M. Coy

ALCOA

Alcoa Remediation Management

Park Avenue East
Building 65
PO Box 150
Massena, NY 13662

January 19, 2001

01-0012

Mr. Gregg A. Townsend, P.E.
NYSDEC
Region 6 Headquarters
317 Washington Street
Watertown, New York 13601

Subject: Alcoa Inc.
Dennison Cross Road Site
2000 Annual Report

Dear Mr. Townsend:

Attached for your review is the *2000 Annual Report for the Dennison Cross Road Site.*

If you have any questions please contact me.

Sincerely,

Thomas C. Lightfoot

Thomas C. Lightfoot
Staff Environmental Engineer

TCL:tmp

Attachment

cc w/out attachment: James Harrington, NYSDEC
John Sheehan, NYSDOH
James Luz, NYSDEC
Elaine Zuk, NYSDEC
Anthony Quartararo, NYSDEC
Darrell Sweredoski, NYSDEC
Leonard Ollivett, NYSDEC
Christina Dowd, NYSDEC
Ann Rice, NYSDEC

M. C.
1-24-01

cc w/attachment: Michael Cox, NYSDEC
James Shaw, Alcoa
Dennis Krause, Alcoa
Joseph Mihm, CDM
Adrian Woods, CDM
Library/File/Alcoa

CDM Camp Dresser & McKee

Alcoa Inc.
Remediation Projects Organization

2000 Annual Report for the Dennison Cross Road Site

January 19, 2001

Report

CERTIFICATION WITH SUBMITTAL OF THE 2000 ANNUAL REPORT FOR THE DENNISON CROSS ROAD SITE

All information contained in this document is to the best of our knowledge, factual and represents CDM's total understanding of the conditions and circumstances at the Alcoa facility and impacted area. The conclusions and recommendations contained in this document represent CDM's best professional engineering judgement on remediation that meets those applicable or relevant and appropriate requirements and represents sound engineering practices and principles required to protect public health and the environment.

Signature: Joseph E. Mihm

Joseph E. Mihm, P.E.
Project Manager
CAMP DRESSER & McKEE

Date: January 19, 2001

Signature: Peter T. Maynard

Peter T. Maynard
Quality Assurance Manager
CAMP DRESSER & McKEE

Date: January 19, 2001

Contents

Figures

Tables

Section 1
Introduction

1.1 Intent of Document

Camp Dresser & McKee (CDM) prepared this *2000 Annual Report for the Dennison Cross Road Site* for Alcoa in Massena, New York. This report provides a summary of the post-closure operations and maintenance activities conducted at the Dennison Cross Road site (DCR) in 2000 and presents the results of the 2000 compliance monitoring program. This report also includes a 5-year evaluation of the operational and monitoring results.

Operations and maintenance were performed in accordance with the *Post-Closure Operation and Maintenance Manual for the Dennison Cross Road Site* (CDM, March 1994). The compliance monitoring program was performed in accordance with the *Post-Closure Monitoring Plan for the Dennison Cross Road Site* (CDM, November 1998).

The purpose of this report is to:

- present a summary of 2000 operations and maintenance;
- present groundwater level and quality results from two rounds of 2000 post-closure compliance monitoring;
- compare 2000 compliance monitoring results to previous results;
- compare the 5-years of operations and post-closure monitoring results to system objectives; and
- recommend changes, if necessary, to the post-closure monitoring program.

1.2 Background Information

The DCR is approximately 1.75 acres in size and is located east of Dennison Road on Alcoa property, but outside of the facility boundary. Figure 1-1 is a site plan showing the DCR and other sites at the Alcoa facility. Figure 1-2 shows the site plan and monitoring locations for the DCR. Background information, including site history and remediation was included in the *Dennison Cross Road Baseline Groundwater Evaluation Report* (CDM, August 1997). The DCR limits of excavation are represented on Figure 1-2 by the limit of the site cap.

1.3 Organization of Report

The remaining sections of this report present a summary of operations and maintenance performed in 2000 (Section 2), results of the 2000 compliance monitoring program (Section 3), an evaluation of the monitoring results (Section 4), 5-year post-closure evaluation (Section 5), and a summary and recommendations (Section 6).

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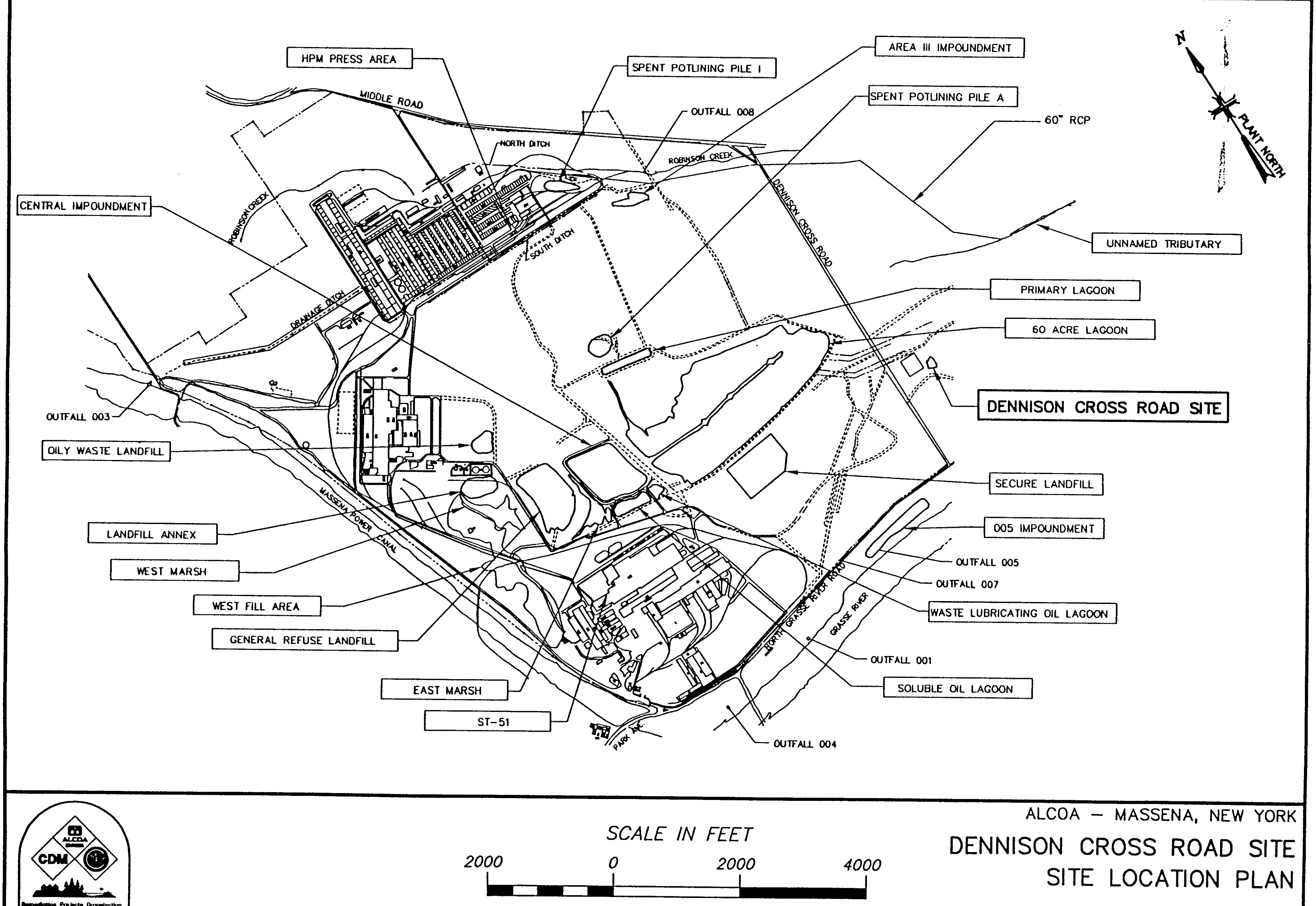
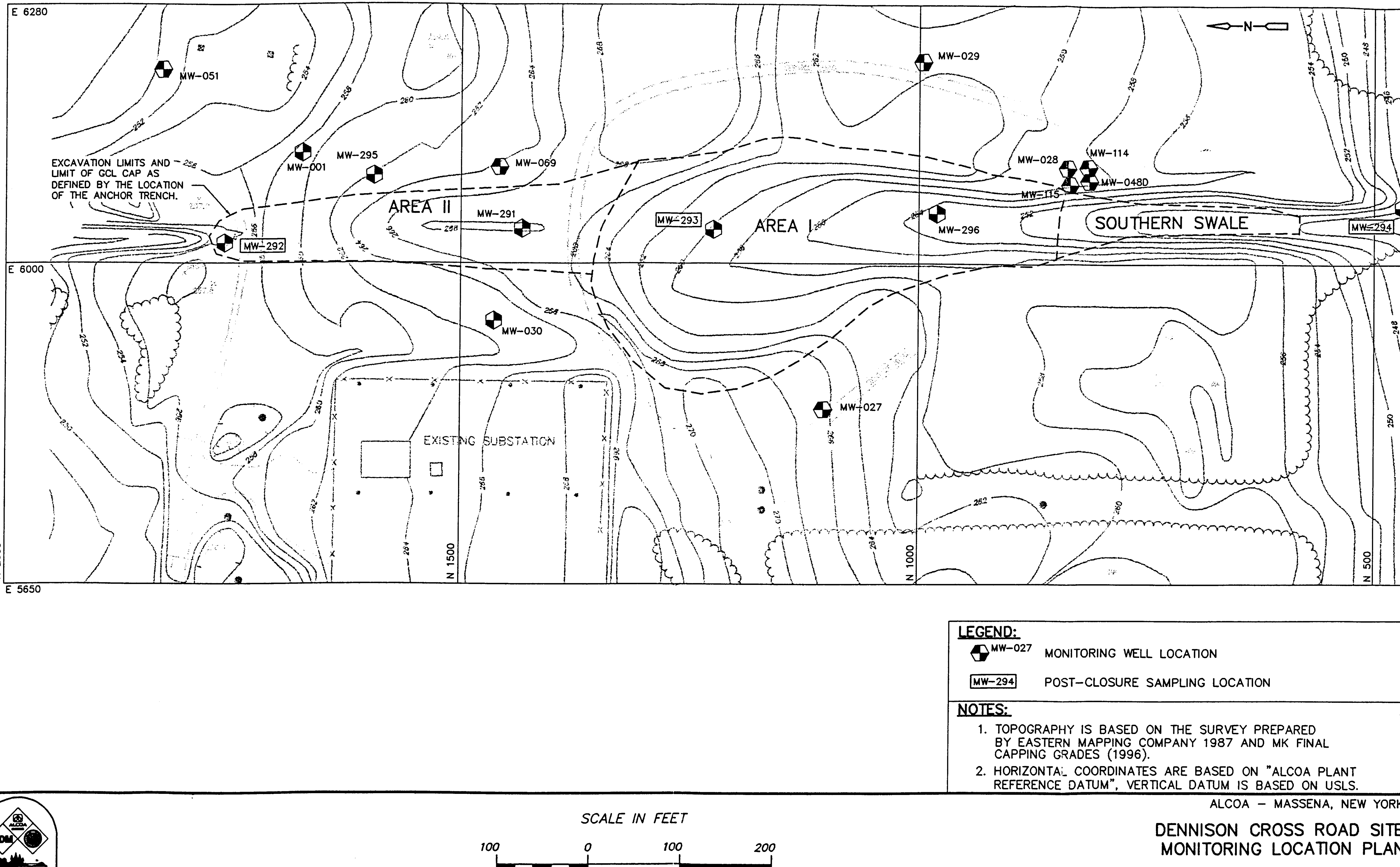


ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SITE LOCATION PLAN

FIGURE 1-1



LEGEND:

MW-027 MONITORING WELL LOCATION

MW-294 POST-CLOSURE SAMPLING LOCATION

NOTES:

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
MONITORING LOCATION PLAN

FIGURE 1-2

R:\ALCOA\DCR\RPTO' CSTDCR12.DWG 12/06/00 Scott G. Castagnier ALCOA/RPO

References used in compiling this report are presented in Section 7.

Appendix A contains 2000 precipitation, water level data and seepage velocity calculations. Appendix B presents the 2000 groundwater quality data and data quality assessments. Appendix C provides the statistical evaluation of the 2000 analytical data.

Section 2
Operations and Maintenance

2.1 Introduction

This section includes the operations and maintenance summary for the DCR. The intent of this section is to summarize the operations and maintenance activities performed at this site by Morrison Knudsen Environmental (MKE) in 2000. These activities involved routine inspections and documentation as well as addressing any deficiencies which were identified during the inspections.

Operations and maintenance were conducted in accordance with the *Post-Closure Operation and Maintenance Manual for the Dennison Cross Road Site* (CDM, March 1994).

Documentation for the operations and maintenance program is available upon request from the Alcoa Remediation Projects Organization (RPO). The following subsections describe the activities performed as part of the 2000 operations and maintenance program.

2.2 Final Cover and Surface Water Control Systems

The final cover system for the DCR was inspected quarterly for evidence of vegetative deterioration, erosion, siltation, ponding, uplift, washouts, leachate breakout and rodent holes. The surface water control system was inspected quarterly for evidence of erosion or obstructions in the drainage swales. Biannual mowing was performed. No problems were observed during the inspections.

2.3 Benchmarks

The site benchmarks are inspected annually. No deterioration or movement was noted in 2000.

2.4 Service Roads

The sitewide service roads are monitored for deterioration and upgraded as needed. Snow removal is performed as required during the winter months.

2.5 Health and Safety

2.5.1 Emergency Equipment Inspections

The MKE industrial health/health and safety (IH/H&S) department administered a detailed health and safety equipment inspection agenda as part of the overall RPO safety program. This includes inspections of both on-going scopes of work at active hazardous waste sites, as well as the periodic operations and maintenance activities at sites in the post-closure stages. Although operations and maintenance activities are normally comprised of 'clean' work, activities involved during manhole entry and electrical/mechanical lockouts, represent hazards equivalent to those at active hazardous waste sites. Some of the inspection criteria included the following:

IH Monitoring Instruments

All monitoring instruments, including sampling pumps, 4-gas detection units, photoionization detectors/flame ionization detectors (PIDs/FIDs), noise monitoring units, heat stress monitors and Draeger devices, are routinely span calibrated at the IH field lab and are annually inspected and/or repaired by the appropriate manufacturer/distributor.

Personal Protective Equipment

All personal protective equipment (PPE) utilized by personnel involved in applications with hazardous waste, including protective clothing and air-purifying respirators, are inspected and maintained according to all applicable standards.

Emergency Equipment

Standard emergency response equipment, such as fire extinguishers, first aid kits, spill kits and eye wash stations, are either deployed to areas where operations and maintenance activities are commencing, or are staged in nearby decontamination trailers for quick action. Furthermore, inspections are conducted monthly or following usage on all equipment to maintain readiness.

2.5.2 Personnel Training/Training Program

The MKE IH/H&S Department administers a detailed training program that includes all personnel assigned to any operations and maintenance and/or RPO duties. The standard training format that MKE uses includes:

- an annual 8-hour refresher as per Code of Federal Regulations (CFR) 29 1910.120 for MKE, CDM and Alcoa staff members;

- RPO project indoctrination on an annual, or upon hiring basis, which covers procedural, health and safety, and industrial hygiene policies as they are administered by MKE;

- site-specific major task meeting and indoctrination's: these meetings are held to ensure that the planned activity is thoroughly reviewed by all involved personnel, with a clear understanding of goals, job functions, compliance issues, etc., and that the training requirements of 29 CFR 1910.120 with respect to health and safety training are met;

- site-specific mini-task meetings: these are held as follow-up training sessions to supplement the major task meeting and indoctrination and are held whenever unexpected conditions or work scope changes are encountered;

- emergency response team training: in order to update the sitewide emergency response team on any new activities at hand, or to review recent developments or concerns, a monthly meeting of all team members is held; and

- other training: specialized training, such as in the use of a self-contained breathing apparatus, or in the proper use of fire extinguishers as demonstrated by the Alcoa fire department, are also conducted as needed. Weekly "tool box" safety meetings are the primary tool in disseminating issues of concern to all RPO members, as well as for the review of recent incidents or injuries on this site or in the surrounding area.

2.6 Security

The DCR is located to the east of the Plant perimeter fence. This site is equipped with an access gate which remains locked and is routinely monitored by Plant security forces.

Section 3
Compliance Monitoring Results

3.1 Overview

The 2000 compliance monitoring program was conducted in accordance with the *Post-Closure Monitoring Plan for the Dennison Cross Road Site* (CDM, November 1998). The monitoring program is summarized in Table 3-1.

Two rounds of groundwater sampling and water level measurements were conducted in 2000. Sampling was conducted in March and November 2000. No deviations from the 2000 monitoring program for the DCR were noted. The results from the monitoring program were supplemented with additional groundwater level measurements from the sitewide comprehensive water level rounds which were performed in May 2000 (high water table) and September 2000 (low water table).

This section presents the precipitation, groundwater elevation and water quality data collected during the 2000 compliance monitoring program for the DCR.

3.2 Monitoring Locations

Table 3-1 presents the sampling points included in the 2000 compliance monitoring program. The construction details for the monitoring wells are summarized in Table 3-2. Figure 1-2 shows the locations of the wells monitored as part of the compliance monitoring program.

3.3 Precipitation Data

Precipitation and other weather data are collected daily at the onsite Alcoa weather station. A graph of monthly precipitation data for 2000 is presented in Figure 3-1. A graph of annual precipitation for 1990 through 2000 is presented in Figure 3-2. Annual data for 1990 to 1994 was obtained from the Massena Airport weather station. Data from 1995 to 2000 is from Alcoa. Daily precipitation data for 2000 is included in Appendix A.

3.4 Water Level Measurements

Groundwater elevations were measured at 16 wells during the compliance monitoring sampling in March and November 2000. Water level measurements also were collected as part of sitewide comprehensive water level rounds in May and September 2000. The May and September water level rounds were conducted to collect data indicative of high and low seasonal water level conditions, respectively. Water level measurements collected during the compliance monitoring and comprehensive water level programs are presented in Table 3-3.

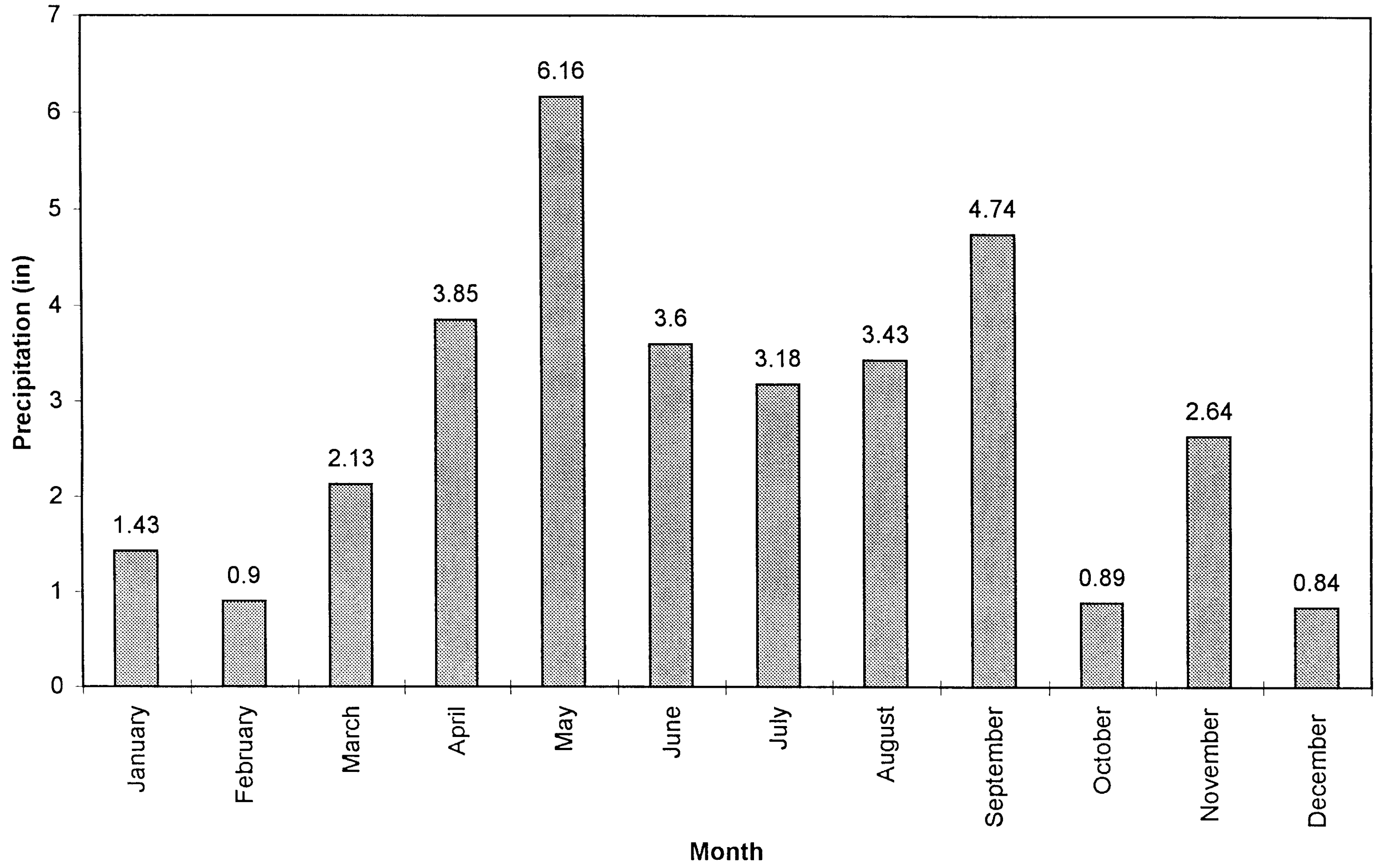
Monitoring Well	Screened Stratum	Compliance Monitoring	
		Analyses	Water Level Frequency[1]
MW-001	IIB	---	S
MW-027	III	---	S
MW-028	IIB	---	S
MW-029	IIB,III	---	S
MW-030	IIB,III	---	S
MW-048D	III	---	S
MW-051	IIB,III	---	S
MW-069	IIB	---	S
MW-114	IIB	---	S
MW-115	IIB	---	S
MW-291	I,IIB	---	S
MW-292	IIB	VOCs	S
MW-293	I,IIB	VOCs	S
MW-294	IIB,III	VOCs	S
MW-295	IIB	---	S
MW-296	IIB	---	S

Note:
1. S = Semiannually

Table 3-1
2000 Post-Closure Groundwater Monitoring Program

Facility Location and ID				Monitoring Well Construction									Screened Interval Summary	
								Screen						
								Depth		Elevation				
Monitoring Well ID	Alcoa Coordinates Easting	Alcoa Coordinates Northing	Ground Elevation (feet)	Material Type and Size	Depth of Well (feet)	Bottom of Hole Elevation (feet)	Top of Inner Casing (feet)	Top (feet)	Bottom (feet)	Top (feet)	Bottom (feet)	USCS	Stratum
MW-001	6119.96	1672.78	247.90	2-inch Dia. PVC	27.00	219.40	261.57	22.00	27.00	225.90	220.90	SM,ML	IIB
MW-027	5840.85	1101.64	260.92	2-inch Dia. PVC	26.00	234.92	263.88	12.00	22.00	248.92	238.92	ML	III
MW-028	6098.70	830.22	258.89	2-inch Dia. PVC	22.00	236.89	261.27	12.00	22.00	246.89	236.89	ML	IIB
MW-029	6218.10	994.75	261.20	2-inch Dia. PVC	22.00	239.20	263.68	10.00	20.00	251.20	241.20	SM/ML	IIB, III
MW-030	5938.80	1462.54	263.00	2-inch Dia. PVC	15.00	248.00	265.43	4.50	14.50	258.50	248.50	SM/ML	IIB, III
MW-048D	6087.61	816.13	258.86	2-inch Dia. PVC	103.33	155.53	261.73	78.00	103.00	180.86	155.86	ML	III
MW-051	6209.86	1827.59	250.53	2-inch Dia. PVC	16.00	234.53	253.21	4.00	14.00	246.53	236.53	SM/ML	IIB, III
MW-069	6103.08	1456.62	264.52	2-inch Dia. PVC	25.00	239.52	267.16	15.00	25.00	249.52	239.52	SM,ML	IIB
MW-114	6095.14	822.00	256.21	2-inch Dia. PVC	32.00	224.21	260.36	12.00	32.00	244.21	224.21	SM	IIB
MW-115	6085.89	829.00	256.50	2-inch Dia. PVC	32.00	224.50	258.97	7.00	32.00	249.50	224.50	SM/ML	IIB
MW-291	6038.51	1432.23	267.32	2-inch Dia. PVC	23.00	244.32	270.48	12.00	22.00	255.32	245.32	GP,CL,SC,SM	I,IIB
MW-292	6021.87	1759.12	256.28	2-inch Dia. PVC	24.00	232.28	259.45	13.00	23.00	243.28	233.28	SM,ML,SW	IIB
MW-293	6037.37	1222.16	259.55	2-inch Dia. PVC	23.50	236.05	262.32	12.50	22.50	247.05	237.05	SM	I,IIB
MW-294	6063.04	467.97	245.68	2-inch Dia. PVC	20.00	225.68	248.30	9.00	19.00	236.68	226.68	SM,ML	IIB,III
MW-295	6096.22	1595.12	262.27	2-inch Dia. PVC	22.00	240.27	264.98	11.00	21.00	251.27	241.27	SM,SW	IIB
MW-296	6054.73	979.57	253.27	2-inch Dia. PVC	19.50	233.77	255.97	8.50	18.50	244.77	234.77	SM,SP	IIB

Table 3-2
Monitoring Well Construction Summary



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January 19, 2001
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Figure 3-1
2000 Monthly Precipitation

