Semiannual Groundwater Quality Report
Third and Fourth Quarter 2002 Monitoring Events

Retention Pond and Reserve Pond Area
Former Kaiser Aluminum Specialty Products Facility

Kaiser Aluminum & Chemical Corporation
Tulsa, Oklahoma

Project No. 5427J
April 2003

Earth Sciences Consultants, Inc.

Providing Environmental Consulting Services Since 1979

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Earth Sciences Consultants, Inc.
One Triangle Lane
Export, PA 15632
724/733-3000
FAX: 724/325-3352

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Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

1.0 Introduction

This technical report was prepared by Earth Sciences Consultants, Inc. on behalf of Kaiser Aluminum & Chemical Corporation (Kaiser) to provide an assessment of groundwater quality conditions within the Retention Pond and Reserve Pond Area at Kaiser's former Specialty Products facility located in Tulsa, Oklahoma (Figure 1). This report summarizes results from the third and fourth quarter 2002 groundwater monitoring events conducted in September and December 2002, respectively.

Three different groundwater-bearing units were identified beneath the Retention Pond and Reserve Pond Area at the facility: Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock. They are currently being monitored as listed below:

- Shallow Overburden/Dross Material: Wells MWS-4, MWS-5, MWS-6, and MWS-11.
- Deep Overburden: Wells P-2, MWD-2, P-3, P-4, MWD-4, P-5, MWD-5, MWD-6, MWD-7, MWD-8, MWD-9, MWD-10, and MWD-11.
- Shallow Bedrock: Wells ST-2 and ST-3.

Monitoring well construction information is summarized in Table 1. Three on-site surface water locations, the Freshwater Pond, the Retention Pond, and Fulton Creek are also monitored on an annual basis. The 18 monitoring well locations and three surface water features are identified in Figure 2. A total of five wells have been removed from the monitoring well network. Well P-4 was abandoned (plugged) in March of 2001 to accommodate the expansion of the stockpiled materials area for the Adjacent Land Remediation Plan (ALRP) activities (Figure 2). Wells P-1, P-7, P-8, and P-10 were abandoned (plugged) in July 2002 to accommodate the controlled backfilling of the Freshwater Pond The Freshwater Pond was backfilled in October and November 2002 in preparation for the planned on-site decommissioning activities.

The purpose of the routine groundwater sampling and analysis activities is to monitor the nature and extent of groundwater containing radioactivity within the Retention Pond and Reserve Pond Area at the Tulsa facility. Chapter 2.0 of this report provides a background description of the Tulsa site. Chapter 3.0 describes the groundwater monitoring field activities performed during the two quarterly monitoring events. Chapter 4.0 presents an analysis of groundwater conditions, as well as a discussion of regulatory criteria related to isotopic concentrations for thorium (Th) in groundwater. A summary of findings and conclusions is included as Chapter 5.0.

2.0 Background

The former Kaiser Aluminum Specialty Products facility is located at 7311 East 41st Street in Tulsa, Oklahoma. It is situated in Tulsa County, Oklahoma, about 5 miles southeast of the downtown center of the City of Tulsa. The site initially occupied approximately 23 acres of land on both sides of 41st Street. Currently, a 3-acre parcel south of 41st Street contains an active aluminum extrusion and fabrication facility. North of East 41st Street are several parcels of land previously devoted to refining, processing, and waste disposal functions. This acreage is split by the Union Pacific Railroad right-of-way. An approximate 3.5-acre parcel south of the railroad (known as the former "operational area") houses an active office building and several inactive industrial structures. An approximate 14-acre land parcel located north of the railroad contains a Retention Pond, a former Freshwater Pond Area, a former Reserve Pond Area, and the Flux Building Area.

