[ ] = Laboratory fluoride values (mg/L) (August 1997 quarterly sampling)
( ) = Laboratory fluoride value (mg/L) (June 1998 field sampling)

Figure 1-18
SCRAP YARD
CROSS SECTION 8-8'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Focused Feasibility Study

CH2MHILL