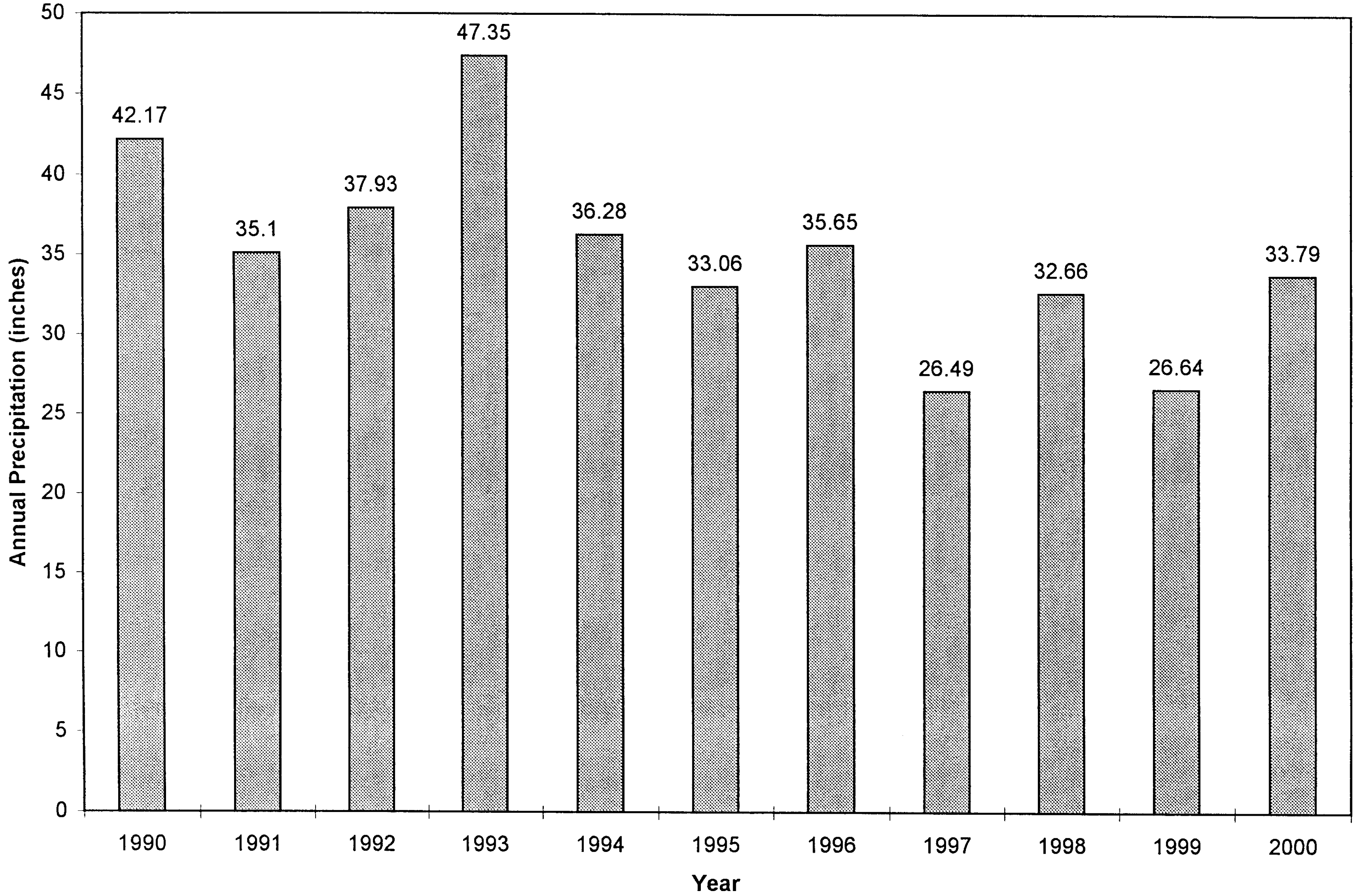

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Figure 3-2
Annual Precipitation for Massena

Well ID	Stratum	Water Level Elevation (feet USLS)			
		March 8, 2000[1]	May 3, 2000[2]	September 25, 2000[2]	November 15, 2000[1]
MW-001	IIB	254.61	254.78	253.02	252.87
MW-027	III	259.13	259.13	258.90	258.73
MW-028	IIB	254.51	254.69	254.03	253.44
MW-029	IIB, III	259.93	259.36	258.72	258.53
MW-030	IIB, III	260.83	260.87	260.79	260.90
MW-048D	III	245.97	247.21	244.63	244.37
MW-051	IIB, III	249.71	248.71	249.01	249.14
MW-069	IIB	260.16	262.17	259.25	258.33
MW-114	IIB	253.88	254.05	253.41	252.82
MW-115	IIB	251.07	251.27	250.62	249.98
MW-291	I, IIB	260.10	263.27	260.28	259.64
MW-292	IIB	251.55	251.57	250.73	250.44
MW-293	I, IIB	259.81	260.19	258.47	258.91
MW-294	IIB, III	241.93	242.13	241.45	241.36
MW-295	IIB	257.83	258.65	255.62	255.18
MW-296	IIB	255.22	255.27	255.24	255.15

Notes:
1. Sampling event water levels
2. Comprehensive water level round

Table 3-3
Summary of 2000 Water Levels

3.5 Groundwater Sampling and Analysis

The compliance monitoring program consisted of two sampling events conducted in March and November 2000. Wells were sampled using the procedures specified in the *Quality Assurance Project Plan* (QAPP) (CDM, July 1995). The low flow purge and sample method specified in the QAPP was used for sampling MW-293 to reduce field turbidity values. Field parameters were measured prior to sampling.

The groundwater samples were analyzed at the Alcoa Massena Operations ChemLab. The analytical results are presented in Table 3-4.

3.6 Data Quality Review

A data quality assessment was performed by CDM using the analytical results provided by the laboratory.

Project generated quality control samples were reviewed and included:

- field duplicates;
- field blanks; and
- trip blanks.

Additionally, the following quality control methods and/or data were reviewed for each sampling event:

- laboratory method blank results;
- matrix spike/matrix spike duplicate comparisons;
- surrogate spike recoveries;
- laboratory duplicate comparisons; and
- sampling holding time summaries.

The complete data quality assessments for March and November 2000 are included in Appendix B. No data quality issues which would affect the usability of the data were noted.

Sample Sample .e Parameter ID	Unit	MW-292-11 3/8/00	MW-292-11D 3/8/00	MW-29' 11/15/	MW-292-12D 11/15/00	MW-293-11 3/8/00	MW-293-12 11/15/00	MW-294-11 3/8/00	MW-29 11/15/
Field Parameters									
pH - Field	SU	7.04	---	7.5	---	6.93	7.27	7.29	7.6
Temperature	deg C	10.9	---	8.9	---	8.4	10.4	8.8	8.7
Specific Conductance - Field	mS/cm	0.96	---	1.08	---	1.12	1.14	0.887	0.99
Turbidity - Field	NTU	53	---	89	---	20	188	61	45
Redox Potential	mVolt	80.1	---	-72.8	---	-110.9	-102.2	62.3	-0.7
VOCs									
Chloromethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl Chloride	µg/l	3.38	3.28	3.68	3.85	1 U	1.35	1 U	1 U
Chloroethane	µg/l	1.92	1.86	1.3	1.38	1 U	1 U	1 U	1 U
Methylene Chloride	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	µg/l	2.68	2.77	3.27	3.31	6.08	12.21	1 U	1 U
Trans-1,2-Dichloroethene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cis-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Benzene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene (Or Ortho)	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene (Or Para)	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
O-Xylene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
P-Xylene	µg/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	µg/l	1 U	1 U	1 U	1 U	1 U	1.09	1 U	1 U

Key:
U = Nondetect
--- = Not Analyzed

Table 3-4
Summary of 2000 Analytical Data

Section 4
Evaluation of Compliance Monitoring Data

4.1 General

This section presents an evaluation of water level measurements and water quality data collected during the 2000 groundwater compliance monitoring program for the DCR. Water level measurements were used to evaluate groundwater flow conditions at the site. Water quality data were compared to baseline conditions to evaluate whether any changes in groundwater quality near the site have occurred.

Evaluations of the changes in water level elevations and groundwater flow at the DCR were presented in previous reports: the *Post-Closure Monitoring Plan for the Dennison Cross Road Site* (CDM, November 1998); the *Dennison Road Baseline Groundwater Evaluation Report* (CDM, August 1997); the *1997 Annual Report for the Dennison Cross Road Site* (April 1998), the *1998 Annual Report for the Dennison Cross Road Site* (CDM, April 1999) and the *1999 Annual Report for the Dennison Cross Road Site* (CDM, February 2000). Water level elevations from 2000 were compared to groundwater flow observations made in the earlier reports listed above.

4.2 Precipitation and Water Level Elevations

4.2.1 Precipitation

Annual precipitation from 1990 to 2000 was shown in Figure 3-2. The annual precipitation rate during the period 1990 to 2000 averaged approximately 35 inches per year. In 2000, the Massena area received 33.79 inches of annual precipitation, which is approximately 1.5 inches less than the average annual amount. Monthly precipitation during 2000 ranged from 0.84 inches (December) to 6.16 inches (May). Variation in precipitation affects the amount of groundwater recharge and therefore produces changes in water level elevations. The largest monthly precipitation measurements in 2000 were recorded during the month of May and September. These summer months typically have low groundwater recharge, due to high rates of evapotranspiration.

4.2.2 Water Level Elevations

The monitoring wells used for the compliance monitoring program were listed in Table 3-1 and shown on Figure 1-2. A majority of the monitoring wells have part or all of their screens located within Stratum IIB, with the exception of MW-027 and MW-048D which are screened entirely in Stratum III. Stratum IIB monitoring wells were used to evaluate the shallow unconfined groundwater system. At the MW-028/MW-114/MW-115/MW-048D well cluster, well MW-028 is considered to be most representative of Stratum IIB conditions.

Water level elevations recorded during the compliance monitoring rounds (March and November) and the two comprehensive water level rounds (May and September) were presented in Table 3-3. Water level elevations at the DCR site fluctuate throughout the year with the high water table generally occurring before the plant growing season in the spring and the low water table occurring at the end of the growing season in the late summer or early fall. For 2000, the highest water levels at most wells were measured in May. The lowest water levels for 2000 were generally measured at most of the wells in November.

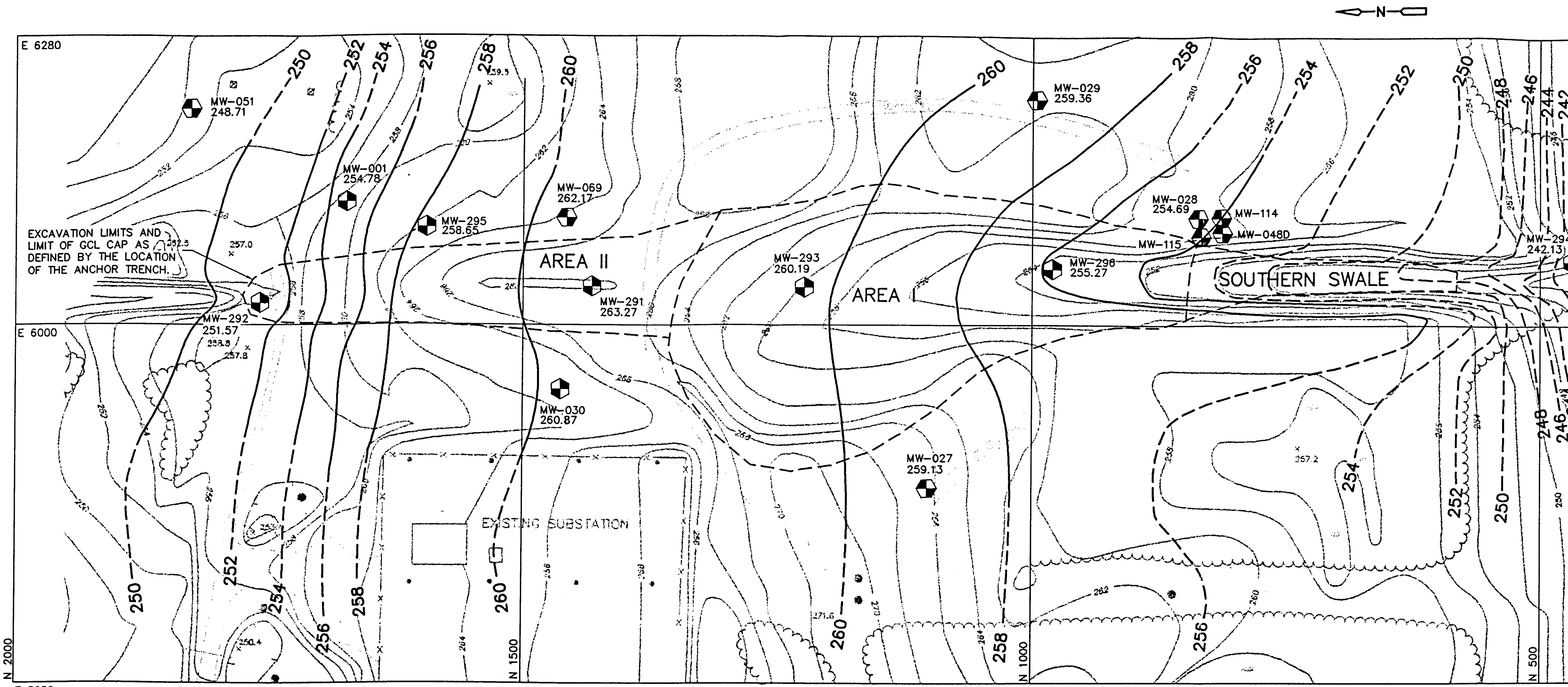
Seasonal water level fluctuations were evaluated based on the four rounds of water levels in 2000 at the DCR. The variation in water level at each well ranged from 0.11 feet at MW-030, west of Area II, to 3.84 feet at MW-069, located east of Area II. In 2000, water levels observed in the wells located within the capped area of the former excavation appeared to fluctuate approximately the same as those outside the excavation. Water level fluctuations within Areas I and II ranged from 0.12 feet at MW-296 to 3.63 feet at MW-291.

The DCR is located on the crest of the southern ridge. Groundwater on the ridge is recharged by infiltration from precipitation. The highest groundwater levels in March were recorded at MW-030 and MW-069 and in May at MW-069 and MW-291. In September and November 2000, the highest groundwater levels were recorded at MW-030. From the ridge crest, water levels decreased to the north and south. The measured potentiometric water level elevations at wells MW-293 and MW-296, within the footprint of the former waste site, continued to be near or above the ground surface elevation in 2000.

4.3 Groundwater Flow

4.3.1 Shallow Overburden Groundwater System

Water level elevations from the May and September 2000 comprehensive water level rounds were used to produce water level contour maps for the shallow overburden groundwater system. The water level elevations measured in May and September were used to represent high and low water table conditions, respectively. Horizontal and vertical hydraulic gradients and horizontal seepage velocities were also estimated from the May and September water levels (Appendix A). Figure 4-1 and Figure 4-2 present the water level contours for May and September 2000, respectively, for the shallow overburden groundwater system. A discussion of the shallow groundwater flow patterns at the DCR follows.



LEGEND

MW-027 258.69 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

--258-- APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE MAY 3, 2000.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET

100 0 100 200

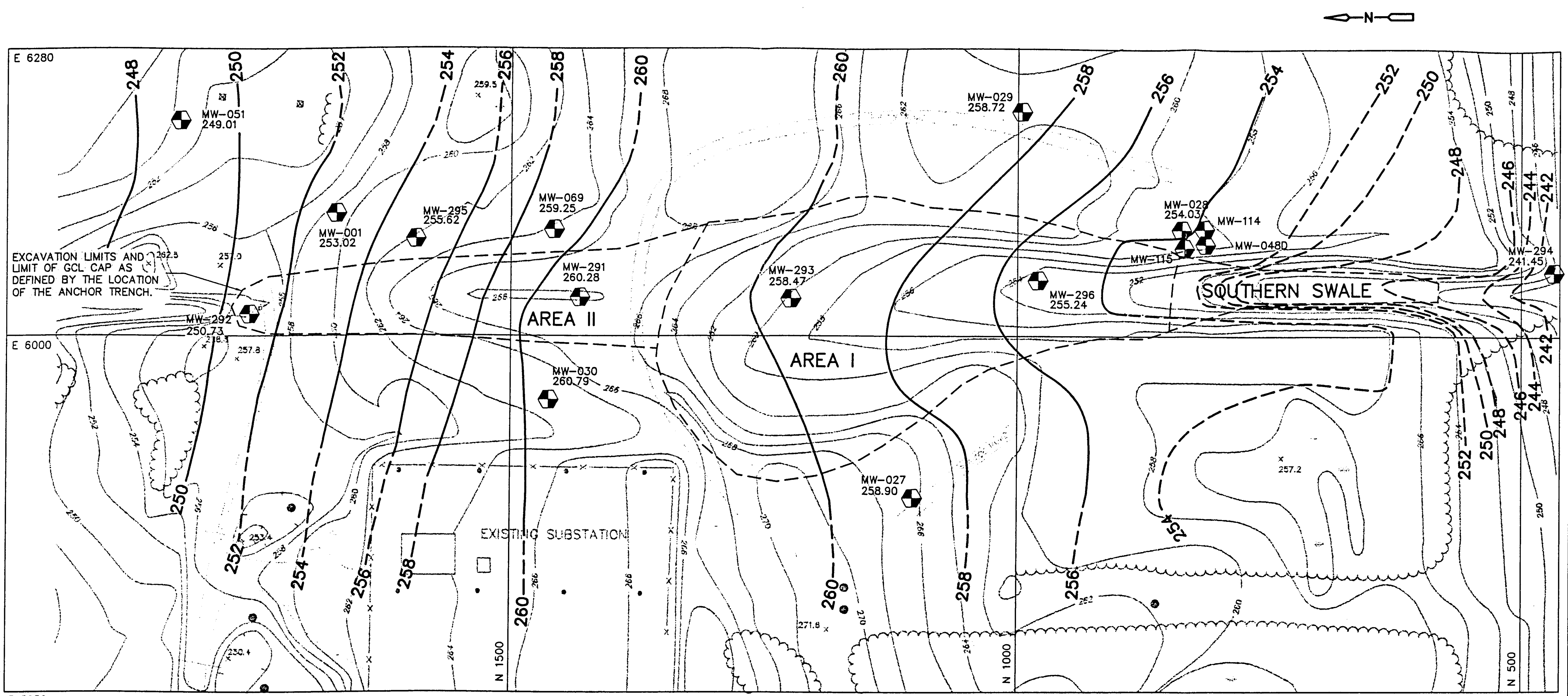
ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN

MAY 2000

FIGURE 4-1

R:\ALCOA\DCR\RPT0\ CSTDCR41.DWG 12/06/00 Scott G. Castagnier ALCOA/RPO



LEGEND

MW-027 257.58 — MONITORING WELL LOCATION, GROUNDWATER ELEVATION

--260-- — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE SEPTEMBER 25, 2000.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET

100 0 100 200

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
SEPTEMBER 2000

FIGURE 4-2

The DCR straddles the crest of the southern ridge. Figure 4-1 and Figure 4-2 show groundwater elevation contours for May 2000 and September 2000, respectively. The contours represent what is typically high (Figure 4-1) and low (Figure 4-2) groundwater level conditions. North of the ridge crest, the hydraulic gradients in May and September were generally to the north toward the central valley. The contours indicate hydraulic gradients away from the former waste area in the vicinity of MW-291, where the highest water levels were measured. South of the ridge crest, hydraulic gradients were to the south toward the Grasse River valley.

Hydraulic gradients were calculated using the May and September water levels and contours. Gradient calculations are included in Appendix A. During high water level conditions in May, horizontal hydraulic gradients from DCR to the north ranged from 0.025 (MW-069 to MW-295) to 0.035 (MW-291 to MW-292). In September, the range of hydraulic gradients to the north remained within the 0.025 to 0.035 range observed in May.

Horizontal hydraulic gradients from DCR to the south ranged from 0.023 (MW-029 to MW-028) to 0.034 (MW-028 to MW-294) in May and September. A vertical hydraulic gradient was calculated at the well cluster east of the southern swale using data from MW-028 (Stratum IIB) and MW-048D (Stratum III). The vertical gradient at this cluster was downward and slightly greater in September (0.14) than in May (0.11).

Groundwater seepage velocities were computed using the shallow overburden water level data collected at the DCR. These calculations are presented in Appendix A. The groundwater seepage velocity was calculated for the area north and south of the crest of the southern ridge near the former waste site. The average horizontal hydraulic conductivity of the shallow overburden deposits north of the ridge crest is 0.67 feet per day. The seepage velocity north of the ridge crest ranged from approximately 28 feet per year to 37 feet per year. The average horizontal hydraulic conductivity of the shallow overburden deposits south of the ridge crest is 0.09 feet per day. The seepage velocity south of the ridge crest was 5 feet per year. These velocities are comparable to those calculated using the 1999 data.

4.4 Groundwater Quality

4.4.1 Overview

This section presents an evaluation of the analytical results for the 2000 compliance monitoring program. In March and November, groundwater samples were collected from MW-292, MW-293 and MW-294 monitoring wells and analyzed for volatile organic chemicals (VOCs).

In accordance with the *Post-Closure Monitoring Plan for the Dennison Cross Road Site* (CDM, November 1998) data quality assessments for the compliance monitoring data were performed and are included in Appendix B. The groundwater analytical results were presented in Table 3-4. No data modifications were necessary as a result of the data assessments. Water quality results are compared to New York State Water

Quality Standards (NYSWQS) for Class GA Fresh Groundwaters (6 NYCRR Part 703.5, August 1999).

4.4.2 Shallow Overburden Groundwater Quality

Groundwater samples analyzed from the DCR are representative of the shallow overburden groundwater system. Post-closure wells MW-292 and MW-294 are located immediately downgradient of the DCR, to the north and south, respectively. Well MW-293 is located within the former waste area and its screen straddles the base of the excavation.

VOCs

During the 2000 compliance monitoring, VOCs were detected in monitoring wells MW-292 and MW-293. The VOCs detected included 1,1-dichloroethane (1,1-DCA), vinyl chloride and chloroethane. VOCs were not detected at MW-294 in 2000.

At MW-292, vinyl chloride was detected in the March and November 2000 sampling rounds at concentrations of 3.33 μg/l and 3.77 μg/l, respectively. The 2000 concentrations exceeded the NYSWQS of 2 μg/l for vinyl chloride but are within the range of concentrations detected from 1996 to 1999 (1.87 μg/l to 7.0 μg/l). VOC 1,1-DCA was detected below NYSWQS in the March and November sampling rounds at concentrations of 2.73 μg/l and 3.29 μg/l respectively. VOC 1,1-DCA was detected at MW-292 in 1996, 1998 and 1999 at concentrations ranging from 1.05 μg/l to 5.14 μg/l. Chloroethane was detected at MW-292 in the March and November sampling rounds at concentrations of 1.89 μg/l and 1.34 μg/l, respectively, which are less than the NYSWQS of 5 μg/l and within the range of concentrations observed from 1996 to 1999 (1.61 μg/l to 5.97 μg/l).

At MW-293, 1,1-DCA was detected in the March and November 2000 sampling rounds at concentrations of 6.08 μg/l and 12.21 μg/l, respectively. The 2000 concentrations of 1,1-DCA exceeded the NYSWQS of 5 μg/l, and the November concentrations were higher than the range of concentrations observed from the 1996 to 1999 (4.07 μg/l to 9.72 μg/l). Vinyl chloride was detected only in the November sampling round at a concentration of 1.35 μg/l. The concentration detected in November was less than the NYSWQS of 2 μg/l. Vinyl chloride was detected at MW-293 in 1996 and 1999 at an estimated concentration of 0.55 μg/l and 1.28 μg/l, respectively.

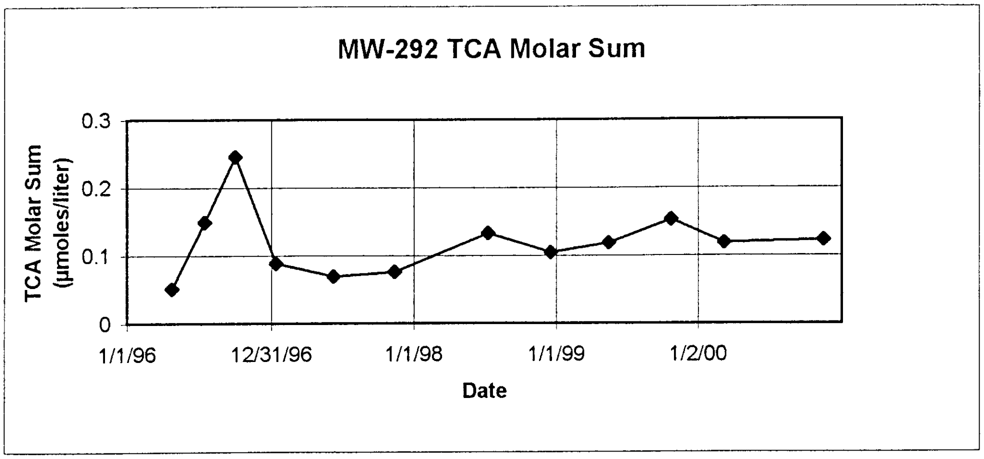
The VOCs detected at the DCR wells, 1,1-DCA, chloroethane and vinyl chloride, are degradation byproducts of 1,1,1-trichloroethane (TCA). The presence of the daughter compounds without TCA from 1996 to 2000 indicates that a continuing source is not present at the DCR and that degradation is occurring.