The Retention Pond currently occupies 8 acres of the 14-acre land parcel north of the railroad. The water level in the Retention Pond varies, based on seasonal precipitation. The Retention Pond is surrounded by a well-maintained berm and there are no surface water discharges from the pond. The Retention Pond is permitted by the Oklahoma Water Resources Board. Occupying approximately 4 acres on the western portion of this parcel is the area of the former Freshwater Pond. The Freshwater Pond was backfilled in October and November 2002. Northeast of the Retention Pond is the area of the former Reserve Pond (approximately 1.5 acres). The Reserve Pond was backfilled in the late 1960s and is currently covered with grass.

Historical operations at the facility included the smelting of scrap magnesium alloy for the production of anodes. Scrap magnesium-thorium alloy was smelted, along with other magnesium materials, to recover the magnesium. Thorium alloy material comprised a small fraction of the total magnesium refined on site. Licensed operations involving the recovery of magnesium-thorium alloy began in 1958 and continued through 1970. Magnesium refining operations continued at the facility until approximately 1985. Aluminum replaced magnesium in smelting and anode manufacture, and the plant continued operating until the 1997-1998 time frame.

The scrap magnesium alloy refining process consisted of placing the material into large melting pots, heating the material until molten, and then siphoning off the pure magnesium. Impurities from the mixture, including Th, separated from the magnesium. This residue material was removed, allowed to cool, and crushed. The crushed material was returned to the heating pots for a second recovery process.

Once refined, the metallic dross residue material was crushed and disposed on site in surface impoundments. These surface impoundments are identified as the Retention Pond and the former Reserve Pond Area.

3.0 Field Activities

A&M Engineering and Environmental Services, Inc. (A&M) of Tulsa, Oklahoma performed the groundwater and surface water sampling for the third and fourth quarter 2002 monitoring events occurring in September and December 2002. Groundwater monitoring activities were conducted in accordance with the June 2002 Work Plan for Groundwater and Surface Water Monitoring (Work Plan) (Revision 2). Kaiser Procedure Nos. KAI-03 for groundwater sampling and KAI-04 for field measurement of chemical parameters were also followed during the quarterly monitoring events. Copies of these documents are included in Appendix A.

The purpose of the sampling was to obtain the following types of data:

- Concentrations of radiological and chemical constituents of interest in groundwater hydraulically upgradient from dross source materials.
- Concentrations of radiological and chemical constituents of interest in groundwater hydraulically downgradient and sidegradient from dross source materials.
- Field measurements of pH, conductivity, and dissolved oxygen in groundwater upgradient and downgradient from dross source materials.

The following subsections describe the general processes used during each monitoring event.

3.1 Static Water Level Measurements

Prior to purging and sampling of any groundwater monitoring well locations, groundwater levels and total depths were measured at each of the 18 current monitoring well locations using an electronic water level indicator. Measurements were made from a referenced survey point on the well casing and were recorded to the nearest 0.01 foot. The water level indicator was decontaminated between locations with a triple rinse of deionized or distilled water.

3.2 Groundwater Sampling

During the two quarterly monitoring events, groundwater sampling was conducted at nine Deep Overburden monitoring wells including Wells P-2, P-3, P-5, MWD-4, MWD-5, MWD-7, MWD-8, MWD-9, and MWD-10. No water samples were collected from the Shallow Bedrock groundwater-bearing unit or the three on-site surface water sampling locations per the monitoring schedule defined in

the Work Plan These groundwater and surface water sampling locations are included in the annual monitoring program, which was implemented during the second quarter 2002 monitoring event.

The analytical parameters for the routine groundwater monitoring program are divided into a set of field-measured parameters (water temperature, turbidity, pH, conductivity, and dissolved oxygen) and a set of laboratory-measured parameters (select metals, select inorganics, select field parameters, and select radiological constituents). The radiological constituents consist of isotopic Th (Th-228, Th-230, and Th-232) and isotopic radium (Ra) (Ra-226 and Ra-228). Gross alpha activity in the groundwater is inferred from Th and Ra isotopic analysis and is not performed as part of the routine monitoring program.