TCA molar sums were computed using the groundwater quality data from wells MW-292 and MW-293. Table 4-1 shows the computed molar sums for the MW-292 and MW-293 groundwater quality data from 1996 to 2000. Figure 4-3 is a graph of the

Sample ID	Sample Date	TCA Mole Sum[1] (µmoles/liter)
MW-292-01	4/23/96	0.051
MW-292-02	7/16/96	0.15
MW-292-03	10/1/96	0.246
MW-292-04	1/13/97	0.089
MW-292-05	6/9/97	0.069
MW-292-06	11/13/97	0.077
MW-292-07	7/10/98	0.133
MW-292-08	12/18/98	0.106
MW-292-09	5/17/99	0.119
MW-292-10	10/25/99	0.153
MW-292-11	3/8/00	0.119
MW-292-12	11/15/00	0.123
MW-293-01	4/23/96	0.117
MW-293-02	7/16/96	0.075
MW-293-03	9/30/96	0.082
MW-293-04	2/4/97	0.079
MW-293-05	6/9/97	0.092
MW-293-06	11/13/97	0.03
MW-293-07	7/10/98	0.094
MW-293-08	12/18/98	0.090
MW-293-09	5/17/99	0.134
MW-293-10	10/25/99	0.097
MW-293-11	3/8/00	0.086
MW-293-12	11/15/00	0.161

Note:
1. TCA Molar Sum = Sum of molar concentrations of chloroethane, 1,1-dichloroethene, 1,1-dichloroethane, vinyl chloride and 1,1,1-trichloroethane

Table 4-1
TCA Molar Sums



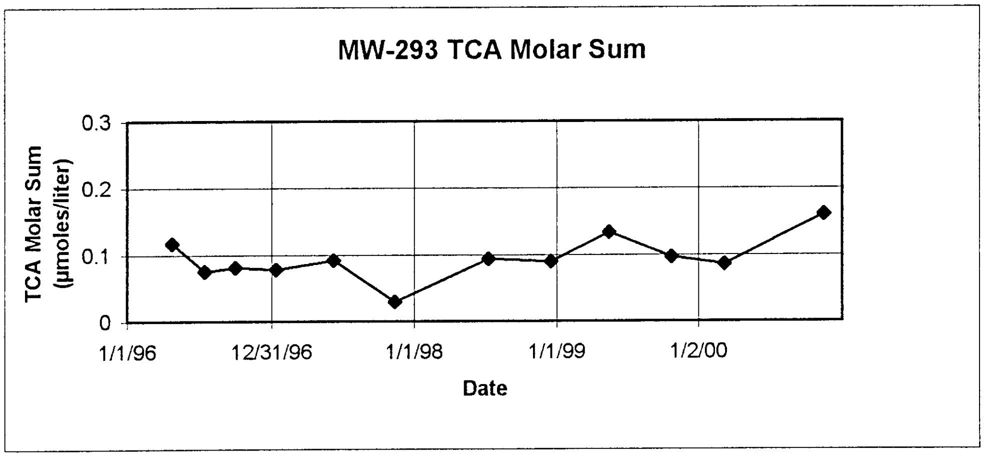


Figure 4-3
TCA Molar Sums

molar sum time history for MW-292 and MW-293. Results of the Mann-Kendall Test are summarized in Table 4-2. No statistically significant trends were noted for VOCs based on the 1996 to 2000 data. The plots on Figure 4-3 do not show any concentration patterns.

4.4.3 Statistical Evaluation

The statistical analyses performed on the 2000 groundwater quality data included summary statistics compiled for each parameter analyzed and a trend analysis. The trend analyses were conducted for organics detected during the 1996 baseline monitoring program. The purpose and methodology of the statistical procedures are summarized below. The mathematical approach for the statistical methods is presented in Appendix C.

Statistical summaries of the baseline and 2000 groundwater quality data are provided in Appendix C. Summary statistics were compiled for each parameter analyzed during the 2000 monitoring program. These summaries include the frequency of detection, range of detected concentrations, mean and standard deviation of the 2000 groundwater quality data. Summary statistics for the 1996 baseline data were included for comparison.

Trend analyses were conducted for parameters that are not naturally occurring, or naturally occurring compounds detected above NYSWQS. For the 2000 detection monitoring results, trend analyses were performed for VOCs detected during or after the baseline program in 1996. Plots of the data with linear regression lines are included in Appendix C. These plots provide a visual representation of the data, but do not necessarily indicate statistically significant trends.

The Mann-Kendall Test and the Sen's Slope Estimator statistical analyses are used to evaluate trends. The Mann-Kendall and Sen's Slope tests are used to determine whether or not there is a statistically significant increasing or decreasing concentration trend. Appendix C presents the results of the trend analyses.

For VOCs, trend analyses were performed using the Mann-Kendall Test on the molar sums. Molar sums of the VOC degradation compounds are computed to evaluate whether the overall molar concentration of the compound and daughter products is increasing or decreasing. As additional degradation occurs, the concentrations of the degradation products may increase, but these increases may not necessarily indicate an increase in the total concentration of VOCs. The molar sum approach accounts for transformations from one compound to another.

For 2000, the concentrations of TCA and its daughter products were summed together on a mole-basis to compare molar sums for the two 2000 sampling events to previous results. The following formulas were used to estimate the molar sums based on knowledge of the formation of breakdown products.

Well	Parameter[1]	Results of the Mann-Kendall Test Trend Analyses[2]
MW-292	TCA Molar Sum (µmole/l)	No Trend
	Chloroform (µg/l)	No Trend
MW-293	TCA Molar Sum (µmole/l)	No Trend
MW-294	Chloroform (µg/l)	No Trend

Notes:
1. These parameters are not naturally occurring, or are naturally occurring parameters detected above NYSWQS.
2. The trend analyses calculations are provided in Appendix C of this report.

Table 4-2
Results of the Trend Analyses

$$\text{Molar concentration } (\mu\text{mole/liter}) = \frac{\text{Compound Concentration } (\mu\text{g/l})}{\text{Molecular Weight (g/mole)}}$$

TCA molar sum = Sum of molar concentration of 1,1,1-TCA, vinyl chloride, chloroethane, 1,1-dichloroethene and 1,1-dichloroethane

Section 5
5-Year Post-Closure Evaluation

5.1 Introduction

The year 2000 was the fifth year of post-closure operations and monitoring at the DCR. Post-closure monitoring at this site is being conducted in accordance with the Record of Decision (ROD), issued in January 1992 and the Preliminary Engineering Plan (PEP) for Alcoa FS I Disposal Areas (Engineering Science, 1991). The post-closure groundwater monitoring program at the DCR is designed to monitor the effectiveness of the implemented remedy and to monitor groundwater concentrations in the vicinity of the site. In accordance with 6 NYCRR Part 373-2.7 (g)(1)(I), Part 360-2.15 and the PEP, the requirements for groundwater monitoring are re-evaluated at the end of each five-year period to determine if additional action or a reduction in monitoring is warranted.

The purpose of this section is to review the 5 years (1996-2000) of operational and groundwater monitoring results for DCR. Results will be compared to the objectives of the remediation, and recommendations for operations or monitoring changes will be made.

5.1.2 Background

6 NYCRR Part 373-2.6 cites requirements for establishing a groundwater monitoring program at a facility that treated, stored or disposed hazardous waste. However, Part 373-2(a)(3)(i) states that the requirements given in 6 NYCRR Part 373-2.6 do not apply after closure of a regulated unit," if all waste, waste residues, contaminated containment system components, and contaminated subsoils are removed and decontaminated at closure." Statistical analysis of the cleanup verification sampling results at DCR indicated that the concentrations of the soil samples from the excavated area were below ROD soil cleanup goals. Since cleanup verification samples did not exceed ROD specified soil cleanup goals, clean closure at the DCR was achieved. Therefore, the monitoring requirements outlined in 6 NYCRR Part 373-2.6, while not applicable for groundwater monitoring at this site, were used as guidance.

The remedy for the DCR was summarized in the March 1991 ROD. The January 1992 ROD reiterated that the required remedy at DCR consisted of removal of wastes and visibly contaminated soils at the site. The ROD also stated that," if soil cleanup goals are achieved, a groundwater monitoring system will be established to evaluate the remedies effectiveness in accordance with the PEP." The PEP stated that, "soil cleanup goals are met if the lowest soil cleanup goals specified in Section VI of the ROD are met (i.e., for areas outside of groundwater management units) and groundwater quality standards are achieved in the area of the waste disposal site."

Based on the requirements of RODs and the PEP, a groundwater monitoring plan in the vicinity of the DCR was implemented.

5.2 Objectives

5.2.1 Design Objectives

In accordance with the ROD, remedial measures and site closure activities at DCR were undertaken and completed in 1995. Based on design objectives, remediation included excavation of waste materials and visibly contaminated soils and disposal in the onsite Secure Landfill (SLF). Intact drums (with solids only) meeting land disposal restrictions (LDRs) were removed and disposed of in the SLF. Drums which were intact but contained liquid residues were placed in overpacks (along with visibly contaminated soils around the drums) and disposed of offsite. In accordance with design objectives, post-excavation cleanup verification sampling and statistical analysis was performed and indicated that cleanup goals were achieved. The area was backfilled and a low-permeability geosynthetic clay cap and protective soil cover was constructed. In addition, a groundwater monitoring system was implemented.

5.2.2 Post-Closure Objectives

At the completion of remedial activities, post-closure requirements at DCR were set forth to monitor the effectiveness of the implemented remedy and monitor groundwater in the vicinity of the site. Maintaining the integrity and effectiveness of the final cover was an objective for post-closure operations. Maintenance included making repairs to the cap, as necessary, to correct the effects of settling, subsidence, erosion, or other events. Protecting surveyed benchmarks and maintaining the groundwater monitoring system were also identified as post-closure objectives in the approved post-closure monitoring plan.

5.2.3 Changes in Site Conditions

Since final closure in 1995, site conditions at DCR have not been altered nor have regulatory limits been changed that affect original remedial objectives.

5.3 Findings of the 5-Year Review

5.3.1 Operations and Maintenance

Operations and maintenance was conducted during the post-closure care period in accordance with the *Post-Closure Operation and Maintenance Manual for the Dennison Cross Road Site* (CDM, March 1994). The final cover system for the DCR was inspected quarterly for evidence of vegetative deterioration, erosion, siltation, ponding, uplift, washouts, leachate breakout and rodent holes. Surface water control systems were inspected quarterly for evidence of erosion or obstructions in the drainage swales. Benchmarks were inspected on an annual basis. Sitewide service roads were monitored for deterioration and upgraded as needed. Mowing was performed on a bi-annual basis. The DCR site is equipped with an access gate which remains locked and is routinely monitored by Plant security forces.

No significant changes or failures in any of the remedial components were noted over the 5-year post-closure period, except for a small washout in the final cover in 1997.

The washout was repaired and re-vegetated with no further problems noted. The final cover is functioning properly and requires no maintenance other than the biannual mowing. The 5-years of monitoring have shown stable conditions for all remedial components. A reduction of inspection and monitoring activities would be appropriate.

5.3.2 Groundwater Compliance Monitoring

Precipitation and Water Level Elevations

Annual precipitation from 1990 to 2000 is shown in Figure 3-2. From 1990 to 2000 the annual precipitation rate averaged approximately 35 inches per year. For the post-closure monitoring period (1996 to 2000) the annual precipitation ranged from 26 inches to 36 inches, consistent with the 10 year average.

The DCR is located on the crest of the southern ridge. Groundwater on the ridge is recharged by infiltration from precipitation. Variation in precipitation affects the amount of groundwater recharge and therefore produces changes in water level elevations. The monitoring wells used for the compliance monitoring program were listed in Table 3-1 and shown on Figure 1-2.

Water levels were monitored quarterly over the past 5 years of post-closure monitoring. During the remediation, the water level elevation in the excavated areas was lowered as a result of remediation activity below the water table. Monitoring wells within the capped area exhibited a gradual increase in water level elevations as water levels equilibrated following closure. A post-closure evaluation of the water levels and horizontal gradients in January 1997 indicated that heads and gradients inside and outside the former waste area were comparable and therefore groundwater conditions had generally equilibrated.

Review of 5 years of post-closure data indicated that the water level elevations at the DCR were observed to fluctuate consistently throughout the year with the high water table generally occurring in the spring and the low water table occurring in the late summer or early fall. For the post-closure period, water levels observed in the wells located within the capped former excavation appeared to fluctuate slightly less than those outside the excavation. Water level elevations observed in monitoring wells MW-292 and MW-293, located within the capped area, ranged a maximum of 5-to 6-feet following equilibrium. Conversely, downgradient well MW-294, located outside the capped area, ranged a maximum of 11 feet over the same period. This indicates that, as designed, the DCR cap is limiting groundwater recharge from infiltration in the immediate vicinity of the capped area.

Groundwater Flow

Water level elevations were used to produce water level contour maps for the shallow overburden groundwater system. High and low water table conditions were evaluated. Copies of the contour maps generated from 1996 to 2000 are provided in Appendix A. In addition, horizontal and vertical gradients and seepage velocities were calculated using recorded water levels. A discussion of shallow groundwater flow patterns at the DCR over the post-closure period follows.

The DCR straddles the crest of the southern ridge. Groundwater contours were comparable for all years reviewed, indicating hydraulic gradients away from the ridge crest in the vicinity of monitoring well MW-291. Shallow overburden groundwater north of the ridge crest flows to the north towards the central valley. South of the ridge crest, shallow overburden groundwater flows south towards the Grasse River valley.

Seepage velocities have remained consistent following closure. The seepage velocity north of the ridge crest ranged from approximately 28 feet per year to 37 feet per year. The seepage velocity to the south of the ridge crest ranged from 5 feet per year to 6 feet per year over the period of review.

A downward vertical gradient was calculated at the well cluster east of the southern swale using data from MW-028 (Stratum IIB) and MW-048D (Stratum III). The vertical gradient was steady over the 5-year review period averaging approximately 0.13. The presence of a persistent gradient of this magnitude indicates a resistance to downward flow.

The groundwater flow data and patterns observed over the 5-year review period were consistent with the conditions observed at the time of baseline monitoring. Five years of monitoring have shown no variability in groundwater flow direction and nominal variability in hydraulic gradients and seepage velocities. Based on the review of the last five years of groundwater flow data, steady state conditions exist and additional water level monitoring (i.e., water level measurements, hydraulic gradient and seepage velocity calculations) is no longer warranted at DCR.

Groundwater Quality

In accordance with the *Dennison Road Baseline Groundwater Evaluation Report* (CDM, August 1997), three groundwater monitoring points were utilized during the post-closure care period to evaluate groundwater quality. The three points were:

- MW-292 located immediately downgradient of the DCR to the north.
- MW-293 located within the former waste area.
- MW-294 located immediately downgradient of the DCR to the south.

As stated in the ROD, constituents of concern for the DCR site were fluoride, PAHs, PCBs, and VOCs. Fluoride and PAHs were eliminated following the baseline groundwater evaluation. Groundwater samples from MW-292 and MW-294 were analyzed for VOCs only. Groundwater samples from MW-293 were analyzed for VOCs and PCBs. PCB analysis was eliminated in 2000 following four consecutive rounds where PCBs were not detected. Constituents detected at the three monitoring wells during the post-closure period are presented in Table 5-1.

Groundwater quality trend analysis for the post-closure period is discussed in detail in Section 4. 1,1,1-TCA, indicative of source material, was not detected during any of the conducted sampling events. Within the footprint of the former excavation area, degradation daughter products vinyl chloride, chloroethane and 1,1-DCA were detected slightly above NYSWQS during various sampling events. As stated in Section 4, no statistically significant increasing trend has been observed for the VOCs detected. For each monitoring well, an evaluation of analytical results collected over the post-closure period is summarized below.

MW-292

MW-292 is located immediately downgradient of DCR to the north and provides samples representative of the groundwater quality to the north. Post-closure monitoring included analysis for PCBs, PAHs, fluoride and VOCs. The post-closure monitoring showed that PCBs, PAHs or fluoride were not detected at MW-292. The only constituents detected at MW-292 were degradation VOC compounds 1,1-DCA, chloroethane and vinyl chloride.

1,1-DCA was only detected during a sampling round in October of 1999. 1,1-DCA was detected at 5.14 μg/l, which exceeds the NYSWQS of 5 μg/l by 0.14 μg/l. 1,1-DCA was not detected above NYSWQS for any other sampling event.

Chloroethane was only detected during a sampling round in October of 1996. Chloroethane was detected at 5.97 μg/l during this sampling event, which exceeds the NYSWQS of 5 μg/l. Chloroethane was not detected above NYSWQS for any other sampling event.

Vinyl chloride was detected at MW-292 during sampling rounds in 1996, 1997, 1998, 1999 and 2000. Vinyl chloride concentrations ranged from 1.86 μg/l to 7 μg/l, with an average of 3.59 μg/l for 12 sampling events. This average is slightly above the NYSWQS of 2.0 μg/l.

No notable increasing trends are evident for any of the VOCs detected at MW-292.

MW-293

MW-293 is situated within the former waste area and provides samples representative of the groundwater quality for the remediated area. Post-closure monitoring included analysis for PCBs, PAHs, fluoride and VOCs. The post-closure monitoring showed that PAHs and fluoride were not detected at MW-293. PCBs were detected initially following closure. However, when representative groundwater samples were collected using low flow purge methods during subsequent sampling events, no PCBs

Sample ID Sample Date Parameter ID	Units	NYSWQS[1]	MW-292-01 4/23/96	MW-292-02 7/16/96	MW-292-02D 7/16/96	MW-292-03 10/1/96	MW-292-04 1/13/97	MW-292-05 6/9/97	MW-292-06 11/13/97	MW-292-07 7/10/98	MW-292-08 12/18/98
Field Parameters											
pH - field	SU	NA	7.31	6.97		6.45	7.05	7.35	7.48	7.26	6.84
Temperature	deg C	NA	8.5	11.7		13.7	7.7	10.25	9.3	10.8	8.8
Specific Conductance - Field	mS/cm	NA	859	0.612		828	0.674	0.88	0.99	1	0.887
Turbidity - Field	NTU	NA	133	109		88.6	242	268	849	147	116
Redox Potential	mVolt	NA	88.5	51		235	30.1	-20.6	-71	-10.7	-34.3
VOCs											
Vinyl Chloride	µg/l	2	1.86	**5.09**	**5.77**	**7**	**3.14**	**2.15**	**3.43/J**	**3.04**	**2.91**
Chloroethane	µg/l	5	-----	2.7	2.9	**5.97**	1.61	1.35	-----	4.2	2.17
1,1-Dichloroethane	µg/l	5	-----	1.24	1.31	3.15	-----	-----	-----	1.05	1.6
Chloroform	µg/l	5	0.64 J	-----	-----	-----	-----	-----	-----	-----	-----
Cis-1,2-Dichloroethene	µg/l	5									-----
PCBs	µg/l										
Aroclor 1248	µg/l		-----	-----	-----	-----	-----	-----			
Aroclor 1254	µg/l		-----	-----	-----	-----	-----	-----			
Aroclor 1260	µg/l		-----	-----	-----	-----	-----	-----			
Total PCBs	µg/l	0.09	-----	-----	-----	-----	-----	-----			

Table 5-1
Summary of DCR Post-Closure Detections

Sample ID Sample Date Parameter ID	Units	NYSWQS[1]	MW-292-09 5/17/99	MW-292-10 10/25/99	MW-292-11 3/8/00	MW-292-11D 3/8/00	MW-292-12 11/15/00	MW-292-12D 11/15/00	MW-293-01 4/23/96	MW-293-02 7/16/96
Field Parameters										
pH - field	SU	NA	7.03	6.92	7.04		7.5		7.18	7.06
Temperature	deg C	NA	11.7	10.3	10.9		8.9		8.4	15.8
Specific Conductance - Field	mS/cm	NA	1.01	0.98	0.96		1.08		977	0.747
Turbidity - Field	NTU	NA	83	35	53		89		65	> 1000
Redox Potential	mVolt	NA	-11.7	35.2	80.1		-72.8		164	116.9
VOCs										
Vinyl Chloride	µg/l	2	**3.41**	**3.62**	**3.38**	**3.28**	**3.68**	**3.85**	-----	-----
Chloroethane	µg/l	5	3.25/J	2.25	1.92	1.86	1.3	1.38	2.43	1.13
1,1-Dichloroethane	µg/l	5	-----	**5.14**	2.68	2.77	3.27	3.31	**6.31**	4.07
Chloroform	µg/l	5	-----	-----	-----	-----	-----	-----	-----	-----
Cis-1,2-Dichloroethene	µg/l	5	-----	-----	-----	-----	-----	-----		
PCBs										
Aroclor 1248	µg/l								-----	-----
Aroclor 1254	µg/l								-----	-----
Aroclor 1260	µg/l								2.679	0.927
Total PCBs	µg/l	0.09							2.679	0.927

Table 5-1
Summary of DCR Post-Closure Detections

Sample ID Sample Date Parameter ID	Units	NYSWQS[1]	MW-293-03 9/30/96	MW-293-04 2/4/97	MW-293-05 6/9/97	MW-293-06 11/13/97	MW-293-06D 11/13/97	MW-293-07 7/10/98	MW-293-07D 7/10/98	MW-293-08 12/18/98
Field Parameters										
pH - field	SU	NA	7.23	7.2		7.24		7.25		6.99
Temperature	deg C	NA	14.2	8.8		10.5		12		9.9
Specific Conductance - Field	mS/cm	NA	1051	1.058		1.13		1.18		1.14
Turbidity - Field	NTU	NA	843	> 1000	625	219		38		11
Redox Potential	mVolt	NA	-48.8	-152.3		-56.1		-72.4		-97.9
VOCs										
Vinyl Chloride	µg/l	2	0.55 J	-----	-----	-----	-----	-----	-----	-----
Chloroethane	µg/l	5	-----	-----	-----	-----	-----	-----	-----	-----
1,1-Dichloroethane	µg/l	5	**5.56**	**5.43**	**6.68**	-----	-----	**6.65**	**7.17**	**6.53**
Chloroform	µg/l	5	-----	-----	-----	-----	-----	-----	-----	-----
Cis-1,2-Dichloroethene	µg/l	5								-----
PCBs										
Aroclor 1248	µg/l		2.475	-----	0.782	-----	-----	-----	-----	-----
Aroclor 1254	µg/l		1.093	-----	-----	-----	-----	-----	-----	-----
Aroclor 1260	µg/l		1.093	4.886	0.64	0.797	0.525	-----	-----	-----
Total PCBs	µg/l	0.09	4.661	4.886	1.422	0.797	0.525	-----	-----	-----

Table 5-1
Summary of DCR Post-Closure Detections

Sample ID Sample Date Parameter ID	Units	NYSWQS[1]	MW-293-08D 12/18/98	MW-293-09 5/17/99	MW-293-09D 5/17/99	MW-293-10 10/25/99	MW-293-10D 10/25/99	MW-293-11 3/8/00	MW-293-12 11/15/00	MW-294-01 4/23/96
Field Parameters										
pH - field	SU	NA		7.27		6.78		6.93	7.27	7.57
Temperature	deg C	NA		10.9		10.7		8.4	10.4	12.9
Specific Conductance - Field	mS/cm	NA		1.15		1.12		1.12	1.14	923
Turbidity - Field	NTU	NA		3		13		20	188	21.9
Redox Potential	mVolt	NA		-78.4		-122.4		-110.9	-102.2	169.3
VOCs										
Vinyl Chloride	µg/l	2	-----	1.28	1.25	-----	-----	-----	1.35	-----
Chloroethane	µg/l	5	-----	-----	-----	-----	-----	-----	-----	-----
1,1-Dichloroethane	µg/l	5	**6.57**	**9.72**	**9.66**	**7.26**	**7.1**	**6.08**	**12.21**	-----
Chloroform	µg/l	5	-----	-----	-----	-----	-----	-----	-----	2.07
Cis-1,2-Dichloroethene	µg/l	5	-----	-----	-----	-----	-----	-----	1.09	
PCBs										
Aroclor 1248	µg/l		-----	-----	-----	-----	-----			-----
Aroclor 1254	µg/l		-----	-----	-----	-----	-----			-----
Aroclor 1260	µg/l		-----	-----	-----	-----	-----			-----
Total PCBs	µg/l	0.09	-----	-----	-----	-----	-----			-----

Table 5-1
Summary of DCR Post-Closure Detections

Sample ID Sample Date Parameter ID	Units	NYSWQS[1]	MW-294-02 7/16/96	MW-294-03 9/30/96
Field Parameters				
pH - field	SU	NA	7.19	7.53
Temperature	deg C	NA	13.7	12
Specific Conductance - Field	mS/cm	NA	0.636	941
Turbidity - Field	NTU	NA	35.5	32.8
Redox Potential	mVolt	NA	137.5	64.9
VOCs				
Vinyl Chloride	µg/l	2	-----	-----
Chloroethane	µg/l	5	-----	-----
1,1-Dichloroethane	µg/l	5	-----	-----
Chloroform	µg/l	5	1.03	1.36
Cis-1,2-Dichloroethene	µg/l	5		
PCBs				
Aroclor 1248	µg/l		-----	-----
Aroclor 1254	µg/l		-----	-----
Aroclor 1260	µg/l		-----	-----
Total PCBs	µg/l	0.09	-----	-----

Note:
1. New York State Water Quality Standards (NYSWQS) for Class GA Groundwaters (6 NYCRR Part 703.5, August 1999).

Key:
Bolded values denote exceedance of NYSWQS.
/J = estimated concentration based on CDM's data quality review.
Blank spaces indicate parameter not analyzed.
---- = Not detected
NA = Not Applicable

Table 5-1
Summary of DCR Post-Closure Detections

were detected. VOC degradation compound 1,1-DCA was detected at concentrations slightly exceeding NYSWQS during various sampling events.

1,1-DCA concentrations exceeding NYSWQS were detected during sampling rounds in 1996, 1997, 1998, 1999 and 2000. 1,1-DCA concentrations ranged from 4.07 µg/l to 12.21 µg/l, with an average of 6.43 µg/l for 12 sampling events. On average this slightly exceeds the NYSWQS of 5.0 µg/l by 1.43 µg/l. No notable increasing trends are evident.

PCBs were detected above NYSWQS during sampling events in 1996 and 1997. It was determined from high field turbidity readings that the PCB concentrations were possibly associated with particulates. A low flow purge and sample method was used for subsequent sampling rounds in 1998 and 1999 and no PCBs were detected. Based on this data, PCBs were eliminated as an analytical parameter for the 2000 sampling rounds.

MW-294

MW-294 is located immediately downgradient of DCR to the south and provides samples representative of the groundwater quality to the south. Post-closure monitoring included analysis for PCBs, PAHs, fluoride and VOCs. PCBs, PAHs and fluoride were not detected at MW-294. No VOCs were detected at MW-294, with the exception of chloroform. The chloroform concentrations detected in 1996 were below NYSWQS. No VOCs were detected during any other sampling event.

5.4 Discussion of Findings

5.4.1 Operations and Maintenance

Based on review of post-closure operations and maintenance documentation, the post-closure operation and maintenance program appeared more than adequate to maintain the integrity of the DCR site. The secure nature of the site and the lack of variability observed in the remedial components over the post-closure period support a reduction in the frequency of inspection. The final cover and surface water control systems can receive inspection during the biannual mowing events. Inspection of benchmarks can be eliminated based on the lack of movement observed over the last 5 years. Security requirements have not changed and maintenance of service roads should be performed only as needed.

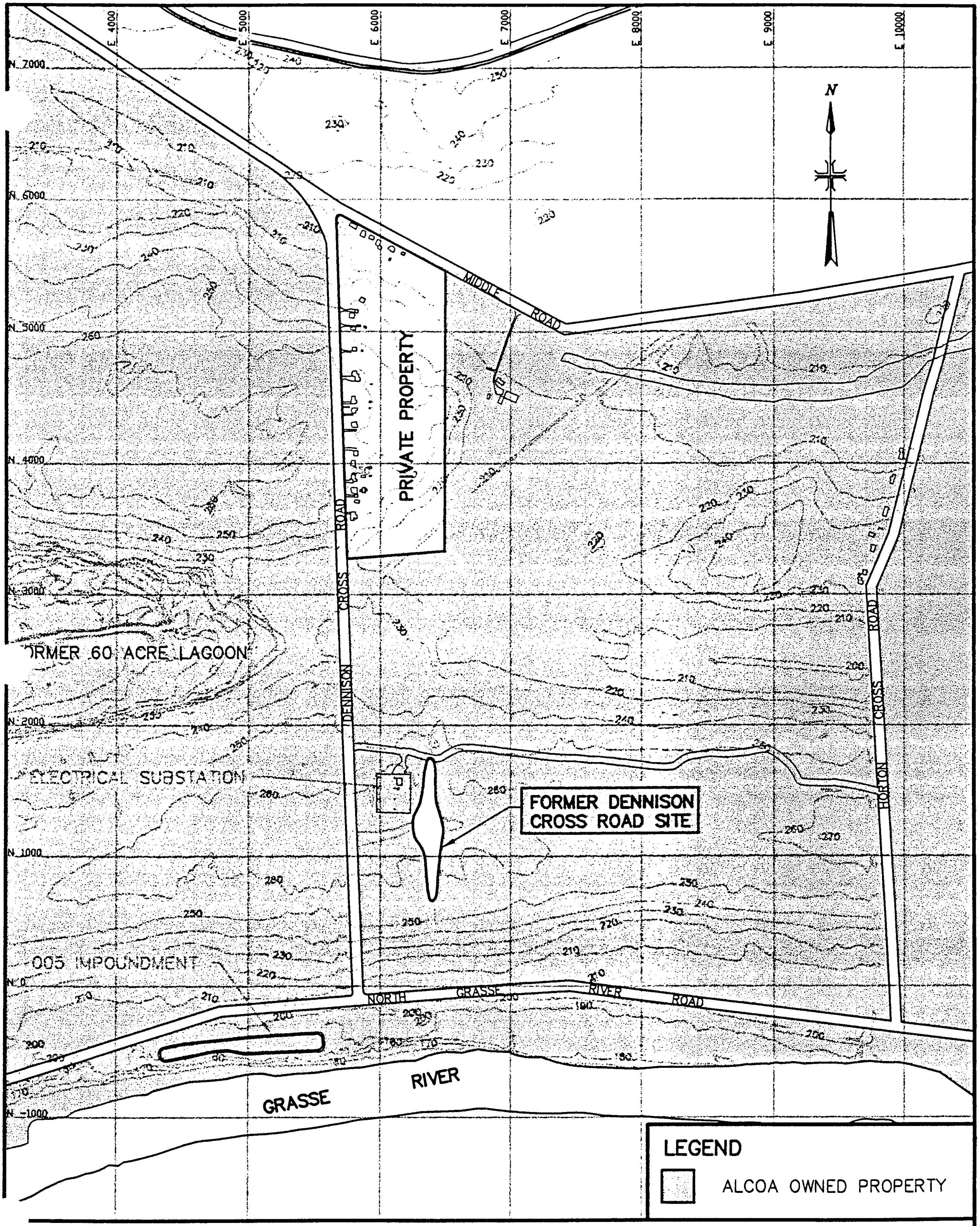
5.4.2 Groundwater Compliance Monitoring

The steady state groundwater flow, seepage velocity and cyclical water level changes observed at the DCR following closure, indicate that the post-closure monitoring plan was adequately designed to assess groundwater quality at the site. Additional characterization and monitoring of water level elevations and groundwater flow is no longer considered necessary based on historical data review.

Over the duration of the post-closure period, PCBs, PAHs and fluoride were not determined to be constituents of concern at the DCR. However, concentrations of degradation by-products of TCA were detected. Presently, only vinyl chloride at MW-292 and 1,1-DCA at MW-293 exceed NYSWQS. MW-293 is situated within the former waste area and represents conditions in the immediate vicinity of the remediated area. Based on the predominant groundwater flow direction, MW-292 evaluates downgradient groundwater quality to the north and MW-294 evaluates downgradient groundwater quality to the south. The lack of statistically significant increasing trends for VOC compounds detected at MW-293, and the relatively minor exceedances observed, indicates minimal impact to groundwater quality. In addition, the lack of statistically significant increasing trends for VOC compounds detected at MW-292, and the relatively minor exceedances observed, support the fact that contaminants of concern have not significantly impacted groundwater quality to the north. To the south, at MW-294, the absence of any detected compounds above NYSWQS indicates that groundwater quality has not been impacted.

Based on the average seepage velocities calculated over the 5-year period (28 to 37 feet per year to the north and 5 to 6 feet per year to the south) the migration of contaminants beyond the immediate vicinity of DCR and from Alcoa owned property is unlikely. The location of DCR relative to surrounding properties is presented in Figure 5-1.

From 1996 to 2000, the presence of degradation products without the source compound 1,1,1-TCA, consistently indicates that the source contaminant has been removed at the DCR site. Residual daughter products of 1,1,1-TCA are expected to naturally attenuate over time. The minor exceedances of degradation breakdown products, the remote and secure nature of the site and the lack of statistically significant increasing trends for detected compounds support the elimination of groundwater monitoring at the DCR.



ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SURROUNDING AREA LOCATION PLAN

SCALE 1" = 1000'

FIGURE 5-1

Section 6
Summary and Recommendations

6.1 Overview

This section presents the summary of 2000 post-closure operations and maintenance activities and groundwater monitoring evaluations. In addition, a summary of the findings of the 5-year review, including conclusions and recommendations, are presented.

6.2 Summary of 2000 Evaluations

The 2000 compliance monitoring program for the DCR consisted of two semiannual groundwater sampling rounds conducted in March and November 2000. Post-closure operations and maintenance for the site included routine inspections and maintenance of the site cover. During 2000, no maintenance problems were observed during routine inspections at the DCR.

The following is an evaluation summary for the 2000 compliance monitoring program results.

- Groundwater contours indicate that the 2000 groundwater flow patterns at the DCR are similar to previous years. Shallow overburden groundwater flows away from the ridge crest to the north and south.

- VOCs were not detected at downgradient well MW-294 in 2000 and have not been detected since 1996.

- At downgradient well MW-292, concentrations of vinyl chloride exceeded NYSWQS. Chloroethane and 1,1-DCA were detected at concentrations below NYSWQS. The 2000 VOC concentrations and the TCA molar sum at MW-292 were comparable to results from previous years.

- At well MW-293, located within the former excavation, 1,1-DCA concentrations exceeded NYSWQS. Vinyl chloride was detected at concentrations below NYSWQS. The 2000 VOC concentrations and the TCA molar sum at MW-293 were comparable to results from previous years.

6.3 Summary of Findings for 5-Year Review

- With the exception of one minor repair to the final cover in 1997, no problems have been observed with the final cover system, surface water controls, benchmarks or service roads. The 5 years of monitoring have shown stable conditions for all remedial components.

- Water level patterns fluctuated consistently, with the high water table generally occurring in the spring and the low water table occurring in the late summer or early fall. Following closure, the water levels in wells located within the capped former excavation were observed to fluctuate less than those outside the excavation.

- Groundwater flow contours and seepage velocities are comparable for all years reviewed, indicating that shallow overburden groundwater flows away from the ridge crest to the north and south.

- At downgradient well MW-292, concentrations of vinyl chloride slightly exceeded NYSWQS. VOC concentrations and the TCA molar sum were comparable for all years within the post-closure period with no statistically significant increasing trends noted.

- At well MW-293, located within the former excavation, concentrations of 1,1-DCA slightly exceeded NYSWQS. VOC concentrations and the TCA molar sum were comparable for all years within the post-closure period with no statistically significant trends noted.

- PCBs were eliminated as an analytical parameter at MW-293 in 2000, following four consecutive rounds of non-detection.

- VOCs have not been detected at downgradient well MW-294 since 1996.

6.4 Conclusions

Based on the evaluation of data in Section 4 and the findings outlined above, the following conclusion are presented:

- Inspection records and post-closure monitoring results indicate that the remedial components implemented at the DCR are functioning effectively and according to design specifications. The secure nature of the site and the lack of variability observed in the remedial components over the post-closure period support a reduction in the frequency of inspection. The final cover and surface water control systems can receive inspection during the biannual mowing events. Inspection of benchmarks can be eliminated based on the lack of movement observed over the last 5 years. Security requirements have not changed and service roads will require upgrading as needed.

- The VOCs detected at DCR wells MW-292 and MW-293 over the post-closure period, 1,1-DCA and vinyl chloride, are degradation byproducts of 1,1,1-TCA. The presence of daughter compounds without 1,1,1-TCA indicates that a continuing source is not present at the DCR.

- No increasing trends for VOCs have been observed at the DCR over the post-closure period. It is expected that residual concentrations will attenuate over time. The relatively minor exceedances of vinyl chloride and 1,1-DCA above NYSWQS, and the secure nature of the site support the conclusion that the risk to human health and the environment is minimal at DCR.

- The post-closure monitoring plan for the DCR site was designed to monitor the effectiveness of the implemented remedy and monitor groundwater concentrations in the vicinity of the site. Based on the results of the 5-year review, it can be concluded that the remediation met the design objectives and the post-closure monitoring has documented cleanup was complete and adequate to protect groundwater quality. The minor exceedances of degradation breakdown products, the remote and secure nature of the site, and the lack of statistically significant increasing trends for detected compounds support the elimination of groundwater monitoring at the DCR.

- In accordance with 6 NYCRR 373-2.7 (g)(1)(ii)(a and b) the post-closure care period may be shortened. This requirement provides that at any time during the post-closure care period, the NYSDEC may in accordance with permit modification procedures: "Shorten the post-closure care period if it is demonstrated that the reduced period is sufficient to protect human health and the environment."

The minimal risk to human health and the environment, the nominal variability in groundwater monitoring results, and the data supporting the effectiveness of the remediation, justify terminating the post-closure care period and delisting the DCR site from the list of inactive hazardous waste sites. As stated, bi-annual mowing and inspections of the final cover system would be continued. Security measures would continue to be enforced.

6.5 Recommendations

Based on the conclusions presented and the statutes outlined in 6 NYCRR 373-2.7, Alcoa recommends delisting DCR from the list of inactive hazardous waste sites and reducing the post-closure operation and monitoring to bi-annual mowing and inspections of the final cover system. Security measures would continue to be enforced.

Section 7
References

CDM. Post-Closure Operation and Maintenance Manual for the Dennison Cross Road Site. March 1994.

CDM. Quality Assurance Project Plan. July 1995.

CDM. Certification Report for the Dennison Cross Road Site. April 1996.

CDM. Dennison Road Baseline Groundwater Evaluation Report. August 1997.

CDM. Post-Closure Monitoring Plan for the Dennison Cross Road Site. November 1998.

CDM. 1997 Annual Report for the Dennison Cross Road Site. April 1998.

CDM. 1998 Annual Report for the Dennison Cross Road Site. April 1999.

CDM. 1999 Annual Report for the Dennison Cross Road Site. February 2000.

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Preliminary Engineering Plan for Alcoa FSI Disposal Areas. 1991

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NYSDEC. Record of Decision, March 1991.

NYSDEC. Record of Decision, January 1992.

Gilbert, R.O. Statistical Methods for Environmental Pollution Monitoring. VanNostrand Reinhold Co., New York. 1987. NYSDEC.

New York Codes, Rules and Regulations. 6 NYCRR Subpart 373-2: Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities. 1996.

Appendix A

Water Level and Precipitation Data

Well ID	Sample Date	TIC Elevation	Depth to Water	Water Level Elevation[1]	Comment
MW-001	3/8/00	261.57	6.96	254.61	
MW-001	5/3/00	261.57	6.79	254.78	
MW-001	9/25/00	261.57	8.55	253.02	
MW-001	11/15/00	261.57	8.70	252.87	
MW-027	3/8/00	263.88	4.75	259.13	
MW-027	5/3/00	263.88	4.75	259.13	
MW-027	9/25/00	263.88	4.98	258.90	
MW-027	11/15/00	263.88	5.15	258.73	
MW-028	3/8/00	261.27	6.76	254.51	Estimated; water level higher than graduations on tape (not flowing)
MW-028	5/3/00	261.27	6.58	254.69	
MW-028	9/25/00	261.27	7.24	254.03	
MW-028	11/15/00	261.27	7.83	253.44	Before Sampling
MW-029	3/8/00	263.68	3.75	259.93	Before Sampling
MW-029	5/3/00	263.68	4.32	259.36	Before Sampling
MW-029	9/25/00	263.68	4.96	258.72	
MW-029	11/15/00	263.68	5.15	258.53	
MW-030	3/8/00	265.43	4.60	260.83	
MW-030	5/3/00	265.43	4.56	260.87	
MW-030	9/25/00	265.43	4.64	260.79	
MW-030	11/15/00	265.43	4.53	260.90	
MW-048D	3/8/00	261.73	15.76	245.97	
MW-048D	5/3/00	261.73	14.52	247.21	Watterra needs fishing out
MW-048D	9/25/00	261.73	17.10	244.63	
MW-048D	11/15/00	261.73	17.36	244.37	
MW-051	3/8/00	253.21	3.50	249.71	
MW-051	5/3/00	253.21	4.50	248.71	
MW-051	9/25/00	253.21	4.20	249.01	
MW-051	11/15/00	253.21	4.07	249.14	
MW-069	3/8/00	267.16	7.00	260.16	
MW-069	5/3/00	267.16	4.99	262.17	
MW-069	9/25/00	267.16	7.91	259.25	
MW-069	11/15/00	267.16	8.83	258.33	Heaved
MW-114	3/8/00	260.36	6.48	253.88	
MW-114	5/3/00	260.36	6.31	254.05	
MW-114	9/25/00	260.36	6.95	253.41	
MW-114	11/15/00	260.36	7.54	252.82	
MW-115	3/8/00	258.97	7.90	251.07	
MW-115	5/3/00	258.97	7.70	251.27	
MW-115	9/25/00	258.97	8.35	250.62	
MW-115	11/15/00	258.97	8.99	249.98	
MW-291	3/8/00	270.48	10.38	260.10	
MW-291	5/3/00	270.48	7.21	263.27	
MW-291	9/25/00	270.48	10.20	260.28	
MW-291	11/15/00	270.48	10.84	259.64	Before Sampling
MW-292	3/8/00	259.45	7.90	251.55	Before Sampling
MW-292	5/3/00	259.45	7.88	251.57	Before Sampling
MW-292	9/25/00	259.45	8.72	250.73	
MW-292	11/15/00	259.45	9.01	250.44	
MW-293	3/8/00	262.32	2.51	259.81	
MW-293	5/3/00	262.32	2.13	260.19	
MW-293	9/25/00	262.32	3.85	258.47	
MW-293	11/15/00	262.32	3.41	258.91	
MW-294	3/8/00	248.3	6.37	241.93	
MW-294	5/3/00	248.3	6.17	242.13	Watterra needs fishing out

A-1

Summary of 2000 Water Levels

Well ID	Sample Date	TIC Elevation	Depth to Water	Water Level Elevation[1]	Comment
IW-294	9/25/00	248.3	6.85	241.45	
MW-294	11/15/00	248.3	6.94	241.36	
MW-295	3/8/00	264.98	7.15	257.83	
MW-295	5/3/00	264.98	6.33	258.65	
MW-295	9/25/00	264.98	9.36	255.62	
MW-295	11/15/00	264.98	9.80	255.18	
MW-296	3/8/00	255.97	0.75	255.22	
MW-296	5/3/00	255.97	0.70	255.27	
MW-296	9/25/00	255.97	0.73	255.24	
MW-296	11/15/00	255.97	0.82	255.15	Heaved

Note:
1. All water level elevations reported in feet USLS.

Appendix A-2

Precipitation Data

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
1/1/00	0.00	0.00
1/2/00	0.13	0.13
1/3/00	0.00	0.13
1/4/00	0.37	0.50
1/5/00	0.00	0.50
1/6/00	0.00	0.50
1/7/00	0.04	0.54
1/8/00	0.00	0.54
1/9/00	0.00	0.54
1/10/00	0.72	1.26
1/11/00	0.03	1.29
1/12/00	0.00	1.29
1/13/00	0.00	1.29
1/14/00	0.00	1.29
1/15/00	0.00	1.29
1/16/00	0.01	1.30
1/17/00	0.00	1.30
1/18/00	0.00	1.30
1/19/00	0.00	1.30
1/20/00	0.00	1.30
1/21/00	0.00	1.30
1/22/00	0.00	1.30
1/23/00	0.00	1.30
1/24/00	0.00	1.30
1/25/00	0.03	1.33
1/26/00	0.00	1.33
1/27/00	0.00	1.33
1/28/00	0.00	1.33
1/29/00	0.00	1.33
1/30/00	0.01	1.34
1/31/00	0.09	1.43
2/1/00	0.00	0.00
2/2/00	0.00	0.00
2/3/00	0.00	0.00
2/4/00	0.00	0.00
2/5/00	0.08	0.08
2/6/00	0.00	0.08
2/7/00	0.00	0.08
2/8/00	0.00	0.08
2/9/00	0.00	0.08
2/10/00	0.00	0.08
2/11/00	0.05	0.13
2/12/00	0.00	0.13
2/13/00	0.00	0.13
2/14/00	0.05	0.18
2/15/00	0.00	0.18
2/16/00	0.11	0.29
2/17/00	0.00	0.29
2/18/00	0.00	0.29

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
2/19/00	0.00	0.29
2/20/00	0.00	0.29
2/21/00	0.00	0.29
2/22/00	0.00	0.29
2/23/00	0.00	0.29
2/24/00	0.31	0.60
2/25/00	0.14	0.74
2/26/00	0.00	0.74
2/27/00	0.11	0.85
2/28/00	0.05	0.90
2/29/00	0.00	0.90
3/1/00	0.05	0.05
3/2/00	0.00	0.05
3/3/00	0.00	0.05
3/4/00	0.00	0.05
3/5/00	0.00	0.05
3/6/00	0.00	0.05
3/7/00	0.00	0.05
3/8/00	0.00	0.05
3/9/00	0.04	0.09
3/10/00	0.00	0.09
3/11/00	0.04	0.13
3/12/00	0.32	0.45
3/13/00	0.00	0.45
3/14/00	0.03	0.48
3/15/00	0.20	0.68
3/16/00	0.38	1.06
3/17/00	0.00	1.06
3/18/00	0.00	1.06
3/19/00	0.00	1.06
3/20/00	0.00	1.06
3/21/00	0.00	1.06
3/22/00	0.00	1.06
3/23/00	0.00	1.06
3/24/00	0.00	1.06
3/25/00	0.00	1.06
3/26/00	0.00	1.06
3/27/00	0.00	1.06
3/28/00	0.86	1.92
3/29/00	0.11	2.03
3/30/00	0.10	2.13
3/31/00	0.00	2.13
4/1/00	0.00	0.00
4/2/00	0.18	0.18
4/3/00	0.03	0.21
4/4/00	0.60	0.81
4/5/00	0.02	0.83
4/6/00	0.10	0.93
4/7/00	0.00	0.93

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
4/8/00	1.59	2.52
4/9/00	0.15	2.67
4/10/00	0.01	2.68
4/11/00	0.01	2.69
4/12/00	0.02	2.71
4/13/00	0.00	2.71
4/14/00	0.00	2.71
4/15/00	0.00	2.71
4/16/00	0.00	2.71
4/17/00	0.00	2.71
4/18/00	0.00	2.71
4/19/00	0.00	2.71
4/20/00	0.00	2.71
4/21/00	0.90	3.61
4/22/00	0.17	3.78
4/23/00	0.07	3.85
4/24/00	0.00	3.85
4/25/00	0.00	3.85
4/26/00	0.00	3.85
4/27/00	0.00	3.85
4/28/00	0.00	3.85
4/29/00	0.00	3.85
4/30/00	0.00	3.85
5/1/00	0.08	0.08
5/2/00	0.00	0.08
5/3/00	0.00	0.08
5/4/00	0.00	0.08
5/5/00	0.53	0.61
5/6/00	0.02	0.63
5/7/00	0.20	0.83
5/8/00	0.42	1.25
5/9/00	1.77	3.02
5/10/00	1.17	4.19
5/11/00	0.02	4.21
5/12/00	0.00	4.21
5/13/00	0.10	4.31
5/14/00	0.00	4.31
5/15/00	0.00	4.31
5/16/00	0.00	4.31
5/17/00	0.00	4.31
5/18/00	1.17	5.48
5/19/00	0.00	5.48
5/20/00	0.00	5.48
5/21/00	0.00	5.48
5/22/00	0.00	5.48
5/23/00	0.03	5.51
5/24/00	0.31	5.82
5/25/00	0.25	6.07
5/26/00	0.00	6.07

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
5/27/00	0.00	6.07
5/28/00	0.00	6.07
5/29/00	0.00	6.07
5/30/00	0.00	6.07
5/31/00	0.09	6.16
6/1/00	0.00	0.00
6/2/00	0.03	0.03
6/3/00	0.00	0.03
6/4/00	0.10	0.13
6/5/00	0.01	0.14
6/6/00	0.17	0.31
6/7/00	0.00	0.31
6/8/00	0.01	0.32
6/9/00	0.18	0.50
6/10/00	0.14	0.64
6/11/00	0.15	0.79
6/12/00	0.00	0.79
6/13/00	0.18	0.97
6/14/00	0.05	1.02
6/15/00	0.63	1.65
6/16/00	0.00	1.65
6/17/00	0.02	1.67
6/18/00	0.12	1.79
6/19/00	0.07	1.86
6/20/00	0.00	1.86
6/21/00	0.54	2.40
6/22/00	0.30	2.70
6/23/00	0.00	2.70
6/24/00	0.00	2.70
6/25/00	0.19	2.89
6/26/00	0.00	2.89
6/27/00	0.27	3.16
6/28/00	0.00	3.16
6/29/00	0.21	3.37
6/30/00	0.23	3.60
7/1/00	0.00	0.00
7/2/00	0.31	0.31
7/3/00	0.14	0.45
7/4/00	0.07	0.52
7/5/00	0.00	0.52
7/6/00	0.00	0.52
7/7/00	0.16	0.68
7/8/00	0.00	0.68
7/9/00	0.35	1.03
7/10/00	0.03	1.06
7/11/00	0.00	1.06
7/12/00	0.00	1.06
7/13/00	0.00	1.06
7/14/00	0.26	1.32

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
7/15/00	0.26	1.58
7/16/00	0.31	1.89
7/17/00	0.01	1.90
7/18/00	0.00	1.90
7/19/00	0.00	1.90
7/20/00	0.00	1.90
7/21/00	0.50	2.40
7/22/00	0.60	3.00
7/23/00	0.00	3.00
7/24/00	0.00	3.00
7/25/00	0.00	3.00
7/26/00	0.00	3.00
7/27/00	0.02	3.02
7/28/00	0.16	3.18
7/29/00	0.00	3.18
7/30/00	0.00	3.18
7/31/00	0.00	3.18
8/1/00	0.26	0.26
8/2/00	0.02	0.28
8/3/00	0.33	0.61
8/4/00	0.00	0.61
8/5/00	0.00	0.61
8/6/00	0.02	0.63
8/7/00	0.03	0.66
8/8/00	0.00	0.66
8/9/00	1.20	1.86
8/10/00	0.00	1.86
8/11/00	1.00	2.86
8/12/00	0.01	2.87
8/13/00	0.00	2.87
8/14/00	0.00	2.87
8/15/00	0.00	2.87
8/16/00	0.32	3.19
8/17/00	0.00	3.19
8/18/00	0.00	3.19
8/19/00	0.00	3.19
8/20/00	0.00	3.19
8/21/00	0.00	3.19
8/22/00	0.00	3.19
8/23/00	0.24	3.43
8/24/00	0.00	3.43
8/25/00	0.00	3.43
8/26/00	0.00	3.43
8/27/00	0.00	3.43
8/28/00	0.00	3.43
8/29/00	0.00	3.43
8/30/00	0.00	3.43
8/31/00	0.00	3.43
9/1/00	0.00	0.00