Following the static water level measurement, the following field-measured parameters were taken after each of the three well volumes purged at each well:

- Water temperature
- Turbidity
- pH
- Conductivity
- Dissolved oxygen content

Upon completion of well purging, samples for the following laboratory-measured parameters were collected:

- Metals – Calcium, magnesium, sodium, potassium, iron, and barium
- Inorganics – Chloride, fluoride, sulfate, nitrate, and silica dioxide
- Field parameters – Temperature, pH, conductivity, and alkalinity
- Radiological constituents
  - Isotopic Th (Th-228, Th-230, and Th-232)
  - Isotopic Ra (Ra-226 and Ra-228)

Additionally, groundwater samples from select wells (P-2, P-3, and P-5) were collected for copper and zinc analysis.

Decontaminated submersible pumps were utilized for both purging the wells prior to sampling and collecting groundwater samples. Three well volumes were removed prior to sampling in all wells except for slow recovering wells, which were purged to near dryness. Purge water was contained and stored on site and properly disposed following receipt of analyses.

3.3 Sample Preservation, Shipment, and Laboratory Analysis

Samples were field filtered using dedicated 0.45-micron filters during sample collection. Samples for laboratory analysis were placed in laboratory-supplied clean containers, properly labeled, and packaged in shuttles for shipment to the analytical laboratory. Samples were chilled from the time of collection until their arrival at the analytical laboratory. Sample shipment occurred daily (same day collection/delivery). Standard chain-of-custody protocol was strictly adhered to during all phases of sample collection, transport, and delivery to the laboratory. Completed chain-of-custody forms are located in Appendix B along with copies of the analytical laboratory reports.

Samples were analyzed by Outreach Laboratory (Outreach) of Broken Arrow, Oklahoma. Upon the receipt of the samples, Outreach immediately transferred aliquots of the samples to appropriate analysis-based containers. Samples designated for metals and Th and Ra isotopic analysis were immediately acidified with nitric acid to a pH of 2.0 or less. Following preservation, samples for Th and Ra isotopic analysis were held for 16 hours prior to analysis.

4.0 Groundwater Monitoring Results

This chapter provides an evaluation of groundwater elevation and chemistry data for the third and fourth quarter 2002 monitoring events conducted in September and December 2002, respectively. As previously mentioned, no water samples were collected from the Shallow Bedrock groundwater-bearing unit or the three on-site surface water sampling locations per the monitoring schedule defined in the Work Plan. These groundwater and surface water sampling locations are included in the annual monitoring program, which was implemented during the second quarter 2002 monitoring event.

4.1 Groundwater Flow Data

Groundwater levels were measured in the 18 site monitoring wells during each monitoring event. The groundwater levels measured in the field were converted to groundwater elevations based upon surveyed measurement reference point elevations reported in feet above mean sea level (MSL). Groundwater elevations are summarized in Table 2.

4.1.1 Shallow Overburden/Dross Material

Monitoring wells screened in the Shallow Overburden/Dross-Material water-bearing unit are located to the east and northeast of the Retention Pond and consist of Wells MWS-4, MWS-5, MWS-6, and MWS-11. Groundwater elevations based on water level measurements obtained during the third and fourth quarter 2002 monitoring events were contoured as shown in Figures 3 and 4 respectively. These piezometric surface maps indicate that shallow groundwater flows north/northeast (toward Fulton Creek) away from the Retention Pond. The uppermost water-bearing zone occurs under unconfined conditions, with a direct relation to surface water, and is influenced by topography within the eastern portion of the site. The hydrologic flow data for the third and fourth quarter monitoring events are relatively consistent with past monitoring event data (Table 2). Groundwater elevation determinations for Well MWS-5 continue to show groundwater mounding in the area of this well, most likely the result of the installation of sheet piling along the eastern property line (Specific Systems) in November 2000 during the ALRP.