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
9/2/00	0.72	0.72
9/3/00	0.04	0.76
9/4/00	0.03	0.79
9/5/00	0.00	0.79
9/6/00	0.00	0.79
9/7/00	0.00	0.79
9/8/00	0.00	0.79
9/9/00	0.00	0.79
9/10/00	0.00	0.79
9/11/00	1.44	2.23
9/12/00	0.84	3.07
9/13/00	0.00	3.07
9/14/00	0.10	3.17
9/15/00	0.29	3.46
9/16/00	0.00	3.46
9/17/00	0.00	3.46
9/18/00	0.00	3.46
9/19/00	0.00	3.46
9/20/00	0.00	3.46
9/21/00	0.12	3.58
9/22/00	0.00	3.58
9/23/00	0.30	3.88
9/24/00	0.45	4.33
9/25/00	0.00	4.33
9/26/00	0.00	4.33
9/27/00	0.41	4.74
9/28/00	0.00	4.74
9/29/00	0.00	4.74
9/30/00	0.00	4.74
10/1/00	0.00	0.00
10/2/00	0.00	0.00
10/3/00	0.00	0.00
10/4/00	0.06	0.06
10/5/00	0.13	0.19
10/6/00	0.00	0.19
10/7/00	0.10	0.29
10/8/00	0.00	0.29
10/9/00	0.00	0.29
10/10/00	0.06	0.35
10/11/00	0.00	0.35
10/12/00	0.00	0.35
10/13/00	0.03	0.38
10/14/00	0.00	0.38
10/15/00	0.00	0.38
10/16/00	0.00	0.38
10/17/00	0.00	0.38
10/18/00	0.47	0.85
10/19/00	0.00	0.85
10/20/00	0.00	0.85

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
10/21/00	0.00	0.85
10/22/00	0.00	0.85
10/23/00	0.00	0.85
10/24/00	0.00	0.85
10/25/00	0.00	0.85
10/26/00	0.00	0.85
10/27/00	0.04	0.89
10/28/00	0.00	0.89
10/29/00	0.00	0.89
10/30/00	0.00	0.89
10/31/00	0.00	0.89
11/1/00	0.00	0.00
11/2/00	0.00	0.00
11/3/00	0.02	0.02
11/4/00	0.00	0.02
11/5/00	0.00	0.02
11/6/00	0.00	0.02
11/7/00	0.00	0.02
11/8/00	0.00	0.02
11/9/00	0.30	0.32
11/10/00	0.28	0.60
11/11/00	0.04	0.64
11/12/00	0.00	0.64
11/13/00	0.00	0.64
11/14/00	0.41	1.05
11/15/00	0.00	1.05
11/16/00	0.00	1.05
11/17/00	0.00	1.05
11/18/00	0.00	1.05
11/19/00	0.00	1.05
11/20/00	0.05	1.10
11/21/00	0.01	1.11
11/22/00	0.00	1.11
11/23/00	0.00	1.11
11/24/00	0.00	1.11
11/25/00	0.00	1.11
11/26/00	1.10	2.21
11/27/00	0.34	2.55
11/28/00	0.09	2.64
11/29/00	0.00	2.64
11/30/00	0.00	2.64
12/1/00	0.00	0.00
12/2/00	0.00	0.00
12/3/00	0.00	0.00
12/4/00	0.00	0.00
12/5/00	0.00	0.00
12/6/00	0.00	0.00
12/7/00	0.00	0.00
12/8/00	0.00	0.00

Date	Daily Precipitation (in)	Monthly Cumulative Precipitation (in)
12/9/00	0.00	0.00
12/10/00	0.00	0.00
12/11/00	0.02	0.02
12/12/00	0.17	0.19
12/13/00	0.00	0.19
12/14/00	0.13	0.32
12/15/00	0.04	0.36
12/16/00	0.30	0.66
12/17/00	0.10	0.76
12/18/00	0.02	0.78
12/19/00	0.00	0.78
12/20/00	0.00	0.78
12/21/00	0.00	0.78
12/22/00	0.00	0.78
12/23/00	0.00	0.78
12/24/00	0.00	0.78
12/25/00	0.00	0.78
12/26/00	0.00	0.78
12/27/00	0.00	0.78
12/28/00	0.00	0.78
12/29/00	0.00	0.78
12/30/00	0.02	0.80
12/31/00	0.04	0.84

Appendix A-3

Seepage Calculations

CAMP DRESSER & McKEE

CLIENT Alcoa
PROJECT DCR-2000 Annual Report
DETAIL Hydraulic Gradient

JOB NO.
DATE CHECKED 01/10/01
CHECKED BY [illegible]

COMPUTED BY C. Waagstaff
DATE 12/15/00
PAGE NO. 1 of 1

Purpose: To calculate the horizontal and vertical hydraulic gradients at wells located at the DCR site.

Gradient = $\frac{dh}{dl}$ (unitless)

	elevation (h)	dh	dl	dh/dl
May:				
MW-296	255.27	13.14	510	0.026
MW-294	242.13			
MW-069	262.17	3.52	140	0.025
MW-295	258.65			
MW-291	263.27	11.7	330	0.035
MW-292	251.57			
MW-028	254.69	12.56	370	0.034
MW-294	242.13			
MW-029	259.36	4.67	200	0.023
MW-028	254.69			
vertical				
MW-028	254.69	7.48	66	0.113
MW-078D	247.21			
September:				
MW-296	255.24	13.79	510	0.027
MW-294	241.45			
MW-069	259.25	3.63	140	0.026
MW-295	255.62			
MW-291	260.28	9.55	330	0.029
MW-292	250.73			
MW-028	254.03	12.58	370	0.034
MW-294	241.45			
MW-029	258.72	4.69	200	0.023
MW-028	254.03			
vertical				
MW-028	254.03	9.4	66	0.142
MW-078D	244.63			

Purpose: To calculate the horizontal hydraulic gradient at DCR and estimate the seepage velocity in the overburden deposits.

Gradient - $\frac{dh}{dl}$ (unitless)

To the North: MW-069 → MW-051 ; dl = 385 ft

	May elev (h)	Sept elev (h)
MW-069	262.17	259.25
MW-051	248.71	249.01

To the South: MW-028 → MW-294 ; dl = 370 ft

	May elev (h)	Sept elev (h)
MW-028	254.69	254.03
MW-294	242.13	241.45

dh/dl

May / Sept

North: MW-069 → MW-051

$dh/dl = \frac{262.17 - 248.71}{385} = 0.035$ $dh/dl = \frac{259.25 - 249.01}{385} = 0.027$

South MW-028 → MW-294

$dh/dl = \frac{254.69 - 242.13}{370} = 0.034$ $dh/dl = \frac{254.03 - 241.45}{370} = 0.034$

Hydraulic conductivity values (K)

North: MW-051 = 0.938 ft/day
MW-069 = 0.074 ft/day
MW-295 = 4.35 ft/day
MW-001 = Not tested.

Geometric Mean, K =

$\sqrt[n]{x_1 \cdot x_2 \cdot \cdots x_n}$

$= \sqrt[3]{0.301} = 0.671$ ft/day

South: MW-029 = 0.399 ft/day
MW-028 = 0.085 ft/day
MW-294 = 2.37×10^{-2} ft/day

Geometric Mean K =

$= \sqrt[n]{X_1 \cdot X_2 \cdot \ldots X_n}$

$= \sqrt[3]{8.037 \times 10^{-4}} = 0.093$ ft/day

<u>Seepage</u> <u>Velocity</u> <u>Estimates</u>

$\bar{V} = \frac{k\, dh/dl}{n_e}$ where: k = hydraulic conductivity, ft/day
dh/dl = gradient
n_e = effective porosity

North: K = 0.671 ft/day, n_e = 0.23

May: $\bar{V} = \frac{0.671 \text{ ft/day} (0.035)}{0.23}$
$\bar{V}$ = 0.102 ft/day
$\bar{V}$ = 37 ft/yr

Sept: $\bar{V} = \frac{0.671 \text{ ft/day} (0.027)}{0.23}$
$\bar{V}$ = 0.079 ft/day
$\bar{V}$ = 28 ft/yr

South: K = 0.093 ft/day n_e = 0.23

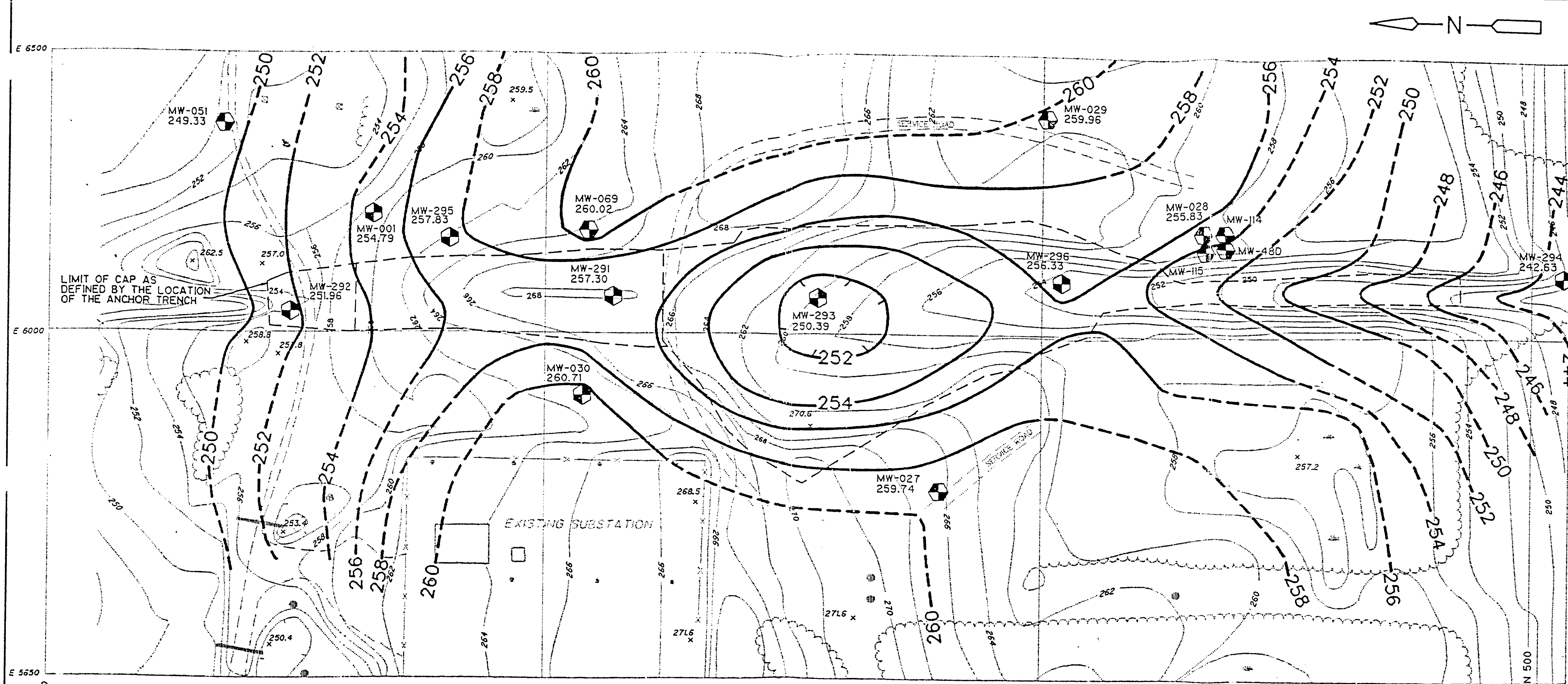
May: $\bar{V} = \frac{0.093 \text{ ft/day} (0.034)}{0.23}$
$\bar{V}$ = 0.014 ft/day
$\bar{V}$ = 5 ft/yr

Sept: $\bar{V} = \frac{0.093 \text{ ft/day} (0.034)}{0.23}$
$\bar{V}$ = 0.014 ft/day
$\bar{V}$ = 5 ft/yr

<u>Conclusion</u>: The seepage velocity estimates for the shallow overburden deposits beneath the DCR site range from 28 to 37 ft/yr north of the crest and 5 ft/yr south of the crest.

Appendix A-4

5-Year Review Contour Maps



LEGEND:

MW-027 259.74 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

— — — THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATES APRIL 29 & 30, 1996

NOTES:

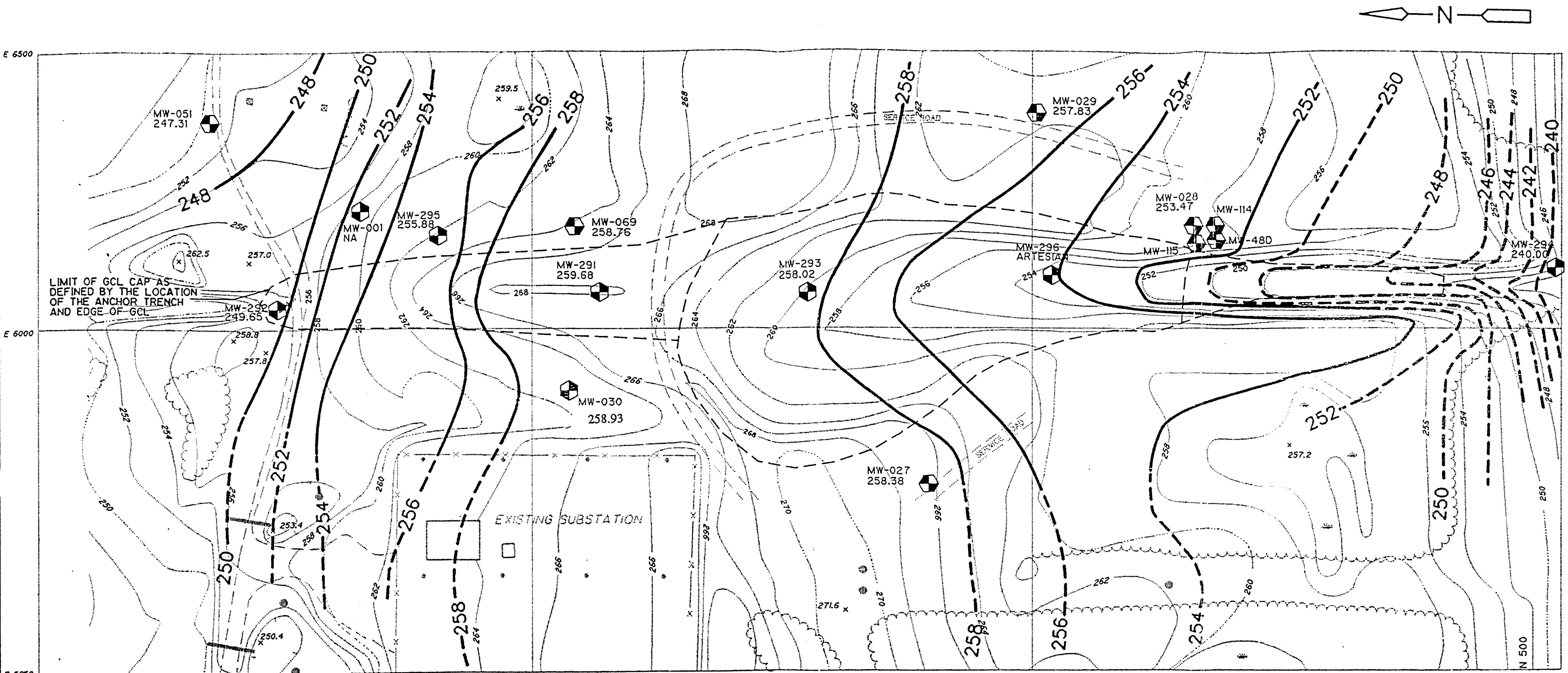
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET
1" = 100'
100 0 100 200

ALCOA - MASSENA, NEW YORK

DENNISON ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
APRIL 1996

FIGURE 4-2



LEGEND:

MW-027 259.74 NA — MONITORING WELL LOCATION / GROUNDWATER ELEVATION / DATA NOT AVAILABLE

THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE JULY 15 AND 17, 1996.

NOTES:

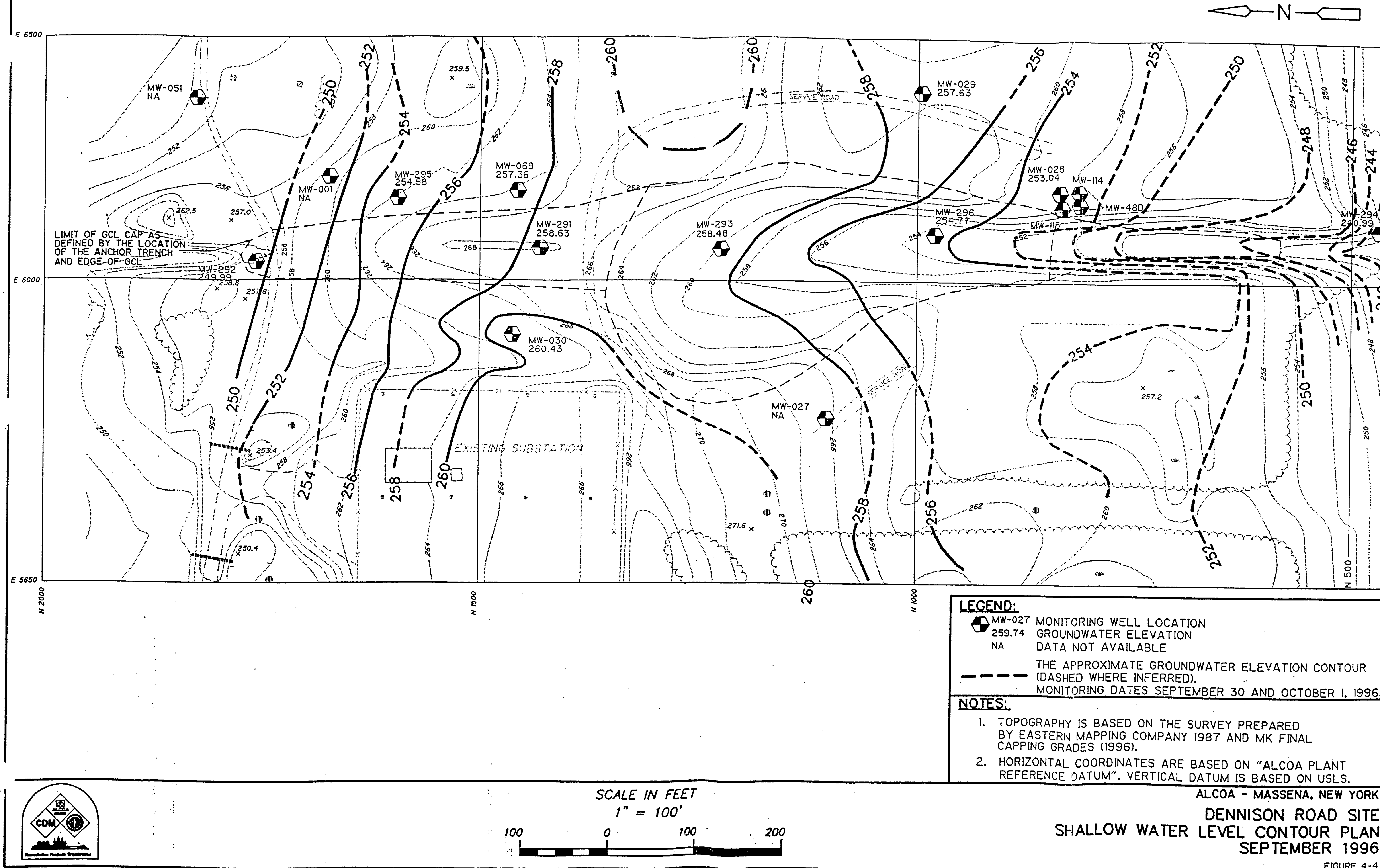
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET
1" = 100'
100 0 100 200

ALCOA - MASSENA, NEW YORK

DENNISON ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
JULY 1996

FIGURE 4-3



LEGEND:

MW-027 259.74 NA — MONITORING WELL LOCATION, GROUNDWATER ELEVATION, DATA NOT AVAILABLE

THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATES SEPTEMBER 30 AND OCTOBER 1, 1996.

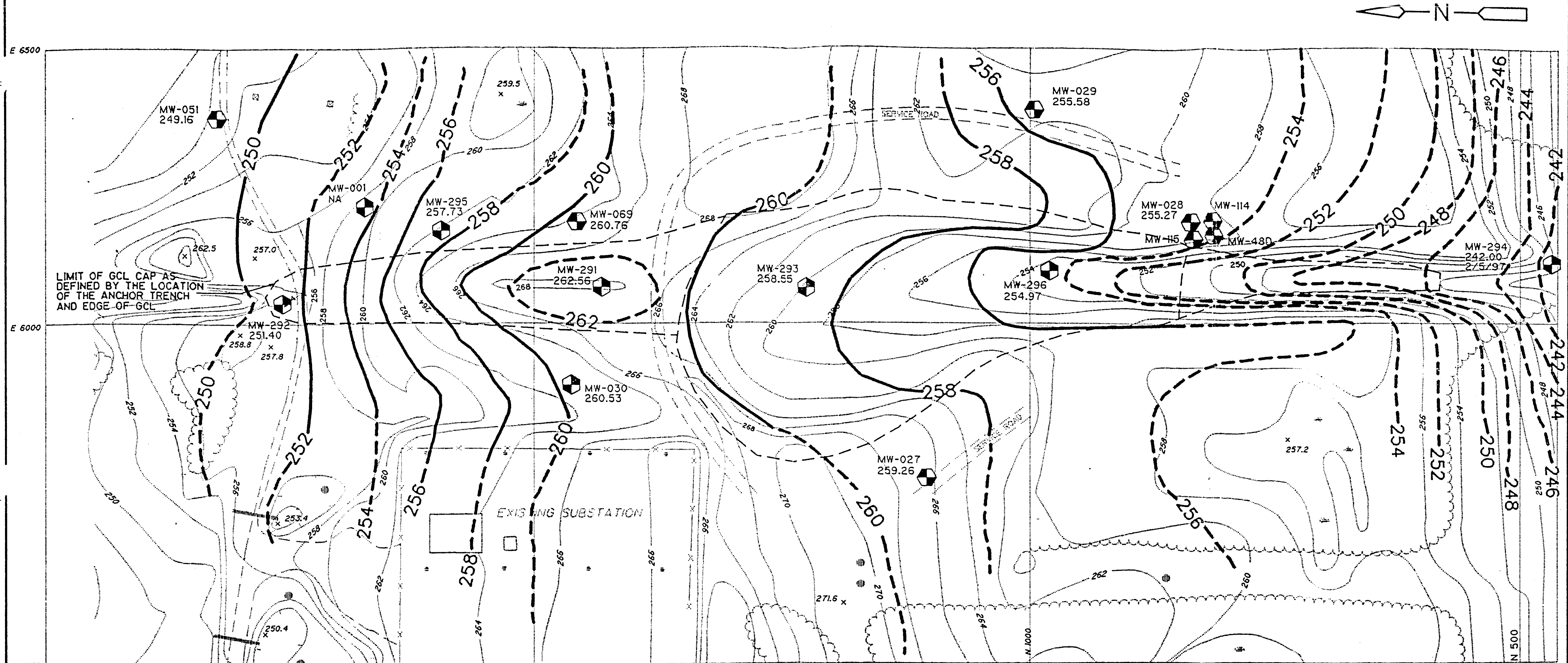
NOTES:

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

ALCOA - MASSENA, NEW YORK

DENNISON ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
SEPTEMBER 1996

FIGURE 4-4



LEGEND:

MW-027 / 259.74 / NA — MONITORING WELL LOCATION / GROUNDWATER ELEVATION / DATA NOT AVAILABLE

— — — THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATES JANUARY 15,17 1997, UNLESS OTHERWISE NOTED.

NOTES:

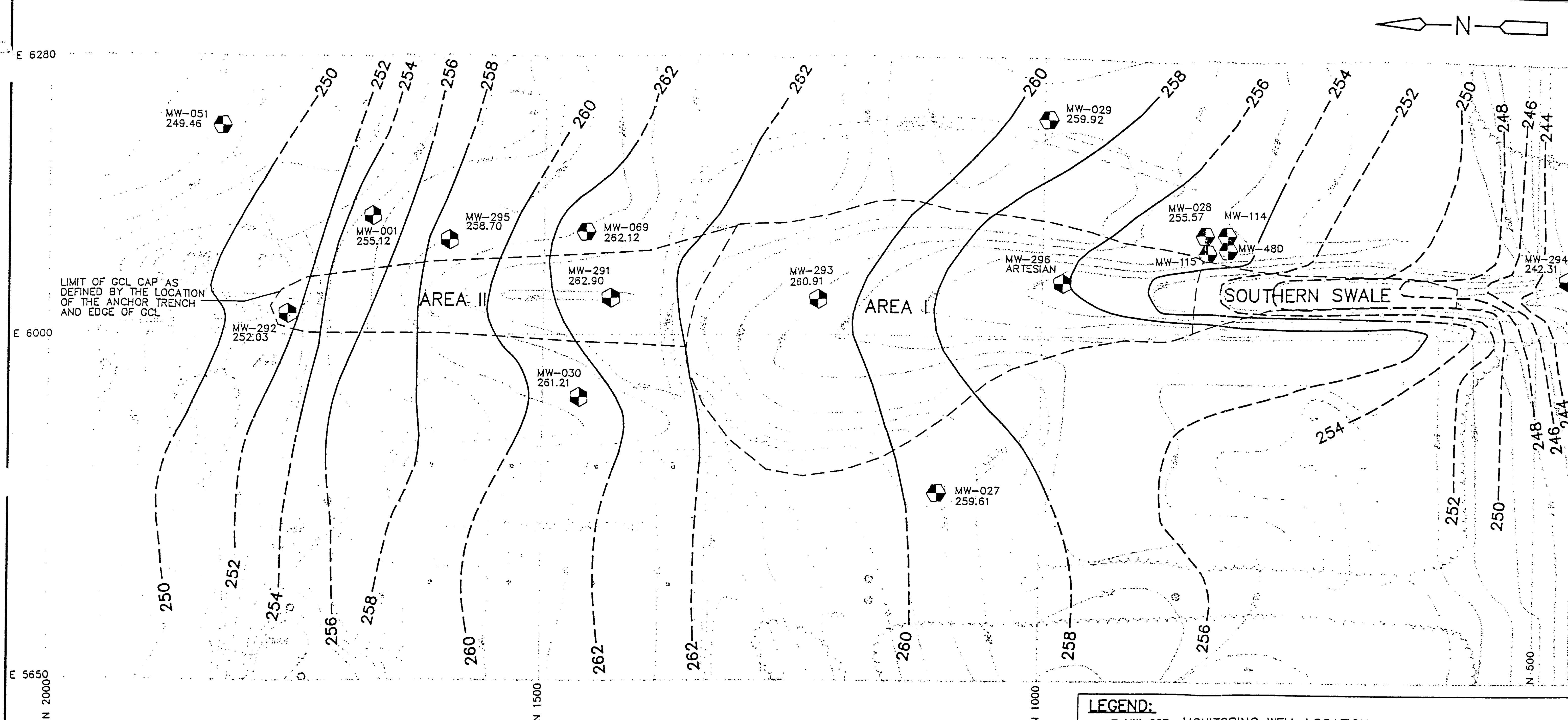
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET
1" = 100'
100 0 100 200

ALCOA - MASSENA, NEW YORK

DENNISON ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
JANUARY 1997

FIGURE 4-5



LEGEND:

MW-027 259.74 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

--258-- THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE MAY 13, 1997.

NOTES:

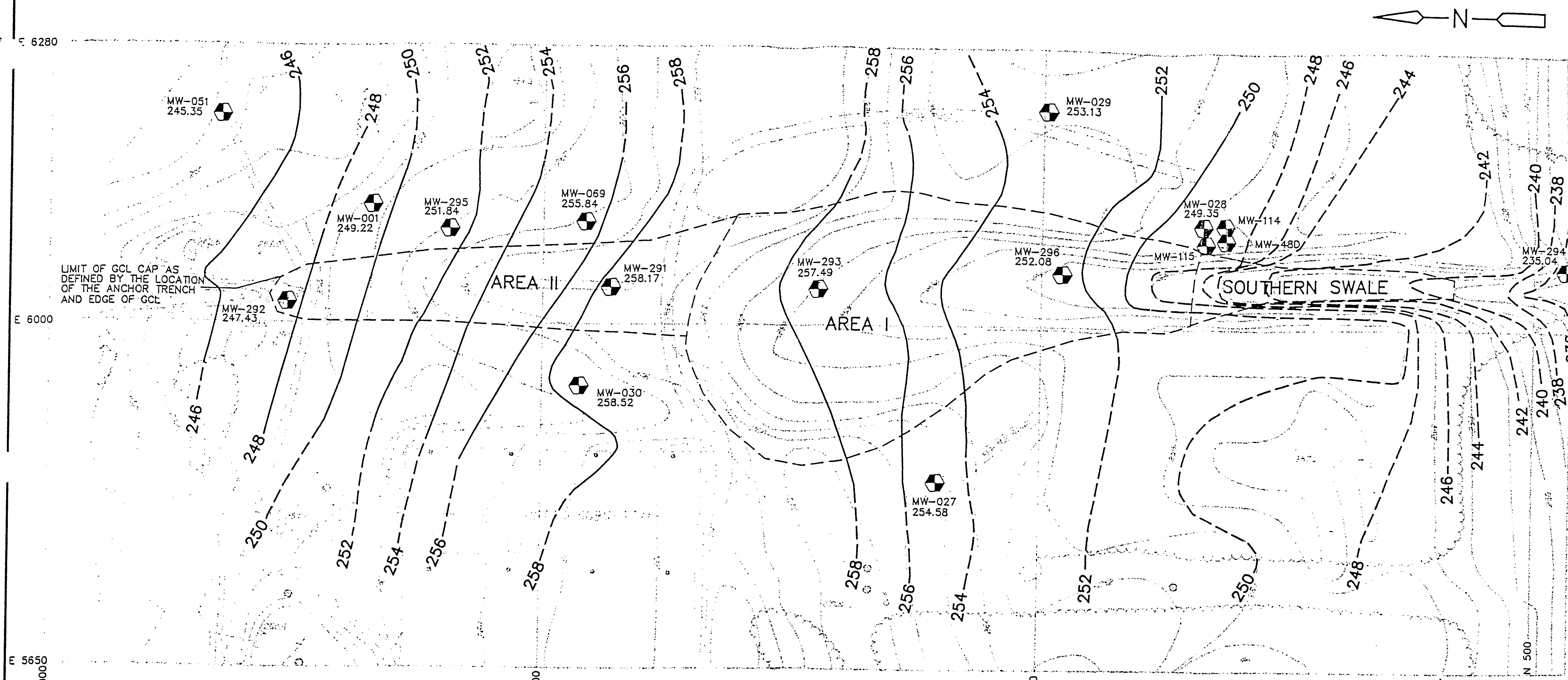
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN

MAY 1997

FIGURE 4-1



LEGEND:

MW-027 259.74 — MONITORING WELL LOCATION, GROUNDWATER ELEVATION

--260-- — THE APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATES SEPTEMBER 16, 1997.

NOTES:

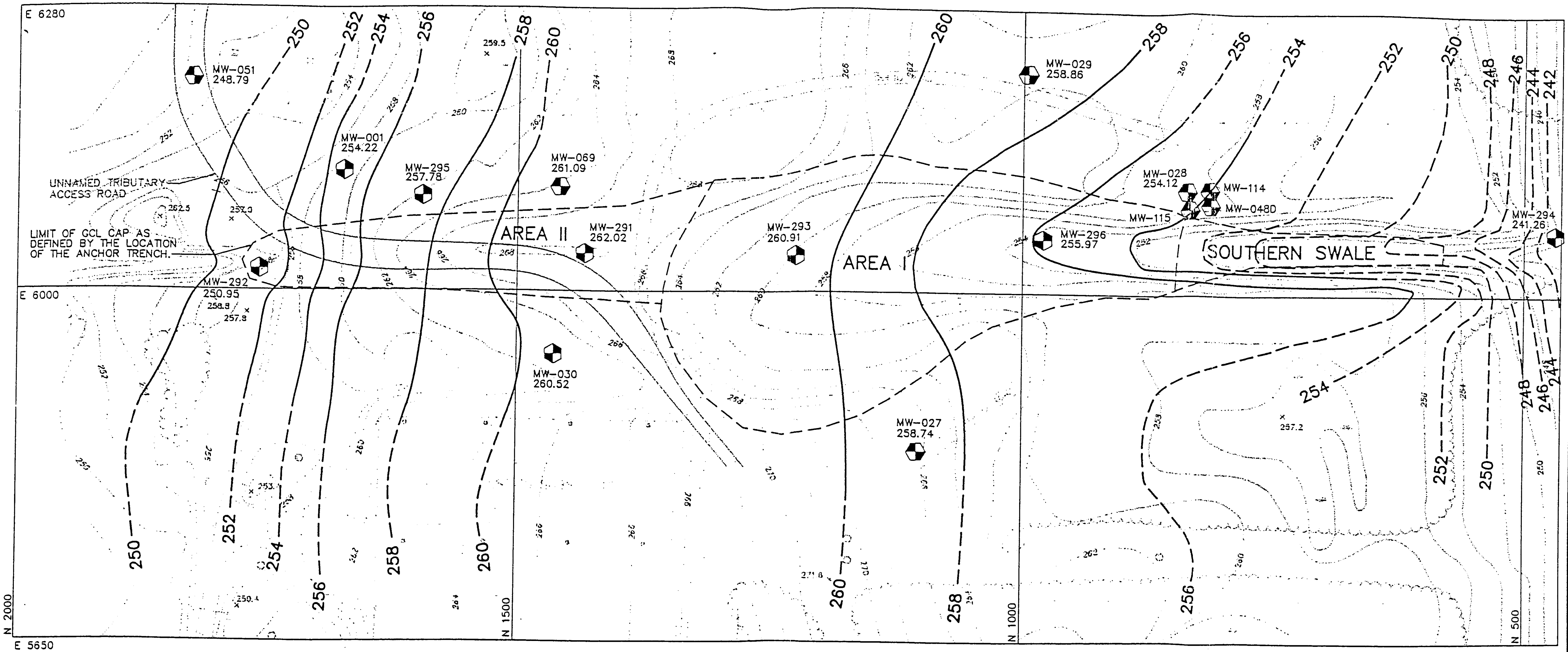
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET
1" = 100'
100 0 100 200

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
SEPTEMBER 1997

FIGURE 4-2



SCALE IN FEET

100 0 100 200

LEGEND

MW-027 259.74 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

--258-- — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE MAY 12, 1998.

NOTES

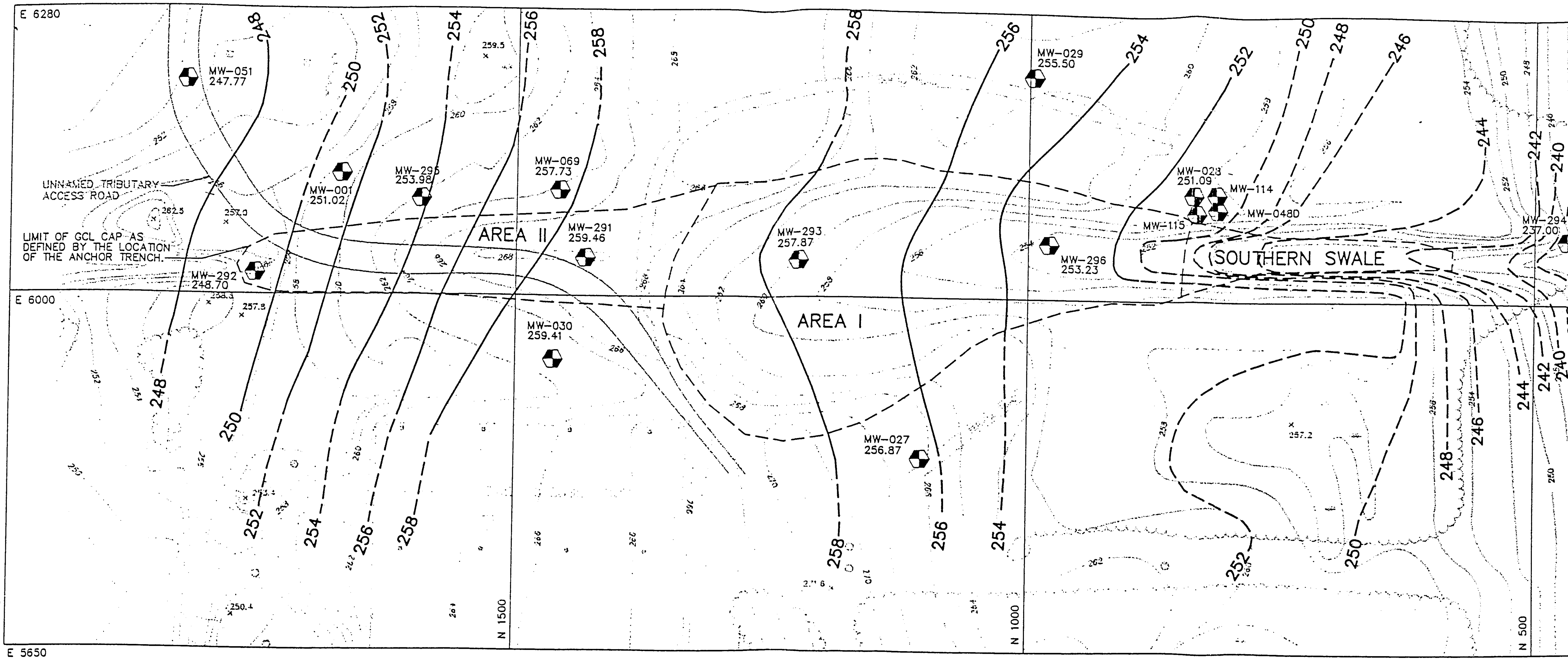
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN

MAY 1998

FIGURE 4-1



LEGEND

MW-027 259.74 — MONITORING WELL LOCATION / GROUNDWATER ELEVATION

--260-- APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATES SEPTEMBER 14, 1998.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

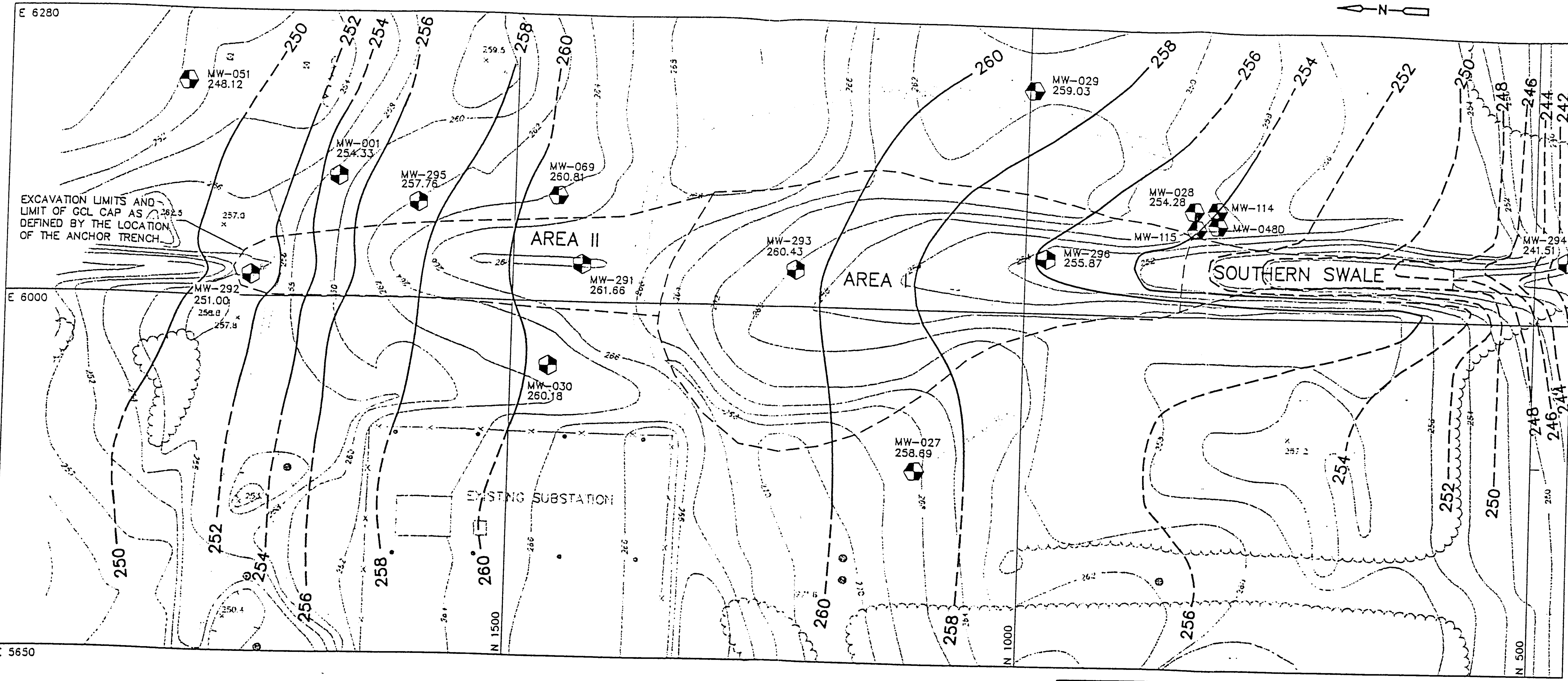
SCALE IN FEET

100 0 100 200

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
SEPTEMBER 1998

FIGURE 4-2



SCALE IN FEET

100 0 100 200

LEGEND

MW-027 258.69 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

--258-- — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE APRIL 26, 1999.

NOTES

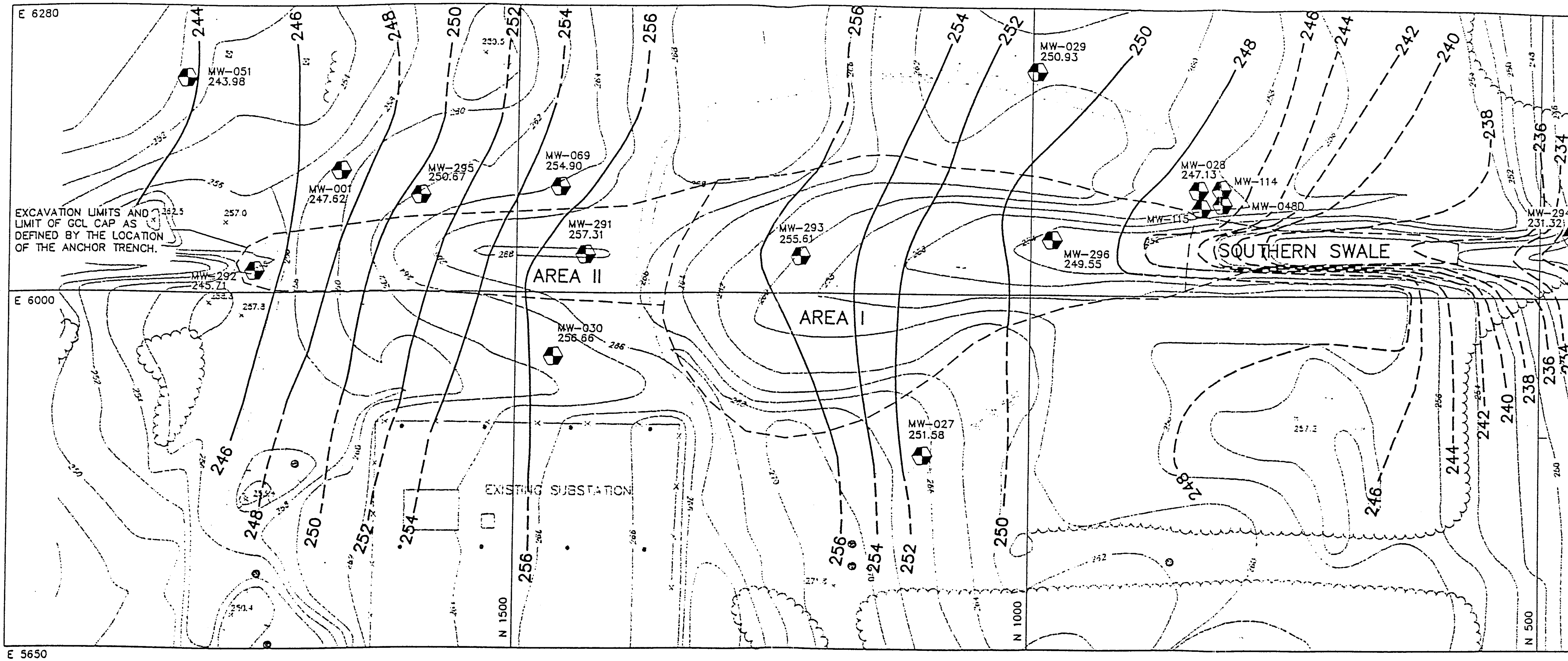
1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN

APRIL 1999

FIGURE 4-1



LEGEND

MW-027 257.58 — MONITORING WELL LOCATION, GROUNDWATER ELEVATION

--260-- APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE SEPTEMBER 7, 1999.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET

100 0 100 200

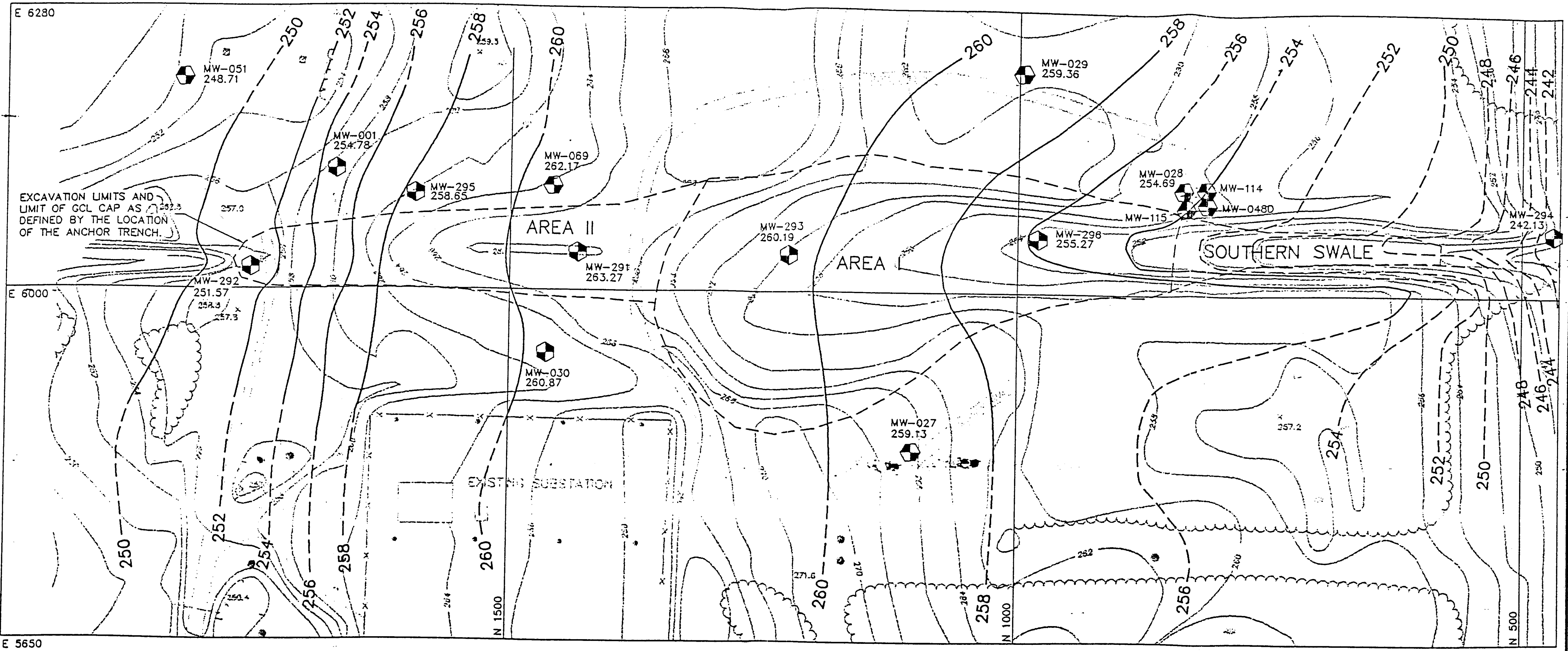
ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE

SHALLOW WATER LEVEL CONTOUR PLAN

SEPTEMBER 1999

FIGURE 4-2



LEGEND

MW-027 258.69 — MONITORING WELL LOCATION GROUNDWATER ELEVATION

--258-- — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE MAY 3, 2000.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM", VERTICAL DATUM IS BASED ON USLS.

SCALE IN FEET

100 0 100 200

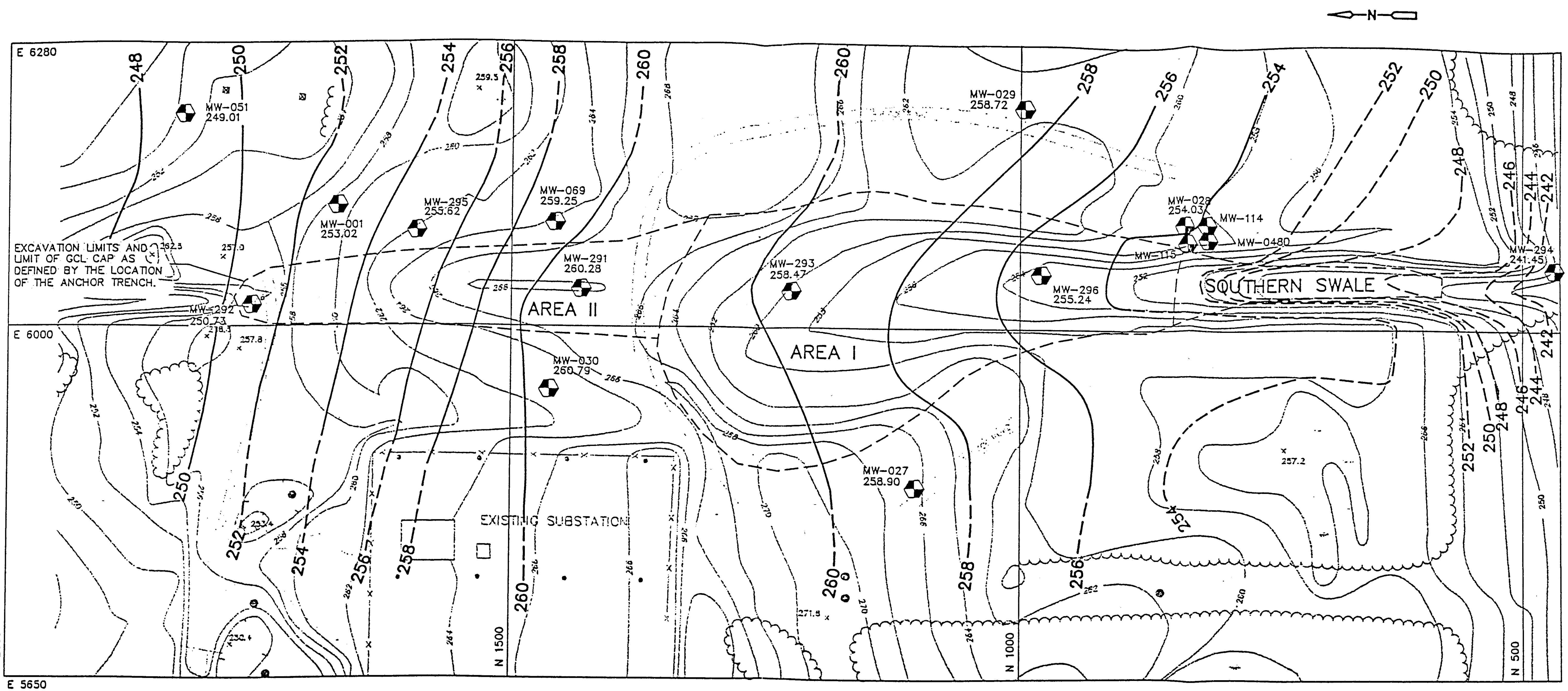
ALCOA - MASSENA, NEW YORK.

DENNISON CROSS ROAD SITE

SHALLOW WATER LEVEL CONTOUR PLAN

MAY 2000

FIGURE 4-1



LEGEND

MW-027 257.58 — MONITORING WELL LOCATION / GROUNDWATER ELEVATION

--260-- — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED). MONITORING DATE SEPTEMBER 25, 2000.

NOTES

1. TOPOGRAPHY IS BASED ON THE SURVEY PREPARED BY EASTERN MAPPING COMPANY 1987 AND MK FINAL CAPPING GRADES (1996).
2. HORIZONTAL COORDINATES ARE BASED ON "ALCOA PLANT REFERENCE DATUM". VERTICAL DATUM IS BASED ON USLS.

ALCOA – MASSENA, NEW YORK

DENNISON CROSS ROAD SITE
SHALLOW WATER LEVEL CONTOUR PLAN
SEPTEMBER 2000

FIGURE 4-2

Appendix B

Analytical Data

CDM Camp Dresser & McKee

Memorandum

00-0307

To: *Tom Lightfoot*

From: *Peter Maynard*

Via: *J.E. Mihm*

Date: *August 18, 2000*

Subject: *Alcoa Remediation Projects Organization*
Dennison Cross Road Site
Post-Closure Monitoring – March 2000
Data Quality Assessment

This memorandum presents the data quality assessment for the semi-annual post-closure monitoring at the Dennison Cross Road site (DCR). Groundwater samples were collected on March 8, 2000 and were analyzed by the Alcoa Massena Operations ChemLab for volatile organics compounds (VOC). Laboratory quality control data associated with these samples were reviewed in accordance with the *Quality Assurance Project Plan* (QAPP) (CDM, July 1995) and EPA Region II CLP data validation criteria as referenced in Organics Review and Preliminary Review, SOP No. HW-6, Revision No. 11, June, 1996. The intent of this review is to provide a general assessment of the overall quality of the data packages based on the review of the following information:

- laboratory method blanks;
- matrix spike/matrix spike duplicates (MS/MSD);
- surrogate spike recovery;
- laboratory reference samples; and
- sample holding time data.

Project-generated quality control data were also reviewed. Field and trip blank samples as well as field duplicate samples were included as part of the sampling program.

All applicable data were evaluated and are summarized below. Analytical results, hold time and field quality control data are summarized in Tables 1 through 4.

Volatile Organics

Samples were analyzed for VOC using EPA Method 8260. No target compounds were detected in the laboratory method blanks nor in the field blank and trip blank submitted with the samples. Sample location MW-292 was collected as a field duplicate. Field duplicate precision was acceptable.

VOC surrogate spike recovery data were reviewed. Sample surrogate spike recoveries were acceptable for all field samples.

Sample MW-293-11 was analyzed as a MS/MSD pair with results exhibiting acceptable precision and accuracy. Additionally, reference samples were analyzed with acceptable results.

The QAPP specifies a holding time of up to 7 days beyond the verified time of sample receipt (VTSR) for sample analysis. In addition, the VTSR must be within 48 hours of sample collection. Table 2 presents a compilation of all the relevant information regarding analysis holding times. All samples were received into the laboratory on the same day as sample collection and all sample analyses were conducted within the QAPP-specified holding time requirement.

No significant deviations from the QAPP requirements or problems with quality control results were determined in this review and the VOC data from the March 2000 DCR sampling round can be used without qualification.

PM:tmp

Attachments

cc: Bob Green
Greg Handly

Sample ID Sample Date Parameter ID	Unit	MW-292-11 3/8/00	MW-292-11D 3/8/00	MW-293-11 3/8/00	MW-294-11 3/8/00
Field Parameters					
pH - Field	SU	7.04	---	6.93	7.29
Temperature	deg C	10.9	---	8.4	8.8
Specific Conductance - Field	mS/cm	0.96	---	1.12	0.887
Turbidity - Field	NTU	53	---	20	61
Redox Potential	mVolt	80.1	---	-110.9	62.3
VOCs					
Chloromethane	µg/l	1 U	1 U	1 U	1 U
Bromomethane	µg/l	1 U	1 U	1 U	1 U
Vinyl Chloride	µg/l	3.38	3.28	1 U	1 U
Chloroethane	µg/l	1.92	1.86	1 U	1 U
Methylene Chloride	µg/l	1 U	1 U	1 U	1 U
1,1-Dichloroethene	µg/l	1 U	1 U	1 U	1 U
1,1-Dichloroethane	µg/l	2.68	2.77	6.08	1 U
Trans-1,2-Dichloroethene	µg/l	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	µg/l	1 U	1 U	1 U	1 U
Chloroform	µg/l	1 U	1 U	1 U	1 U
1,2-Dichloroethane	µg/l	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	µg/l	1 U	1 U	1 U	1 U
Carbon Tetrachloride	µg/l	1 U	1 U	1 U	1 U
Bromodichloromethane	µg/l	1 U	1 U	1 U	1 U
1,2-Dichloropropane	µg/l	1 U	1 U	1 U	1 U
Cis-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U
Trichloroethene	µg/l	1 U	1 U	1 U	1 U
Dibromochloromethane	µg/l	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	µg/l	1 U	1 U	1 U	1 U
Trichlorofluoromethane	µg/l	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/l	1 U	1 U	1 U	1 U
Benzene	µg/l	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene (Or Ortho)	µg/l	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/l	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene (Or Para)	µg/l	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U
Bromoform	µg/l	1 U	1 U	1 U	1 U
Tetrachloroethene	µg/l	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	µg/l	1 U	1 U	1 U	1 U
Toluene	µg/l	1 U	1 U	1 U	1 U
Chlorobenzene	µg/l	1 U	1 U	1 U	1 U
Ethylbenzene	µg/l	1 U	1 U	1 U	1 U
O-Xylene	µg/l	1 U	1 U	1 U	1 U
P-Xylene	µg/l	1 U	1 U	1 U	1 U

Key:
U = Nondetect
--- = Not Analyzed

Table 1
Summary of Analytical and Field Data

Sample ID	Sample Date	VTSR[1]	VOCs Target - 7 day from VTSR to Analysis
MW-292-11	3/8/00	3/8/00	3/15/00
MW-292-11D	3/8/00	3/8/00	3/15/00
MW-293-11	3/8/00	3/8/00	3/15/00
MW-294-11	3/8/00	3/8/00	3/15/00
MW-618-01FBW	3/8/00	3/8/00	3/15/00
MW-618-02TB	3/8/00	3/8/00	3/15/00

Note:
1. VTSR = verified time of sample receipt

Table 2
Summary of Holding Times

Sample ID Sample Date Parameter ID	Unit	MW-618-01 3/8/00
VOCs		
Targeted Compounds	µg/l	1 U

Key:
U = Nondetect

Table 3
Summary of Field Blank

Sample ID Sample Date Parameter ID	Unit	MW-618-02 3/8/00
VOCs		
Targeted Compounds	µg/l	1 U

Key:
U = Nondetect

Table 4
Summary of Trip Blank

Sample ID Sample Location Sample Date Parameter ID	Unit	Original Sample MW-292-11 MW-292 3/8/00	Duplicate Sample MW-618-03 MW-292 3/8/00	Relative Percent Difference[1] %
VOCs				
Vinyl Chloride	µg/l	3.38	3.28	3.00
Chloroethane	µg/l	1.92	1.86	3.17
1,1-Dichloroethane	µg/l	2.68	2.77	3.30
Other Targeted Compounds	µg/l	1 U	1 U	---

Note:

1. Precision is evaluated by calculating the relative percent difference (RPD) using the following formula:

$$| 2 * (X1 - X2) / (X1 + X2) * 100 |$$

where X1 is the original sample and X2 is the duplicate sample.

Key:

--- = RPD not calculated for nondetected parameters

U = Nondetect; value reported as detection limit

Table 5
Summary of Field Duplicate

CDM Camp Dresser & McKee

Memorandum

00-0421

To: Tom Lightfoot

From: Peter Maynard

Via: J.E. Mihm

Date: December 19, 2000

Subject: Alcoa Remediation Projects Organization
Dennison Cross Road Site
Post-Closure Monitoring – November 2000
Data Quality Assessment

This memorandum presents the data quality assessment for the semi-annual post-closure monitoring at the Dennison Cross Road (DCR) site. Groundwater samples were collected on November 15, 2000 and were analyzed by the Alcoa Massena Operations ChemLab for volatile organics compounds (VOCs). Laboratory quality control data associated with these samples were reviewed in accordance with the *Quality Assurance Project Plan* (QAPP) (CDM, July 1995) and EPA Region II CLP data validation criteria as referenced in Organics Review and Preliminary Review (SOP No. HW-6, Revision No. 11, June, 1996). The intent of this review is to provide a general assessment of the overall quality of the data packages based on the review of the following information:

- laboratory method blanks;
- matrix spike/matrix spike duplicates (MS/MSD);
- surrogate spike recovery;
- laboratory reference samples; and
- sample holding time data.

Project-generated quality control data were also reviewed. Field and trip blank samples as well as field duplicate samples were included as part of the sampling program.

All applicable data were evaluated and are summarized below. Analytical results, hold time and field quality control data are summarized in Tables 1 through 5.

VOCs

Samples were analyzed for VOCs using EPA Method 8260. No target compounds were detected in the laboratory method blanks nor in the field blank and trip blank submitted with the samples. Sample location MW-292 was collected as a field duplicate. Field duplicate precision was acceptable.

VOC surrogate spike recovery data were reviewed. Sample surrogate spike recoveries were acceptable for all field samples.

Sample MW-293-12 was analyzed as a MS/MSD pair with results exhibiting acceptable precision and accuracy. Additionally, reference samples were analyzed with acceptable results.

The QAPP specifies a holding time of up to 7 days beyond the verified time of sample receipt (VTSR) for sample analysis. In addition, the VTSR must be within 48 hours of sample collection. Table 2 presents a compilation of all the relevant information regarding analysis holding times. All samples were received into the laboratory on the same day as sample collection. All sample analyses were conducted within the QAPP-specified holding time requirement.

No significant deviations from the QAPP requirements or problems with quality control results were determined in this review and the VOC data from the November 2000 DCR sampling round can be used without qualification.

PM:tmp

Attachments

cc: Bob Green
Adrian Woods

Sample ID Sample Date Parameter ID	Units	MW-292-12 11/15/00	MW-292-12D 11/15/00	MW-293-12 11/15/00	MW-294-12 11/15/00
Field Parameters					
pH - Field	SU	7.5	—	7.27	7.6
Temperature	deg C	8.9	—	10.4	8.7
Specific Conductance - Field	mS/cm	1.08	—	1.14	0.99
Turbidity - Field	NTU	89	—	188	45
Redox Potential	mVolt	-72.8	—	-102.2	-0.7
VOCs					
Chloromethane	µg/l	1 U	1 U	1 U	1 U
Bromomethane	µg/l	1 U	1 U	1 U	1 U
Vinyl Chloride	µg/l	3.68	3.85	1.35	1 U
Chloroethane	µg/l	1.3	1.38	1 U	1 U
Methylene Chloride	µg/l	1 U	1 U	1 U	1 U
1,1-Dichloroethene	µg/l	1 U	1 U	1 U	1 U
1,1-Dichloroethane	µg/l	3.27	3.31	12.21	1 U
Trans-1,2-Dichloroethene	µg/l	1 U	1 U	1 U	1 U
Chloroform	µg/l	1 U	1 U	1 U	1 U
1,2-Dichloroethane	µg/l	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	µg/l	1 U	1 U	1 U	1 U
Carbon Tetrachloride	µg/l	1 U	1 U	1 U	1 U
Bromodichloromethane	µg/l	1 U	1 U	1 U	1 U
1,2-Dichloropropane	µg/l	1 U	1 U	1 U	1 U
Cis-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U
Trichloroethene	µg/l	1 U	1 U	1 U	1 U
Dibromochloromethane	µg/l	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	µg/l	1 U	1 U	1 U	1 U
Trichlorofluoromethane	µg/l	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/l	1 U	1 U	1 U	1 U
Benzene	µg/l	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene (Or Ortho)	µg/l	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	µg/l	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene (Or Para)	µg/l	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene	µg/l	1 U	1 U	1 U	1 U
Bromoform	µg/l	1 U	1 U	1 U	1 U
Tetrachloroethene	µg/l	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	µg/l	1 U	1 U	1 U	1 U
Toluene	µg/l	1 U	1 U	1 U	1 U
Chlorobenzene	µg/l	1 U	1 U	1 U	1 U
Ethylbenzene	µg/l	1 U	1 U	1 U	1 U
O-Xylene	µg/l	1 U	1 U	1 U	1 U
P-Xylene	µg/l	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	µg/l	1 U	1 U	1.09	1 U

Key:
U = Nondetect
— = Not Analyzed

Table 1
Summary of November 2000 Data

Sample ID	Sample Date	VTSR[1]	VOCs Target - 7 day from VTSR to Analysis
MW-292-12	11/15/00	11/15/00	11/20/00
MW-292-12D	11/15/00	11/15/00	11/20/00
MW-293-12	11/15/00	11/15/00	11/20/00
MW-294-12	11/15/00	11/15/00	11/20/00
MW-618-04TB	11/15/00	11/15/00	11/20/00
MW-618-05FBW	11/15/00	11/15/00	11/20/00

Note:
1. VTSR = verified time of sample receipt

Table 2
Summary of Holding Times

Sample ID Sample Date Parameter ID	Units	MW-618-05 11/15/00
VOCs Targeted Compounds	µg/l	1 U

Key:
U = Nondetect

Table 3
Summary of Field Blank

Sample ID Sample Date Parameter ID	Units	MW-618-04 11/15/00
VOCs Targeted Compounds	µg/l	1 U

Key:
U = Nondetect

Table 4
Summary of Trip Blank

Sample ID Samle Location Sample Date Parameter ID	Units	Original Sample MW-292-12 MW-292 11/15/00	Duplicate Sample MW-618-06 MW-292 11/15/00	Relative Percent Difference[1] %
VOCs				
Vinyl Chloride	µg/l	3.68	3.85	4.52
Chloroethane	µg/l	1.3	1.38	5.97
1,1-Dichloroethane	µg/l	3.27	3.31	1.22
Other Targeted Compounds	µg/l	1 U	1 U	—

Note:

1. Precision is evaluated by calculating the relative percent difference (RPD) using the following formula:

$$|2 * (X1 - X2) / (X1 + X2) * 100|$$

where X1 is the original sample and X2 is the duplicate sample.

Key:

--- = RPD not calculated for nondetected parameters

U = Nondetect; value reported as detection limit

Table 5
Summary Field Duplicate

Appendix C

Statistical Evaluation

Appendix C-1

Statistical Methods

Appendix C-1
Statistical Methods

Several statistical approaches are presented below that are used to analyze groundwater monitoring data. These approaches will also be used for evaluating future data collected during the post-closure monitoring program.

Control charts formulated on a per-well basis may be used to compare future monitoring results to baseline data. This statistical method is appropriate for naturally occurring parameters that are detected below the NYSWQS. The data for each parameter in each well is plotted on a time scale and the plot is evaluated for trends or changes in concentration levels.

Trend analyses are conducted for parameters that are not naturally occurring, or naturally occurring compounds detected above NYSWQS. When TCE and TCA degradation products are detected, molar sums of the TCE and TCA compound families are computed to evaluate whether the overall molar concentration of the compound family is increasing or decreasing. The molar sum approach is used for wells with TCE and TCA degradation because the concentration of the molar concentrations for the compound family would account for transformations from one compound to another.

If a parameter is not detected during the baseline period, but appears in future monitoring rounds, a statistical method such as the Poisson analysis approach may be used to evaluate whether isolated instances of low levels of concentration are significant.

Control Chart

The Shewhart upper and lower control limit is computed using the following equations:

$$SCL = \bar{x} \pm [(4.5 * S)/\eta^{1/2}]$$

where:

SCL	=	Shewhart Control Limit
_	=	mean of baseline data
S	=	standard deviation of baseline data
n	=	number of sampling events averaged to obtain one independent quarterly sample

Using the control chart, the standardized mean and Cumulative Sum are compared to two decision criteria, the Shewhart Control Limit and "h".

The standardized mean, Z_i, is computed as follows (in terms of standard deviations):

$$Zi = [(Xi - \bar{x}) * \eta^{1/2}]/S$$

where:

Z_i = standardized mean for each detection monitoring data point, i (units of standard deviation)
X_i = chemical concentration measured (mg/l or µg/l)
_ = mean of baseline data (mg/l or µg/l)
S = standard deviation of baseline data (mg/l or µg/l)
n = number of sampling events averaged to obtain one independent quarterly sample and the Cumulative Sum is defined below (in terms of standard deviation):

$$CUSUM_i = max^{`}(0, (Z_i - k) + CUSUM_{i-1})$$

where:

$CUSUM_i$ = cumulative sum for the present detection monitoring data point, i, (units of standard deviation)
Z_i = standardized mean for the present detection monitoring data point, i, (unit of standard deviation)
k = 1 (reference value which will allow displacement of 2 standard deviations to be detected quickly). This value is suggested by EPA (EPA, 1989)
$CUSUM_{i-1}$ = cumulative sum for the previous detection monitoring data point, i-1
(units of standard deviation)

The Shewhart control limit and "h" are defined below:

$$SCL = x + [(4.5 * S)/n^{1/2}] \text{ and } h = x + [(5*S)/n^{1/2}]$$

where:

SCL = Shewhart Control Limit (mg/l or µg/l)
_ = mean of baseline data (mg/l or µg/l)
S = standard deviation of baseline data (mg/l or µg/l)
n = number of sampling events averaged to obtain one independent quarterly sample

When expressed in terms of standard deviations, SCL=4.5 and h=5.

The CUSUM is calculated at each sampling interval and added to the previous cumulative sum. As specified in the EPA statistical guidance documents, when the cumulative sum exceeds the value of h (in units of standard deviation=5), a statistically significant increasing trend is present. Similarly, when the standardized mean is greater than the Shewhart Control Limit (in units of standard deviation=4.5), sampling results are inconsistent with past data and indicate statistically significant evidence of possible contamination.

EPA guidance recommends that the control chart be developed based on eight rounds of baseline sampling (EPA, 1989). This allows for a better determination of the variance that can occur because of the seasonal variation and variability due to residual baseline groundwater contamination. In some instances, there may only be four baseline sampling rounds, and the data collected over the next two years will be evaluated for possible inclusion into the control charts. If eight rounds of data are determined necessary for the computation of control limits, revised control limit exceedance concentrations will serve as a basis for comparison for the subsequent year's detection monitoring data.

Non-Parametric Trend Analyses

Mann-Whitney Test

The Mann-Whitney Test (also known as the Wilcoxon Rank-Sum Test) is an intrawell trend analysis that will be used to determine whether a statistically increasing or decreasing trend exists. This test is recommended by EPA in *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance* (EPA, July 1992) for compliance well to background well comparisons. Reduced monitoring should be considered if there is a statistically significant decreasing trend in overall contamination.

The Mann-Whitney Test requires at least 8 data points. Fewer data points would not be statistically significant. The Mann-Whitney Test is applied as follows:

1. Separate the data set by sampling time into Periods 1 and 2. There will be n Period 1 values, m Period 2 values, and $n + m = N$. This test can be performed when 4 rounds of future monitoring data have been collected, such that $n = 4$ (baseline data) and $m = 4$ (future monitoring data).

2. Label each data point as Period 1 or Period 2.

3. List each value from the smallest to largest and number (rank) them from 1 to N. If there are no elevated detection limits, quantify the nondetects at zero so that they are considered equivalent. If two or more observations have the same value, assign each one the same average rank. Thus, if two points have the same concentrations and fit into the 7th and 8th rank places, the average rank of 7.5 would be assigned to each.

4. Compute the test statistic T as the sum of the ranks of the n Period 1 data points.

5. The null hypothesis (H_o) being tested is that there has been no change in concentration from Period 1 to Period 2 at the 0.1 significance level. The T value is compared to the quantile, an interval within which the null hypothesis is true. The quantile is obtained from Table A7 (Conover, 1980) entitled *Quantiles of the Mann-Whitney Test Statistic.* If the calculated T value lies within the interval, including the endpoints, listed below, then H_o is true and there has been no change. If H_o is false, there has been a change and the data must be inspected to determine whether there has been an increase or decrease over time.

N	*n*	*m*	Range of T for which H_o is true
8	4	4	12-24 (from statistical tables in Conover, 1980)

Linear regression is a useful method for evaluation of groundwater trends when data has been collected over several years and no data are missing and all values are quantified. For post-closure monitoring activities where the number of sampling intervals is not sufficient to allow for the use of parametric linear regression techniques, two non-parametric trend analyses techniques may be used: Mann-Kendall Test and Sen's Slope Estimator. Both tests are distribution free tests that can be used if data is missing or reported below the detection limit. The techniques are used to determine if the slope of the trend line is different from zero and for post-closure evaluations to evaluate if the concentration of the parameters under consideration are increasing or decreasing over time.

Mann-Kendall Test

This non-parametric analysis is used to determine whether there is a statistically significant increase or decrease in concentration levels over time. The Mann-Kendall Test uses relative magnitude of data rather than values for evaluating trend.

The following procedure is used for calculation of the Mann-Kendall Test statistic:

- List the data in the order in which they were collected over time: x_1, x_2, x_3, and x_4, where x_i is the datum at time i.

- Determine the sign of all $n^*(n\text{-}1)/2$ possible differences $x_j - x_k$, where j>k. Note that *n* refers to the number of data points (4 in the case of baseline).

Compute the Mann-Kendall statistic, S, using the formula listed.

$$S = \frac{\Sigma\Sigma}{kj} sign(x_j - x_k)$$

A convenient way of arranging the calculation is shown below (for the case of 4 sampling intervals):

Data Values Listed in the Order Collected Over Time				No. of (+) Signs	No. of (-) Signs
x1	x2	x3	x4		
	$x_2 - x_1$	$x_3 - x_1$	$x_4 - x_1$		
		$x_3 - x_2$	$x_4 - x_2$		
			$x_4 - x_3$		

S = Sum[no.(+)signs] - Sum[no.(-)signs]

The Mann-Kendall statistic is the number of positive differences minus the number of negative differences. If S is a larger positive number, measurements taken later in time tend to be larger than those taken earlier. If S is a large negative number, measurements taken later tend to be smaller. The null hypothesis, H_o, states that no trend currently exists in the data. The alternative hypothesis, H_A, maintains that an increasing or decreasing trend is present.

The following procedures should be followed to determine whether to accept or reject the null hypothesis:

For a sample size of 10 or less, the S statistic is used to find the probability value obtained from Table A18 (Gilbert, 1987, *Statistical Methods for Environmental Pollution Monitoring*). This probability value is compared to a/2 to determine whether a statistically significant trend exists. The null hypothesis, H_o, is rejected if the probability value is less than a/2 and accepted if the probability value is greater than or equal to a/2.

For a sample size of greater than 10 with several tied data groups, the sample size is used to find the tabulated S value in Table A12 (Conover, 1987). This tabulated S value is compared to S to determine whether a statistically significant trend exists. The null hypothesis, H_o, is rejected if the absolute value of S is greater than the tabulated S and accepted if the absolute value of S is equal to or less than the tabulated S.

For a sample size of greater than 40, or greater than 10 if few tied groups of data exist, the alternate analysis will be performed:

- Determine whether any data values are tied to any other (i.e. share the same value). If so, g is the number of tied groups and t_p is the number of data in the pth group.

- Calculate the variance as follows:

$$VAR(S) = \frac{1}{18}[n(n-1)(2n+5) - \sum_{p=1}^{g} t_p(t_p-1)(2t_p+5)]$$

Where n is the sample size of the data under analysis.

- Use the Mann-Kendall statistic (S) and the VAR(S) to determine the test statistic Z as follows:

$$Z = \frac{S-1}{[VAR(S)]^{1/2}}, if\ S > 0$$

$$Z = 0, if\ S = 0$$

$$Z = \frac{S+1}{[VAR(S)]^{1/2}}, if\ S < 0$$

Use the absolute value of Z to find the probability value in Table A1of the cumulative normal distribution (Gilbert, 1987, *Statistical Methods for Environmental Pollution Monitoring*). Compare the probability value to a/2 to determine whether a statistically significant trend exists. The null hypothesis, H_o, is rejected if the probability value is less than a/2 and accepted if the probability value is greater than or equal to a/2.

Sen's Slope Estimator

Sen's Slope Estimator provides a non-parametric technique to evaluate the magnitude of trend when applied to groundwater data collected over time (Sen, 1968). The technique is related to the Mann-Kendall trend analyses technique and allows for the computation of the confidence interval of the median slope. Whereas the Mann-Kendall trend analyses approach evaluates the direction of slope (increasing or decreasing) between each combination of monitoring intervals, Sen's approach requires the computation of the sign and magnitude of slope between each of combination of monitoring intervals and then selects the median slope as an estimate of the slope for the period under consideration.

The following procedure is used for calculation of the Sen's Slope Estimator:

- List the data in the order in which they were collected over time: x_1, x_2, x_3 and x_4, where x_i is the datum at time i.
- Determine the possible differences $x_j - x_k$, where $j > k$.
- Then tabulate the following:

Data values illustrated here for 4 intervals listed in the order collected over time, and all possible slopes using the same algorithm as for the Mann-Kendall test.

t_1	t_2	t_3	t_4
x_1	x_2	x_3	x_4
	$\frac{x_2-x_1}{(t_2-t_1)}$	$\frac{x_3-x_1}{(t_3-t_1)}$	$\frac{x_4-x_1}{(t_4-t_1)}$
		$\frac{x_3-x}{(t_3-t_2)}$	$\frac{x_4-x_2}{(t_4-t_2)}$
			$\frac{x_4-x_3}{(t_4-t_3)}$

Where t_i is the date of sample collection.

- Calculate the median slope using the calculated values from above.

Appendix C-2

Summary Statistics

Appendix C-2
Summary Statistics

Decription

This appendix includes statistical summaries for each well prepared for all parameters detected during the post-closure monitoring program.

The baseline statistics were presented previously in the *Dennison Road Baseline Groundwater Evaluation Report* (CDM, August 1997) and were compiled from data collected between April 1996 and February 1997.

The 2000 post-closure monitoring data were collected in March and November 2000.

APPENDIX C-2A
ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT

MW-292 SUMMARY STATISTICS

			Results of Baseline Evaluation Groundwater Sampling					Results of 2000 Groundwater Sampling			
Parameter	Units	NYSWQS	Frequency of Detection	Range of Detected Concentrations	Arithmetic Average	Standard Deviation	Median	Frequency of Detection	Range of Detected Concentrations	Arithmetic Average	Standard Deviation
Volatiles											
Vinyl Chloride	µg/l	2.00	4/4	1.86 - 7.00	4.35	2.30	4.28	2/2	3.33 - 3.77	3.55	0.31
Chloroethane	µg/l	5.00	3/4	1.61 - 5.97	2.72	2.36	2.21	2/2	1.34 - 1.89	1.62	0.39
1,1-Dichloroethane	µg/l	5.00	2/4	1.28 - 3.15	1.36	1.25	0.89	2/2	2.73 - 3.29	3.01	0.40
Chloroform	µg/l	7.00	1/4	0.64	0.54	0.07	0.50	0/2			

APPENDIX C-2B
ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT

MW-293 SUMMARY STATISTICS

Parameter	Units	NYSWQS	Results of Baseline Evaluation Groundwater Sampling					Results of 2000 Groundwater Sampling			
			Frequency of Detection	Range of Detected Concentrations	Arithmetic Average	Standard Deviation	Median	Frequency of Detection	Range of Detected Concentrations	Arithmetic Average	Standard Deviation
Volatiles											
Vinyl Chloride	µg/l	2.00	1/4	0.55 J	0.51	0.03	0.50	1/2	1.35	1.35	0.00
Chloroethane	µg/l	5.00	2/4	1.13 - 2.43	1.14	0.91	0.82	0/2			
1,1-Dichloroethane	µg/l	5.00	4/4	4.07 - 6.31	5.34	0.93	5.50	2/2	6.08 - 12.21	9.15	4.33
1,2-Dichloroethene (total)	µg/l	5.00 (cis)	0/4					1/2	1.09	1.09	0.00

APPENDIX C-2C
ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT

MW-294 SUMMARY STATISTICS

Parameter	Units	NYSWQS	Results of Baseline Evaluation Groundwater Sampling					Results of 2000 Groundwater Sampling			
			Frequency of Detection	Range of Detected Concentrations	Arithmetric Average	Standard Deviation	Median	Frequency of Detection	Range of Detected Concentrations	Arithmetric Average	Standard Deviation
Volatiles											
Chloroform	µg/l	7.00	3/4	1.03 - 2.07	1.24	0.66	1.20	0/2			

Appendix C-3

Trend Analyses

Molar Sums
Data Plots
Mann-Kendall Test
Sen's Slope Estimator

Appendix C-3
Trend Analyses

Molar Sums

Molar sums were used to evaluate trends for the TCA compound families. Molar sums were computed as follows:

> Molar concentration (µmole/liter) = Compound concentration (µg/l)/Molecular Weight (µg/mole).
>
> TCA molar sum = Sum of molar concentrations of 1,1,1 TCA, vinyl chloride, chloroethane, 1,1-dichloroethene and 1,1-dichloroethane.

Molar sum results are presented in Table C-3A.

Table
ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT

TCA Molar Sums

Sample ID Sample Date	Molecular Weight (g/mole)	Units	MW-292-01 4/23/96	MW-292-02 7/16/96	MW-292-03 10/1/96	MW-292-04 1/13/97	MW-292-05 6/9/97	MW-292-06 11/13/97
TCA Sum								
1,1,1-Trichloroethane	133.42	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride	62.45	µg/l	1.86	5.43	7.00	3.14	2.15	3.43 J
Chloroethane	64.45	µg/l	0.50 U	2.70	5.97	1.60	1.35	0.50 U
1,1-Dichloroethene	96.65	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	99.91	µg/l	0.50 U	1.20	3.20	0.50 U	0.50 U	0.50 U
TCA Molar Sum	---	µmole/l	0.051	0.150	0.246	0.089	0.069	0.077

Sample ID Sample Date	Molecular Weight (g/mole)	Units	MW-292-07 7/10/98	MW-292-08 12/18/98	MW-292-09 5/17/99	MW-292-10 10/25/99	MW-292-11 3/8/00	MW-292-12 11/15/00
TCA Sum								
1,1,1-Trichloroethane	133.42	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride	62.45	µg/l	3.04	2.91	3.41	3.62	3.33	3.77
Chloroethane	64.45	µg/l	4.20	2.17	3.25 J	2.25	1.89	1.34
1,1-Dichloroethene	96.65	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	99.91	µg/l	1.05	1.60	0.50 U	5.14	2.73	3.29
TCA Molar Sum	---	µmole/l	0.133	0.105	0.119	0.153	0.119	0.123

Key:
U = nondetect; value reported is 1/2 the detection limit which was used in the molar sum calculation.
J = estimated value.

Tabl

ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT

TCA Molar Sums

Sample ID Sample Date	Molecular Weight (g/mole)	Units	MW-293-01 4/23/96	MW-293-02 7/16/96	MW-293-03 9/30/96	MW-293-04 2/4/97	MW-293-05 6/9/97	MW-293-06 11/13/97	MW-293-07 7/10/98	MW-293-08 12/18/98	MW-293-09 5/17/99	MW-293-10 10/25/99	MW-293-11 3/8/00	MW-293-12 11/15/00
TCA Sum														
1,1,1-Trichloroethane	133.42	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl Chloride	62.45	µg/l	0.50 U	0.50 U	0.55 J	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.27	0.50 U	0.50 U	1.35
Chloroethane	64.45	µg/l	2.40	1.10	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	96.65	µg/l	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	99.91	µg/l	6.30	4.10	5.60	5.40	6.68	0.50 U	6.91	6.55	9.69	7.18	6.08	12.21
TCA Molar Sum	---	µmole/l	0.117	0.075	0.082	0.079	0.092	0.030	0.094	0.090	0.134	0.097	0.086	0.161

Key:

U = nondetect; value reported is 1/2 the detection limit which was used in the molar sum calculation.

J = estimated value.

Appendix C-3
Trend Analyses

Data Plots

This section presents plots of compliance monitoring data for wells and parameters subject to trend analyses. Trend analyses were performed for detected parameters that are not naturally occurring (VOCs) and naturally occurring parameters detected at concentrations above NYSWQS (none in this instance).

The plots are a visual tool for identifying trends. The linear regression line for each data set also is plotted. However, the observed trends indicated by the slope of the linear regression line are not necessarily statistically significant.

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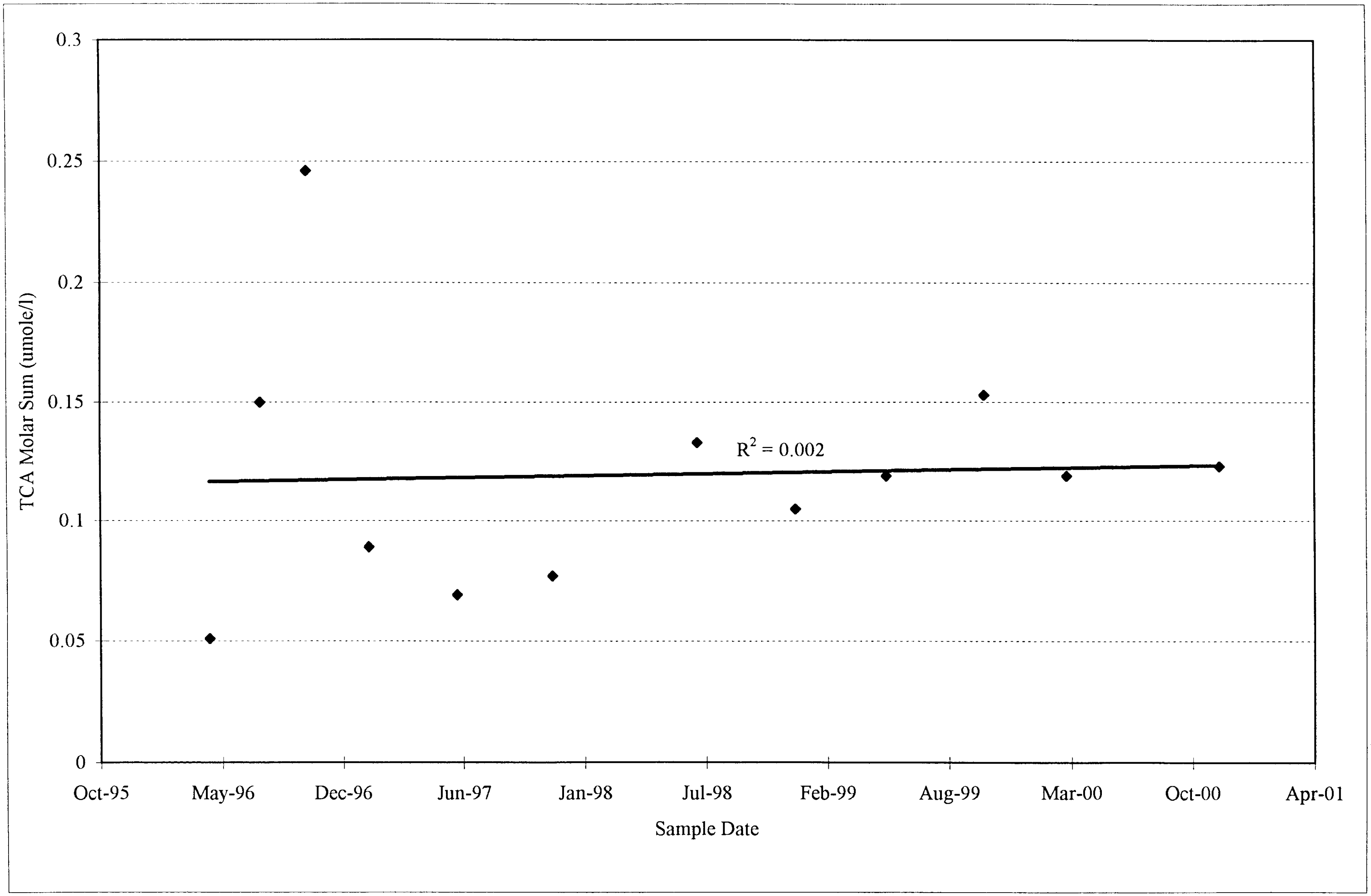
2000 ANNUAL REPORT
MW-292 SUMMARY OF TCA MOLAR SUM CONCENTRATIONS



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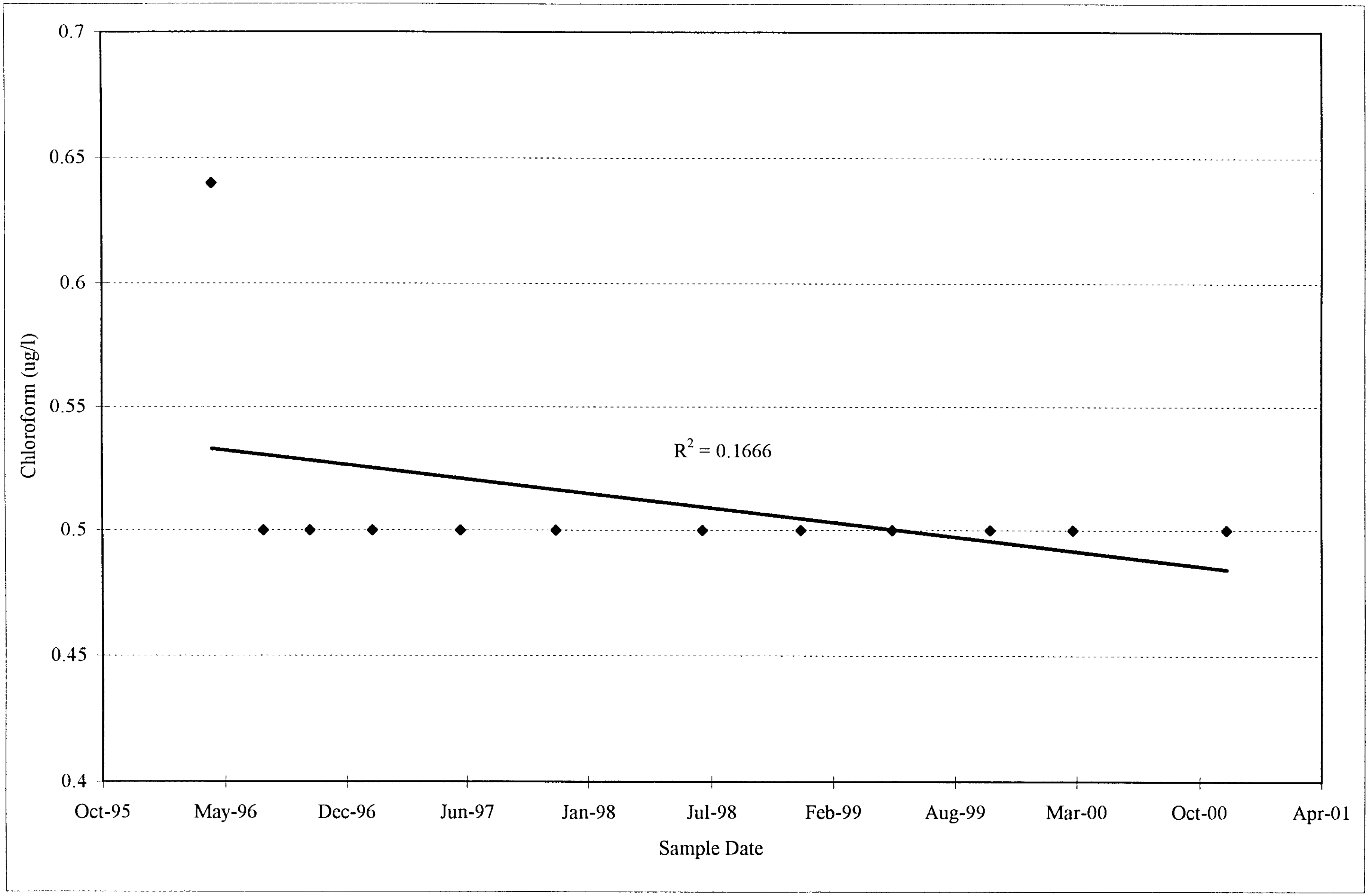
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT
MW-292 SUMMARY OF CHLOROFORM CONCENTRATIONS



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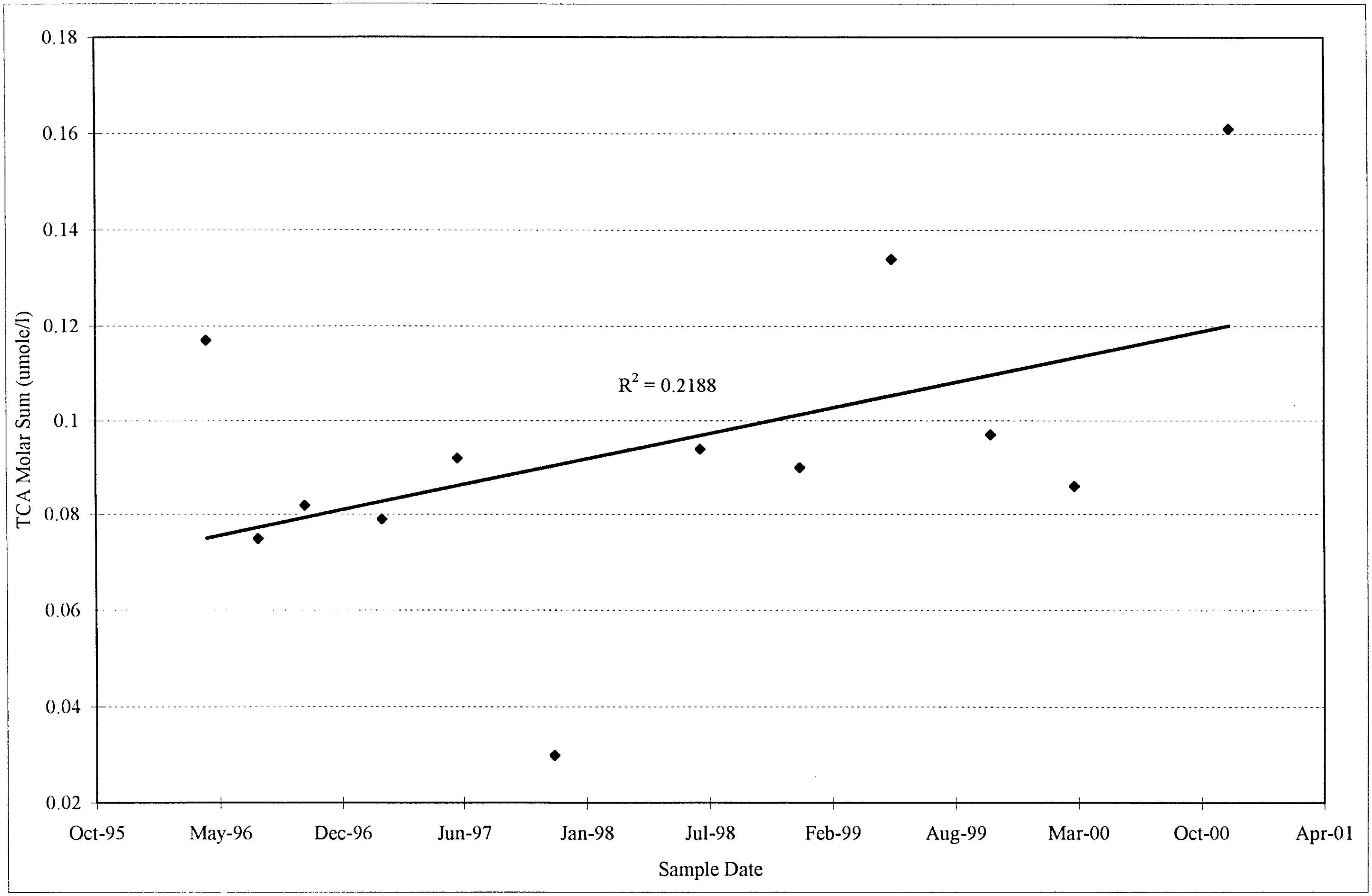
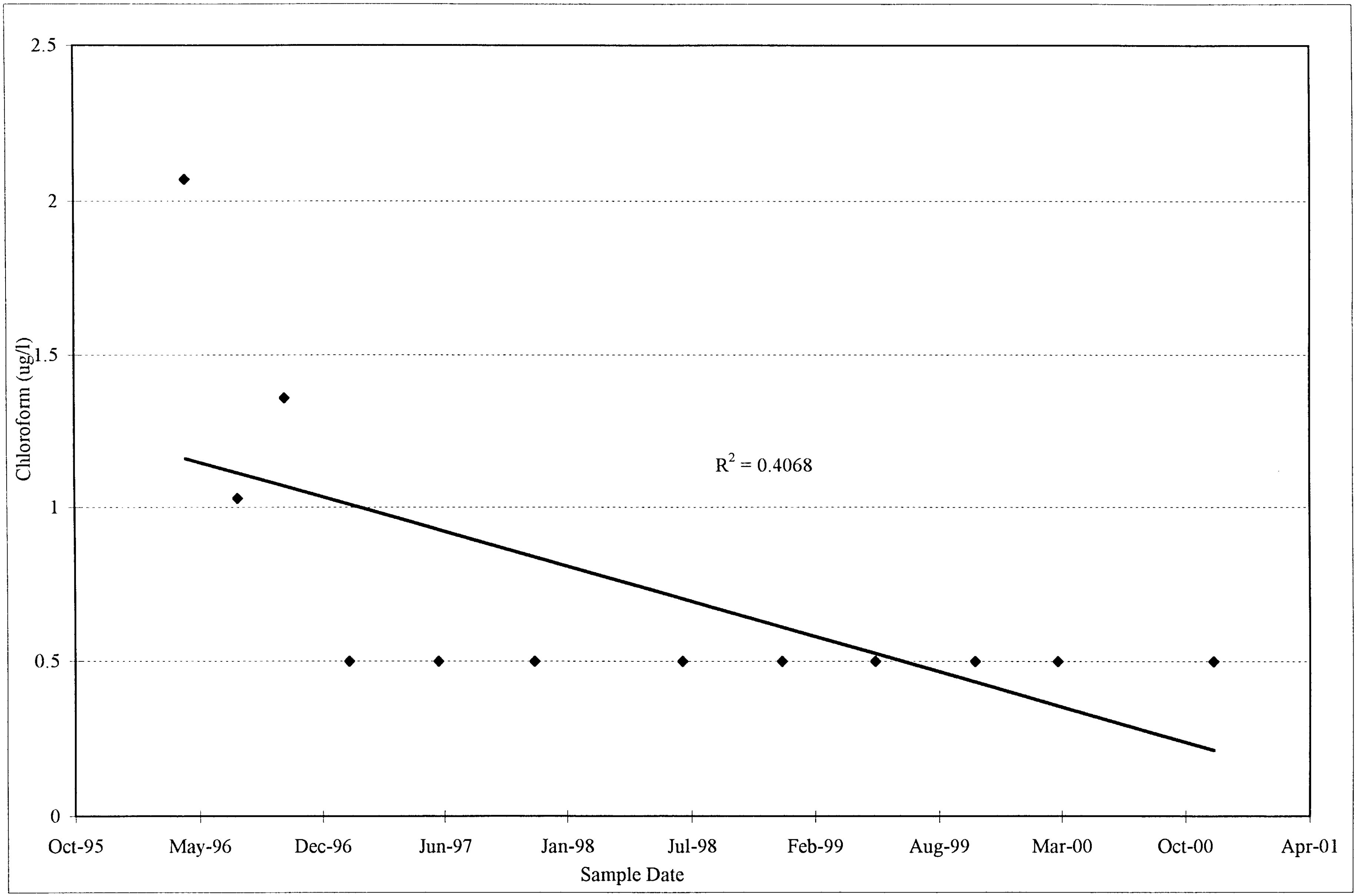
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT
MW-293 SUMMARY OF TCA MOLAR SUM CONCENTRATIONS



ALCOA REMEDIATION PROJECTS ORGANIZATION
DENNISON CROSS ROAD SITE
2000 ANNUAL REPORT
MW-294 SUMMARY OF CHLOROFORM CONCENTRATIONS



Appendix C-3
Trend Analyses

Mann-Kendall Test

This section contains the statistical calculation of the Mann-Kendall Test. This test is a nonparametric analysis used to determine whether a statistically significant trend exists for parameters that are not naturally occurring or naturally occurring parameters detected above NYSWQS. A discussion of the analysis is included in Appendix C-1, Statistical Methods.

ALCOA, DENNISON CROSS ROAD
GROUNDWATER POST-CLOSURE DATA ANALYSIS
JANUARY 18, 2001

The following four data sets were analyzed by the Mann-Kendall test for trend:

1. MW-292 micromolar equivalents of TCA
2. MW-292 chloroform (μg/L)
3. MW-293 micromolar equivalents of TCA
4. MW-294 chloroform (μg/L)

One of the data sets (No. 3 above) contained no tied values, so the large sample normal approximation was valid for interpretation of the Mann-Kendall results. Thus, the calculated Z value was compared to the normal distribution Z(0.025) = -1.9600 and Z(0.975) = 1.9600 for a two-sided test at the 95 percent confidence level. The result is as follows:

MW-293 micromolar TCA yielded Z = 1.440, which is between -1.96 and +1.96: NO CHANGE.

Another of the data sets (#1 above) contained one tied value and the sample size is in between 10 and 40, so the large sample normal approximation was valid for interpretation of the Mann-Kendall results. Thus, the calculated Z value was compared to the normal distribution Z(0.025) = -1.9600 and Z(0.975) = 1.9600 for a two-sided test at the 95% confidence level. The result is as follows:

MW-292-micromolar TCA yielded Z = 0.962, which is between -1.96 and +1.96: NO CHANGE.

The other two data sets (#2 and #4 above) contained many values tied at below the detection limit. The small sample approximation was appropriate, so the calculated S values were compared to the Mann-Kendall test statistic quantiles w(0.025) = -28 and w(0.975) = 28 for a two-sided test at the 95% confidence level. The results are as follows:

MW-292 chloroform yielded S = -11, which is between -28 and +28: NO CHANGE.

MW-294 chloroform yielded S = -28, which is between -28 and +28 (not less than -28): NO CHANGE.

Each of the tested data sets showed no change over the monitoring time period. No Sen's Slope calculations were performed.

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GROUNDWATER POST-CLOSURE DATA AND
MANN-KENDALL TEST RESULTS

	MW-292		MW-293	MW-294
	TCA	Chloroform	TCA	Chloroform
DATE	μmol/L	μg/L	μmol/L	μg/L
4/23/96	0.051	0.64	0.117	2.07
7/16/96	0.15	0.5	0.075	1.03
10/1/96	0.246	0.5	0.082	1.36
1/13/97	0.089	0.5	0.079	0.5
6/9/97	0.069	0.5	0.092	0.5
11/13/97	0.077	0.5	0.03	0.5
7/10/98	0.133	0.5	0.094	0.5
12/18/98	0.105	0.5	0.09	0.5
5/17/99	0.119	0.5	0.134	0.5
10/25/99	0.153	0.5	0.097	0.5
3/8/00	0.119	0.5	0.086	0.5
11/15/00	0.123	0.5	0.161	0.5
	S :	S :	S :	S :
	15	-11	22	-28
	# G :	# G :	# G :	# G :
	1	1	0	1
	VAR(S) :	VAR(S) :	VAR(S) :	VAR(S) :
	211.66667	47.6666667	212.66667	120.666667
	Z :	Z :	Z :	Z :
	0.9622808	-1.4484136	1.4400235	-2.4579334

Appendix C-3
Trend Analyses

Sen's Slope Estimator

This section contains the statistical calculation of the Sen's Slope Estimator. This test is a nonparametric analysis used to estimate the rate of change (slope) for parameters that are not naturally occurring or naturally occurring parameters detected above NYSWQS. The Sen's Slope Estimator is performed for the wells and parameters that show a statistically significant trend according to the Mann-Kendall Test. A discussion of the analysis is included in Appendix C-1, Statistical Methods.