4.1.2 Deep Overburden

Wells used to monitor groundwater occurring in the Deep Overburden are P-2, MWD-2, P-3, MWD-4, P-5, MWD-5, MWD-6, MWD-7, MWD-8, MWD-9, MWD-10, and MWD-11. Groundwater level measurements obtained during the two monitoring events were used to create potentiometric surface maps as shown in Figures 5 and 6. These potentiometric surface maps indicate that groundwater in this confined unit flows in an east/northeast direction following the axis of the bedrock valley identified dur-

ing previous investigations (A&M, 1999). Based on the December 2002 groundwater elevation for Monitoring Wells P-2 (694.83 feet MSL) and MWD-8 (679.95 feet MSL), the average horizontal hydraulic gradient across the site is approximately 0.01 foot per foot, with steeper gradients occurring in the west and south areas along the side of the bedrock valley. The hydrologic flow data for the two monitoring events are relatively consistent with past monitoring event data (Table 2).

Groundwater data in areas that have a Shallow and Deep Overburden monitoring well nest (i.e., MWS-4/MWD-4, MWS-5/MWD-5, and MWS-11/MWD-11) suggest there is a downward vertical gradient from the Shallow Overburden to the Deep Overburden units. The relationship may vary based on surface water levels in the Retention Pond but offers potential for downward migration from the Retention Pond and Shallow Overburden to the Deep Overburden unit.

4.1.3 Shallow Bedrock

Two monitoring wells (ST-2 and ST-3) are screened within the competent Shallow Bedrock water-bearing unit. However, based on the significant difference in groundwater elevations between the two locations (approximately 23 feet for the September 2002 monitoring event) and lithological conditions presented in their respective boring logs (A&M, July 1999), it does not appear that these two wells monitor the same hydrologic unit.

Based on the groundwater elevations from September 2002 for Wells MWD-2 (698.58 feet MSL) and ST-2 (656.70 feet MSL), a downward vertical gradient exists from the Deep Overburden unit to the Shallow Bedrock aquifer southwest of the Freshwater Pond. However, in the area northeast of the Retention Pond, groundwater elevations from September 2002 for Wells MWD-7 (677.22 feet MSL) and ST-3 (679.33 feet MSL), indicate that an upward vertical gradient exists from the Shallow Bedrock to the Deep Overburden unit. The presence of an upward vertical gradient in this area appears to be influenced by the dip of the top of bedrock across the site, as indicated in A&M's report (July 1999).

4.2 Groundwater Quality Conditions

The following sections of this chapter address the groundwater quality conditions for the Deep Overburden groundwater-bearing unit being monitored beneath the Retention Pond and Reserve Pond Area. Groundwater quality data for the Deep Overburden groundwater-bearing unit are presented in Tables 4 and 5. Because of the specific interest in isotopic Th and Ra activity concentrations in groundwater, the data from the September and December 2002 monitoring events have been summarized and presented in Figures 7 and 8. Analytical data reports are contained in Appendix B. Time trend

analysis by location for radionuclides and inorganic constituents of interest are presented in Appendices C and D, respectively.

Groundwater quality data collected during the two quarterly monitoring events were compared to maximum contaminant levels (MCLs) based on U.S. Environmental Protection Agency (USEPA) primary and secondary drinking water standards (Table 3). However, it should be noted that the site groundwater is not likely to ever be a drinking water source. Specific MCLs do not exist for Th-228, Th-230, and Th-232. However, Th is an alpha emitter and would, therefore, fall under 40 Code of Federal Regulations 141.15 regarding "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems." Specifically, the MCL for gross alpha particle activity (including Ra-226 but excluding radon and uranium) is 15 picocuries per liter (pCi/l). Therefore, in evaluating if the gross alpha particle activity MCL is exceeded, the combined totals for Ra-226, Th-228, Th-230, and Th-232 are considered.

4.2.1 Deep Overburden

Wells used to monitor the groundwater quality conditions in the Deep Overburden unit are P-2, P-3, MWD-4, P-5, MWD-5, MWD-7, MWD-8, MWD-9, and MWD-10. Well P-2 is located hydraulically upgradient of the Retention Pond and former Reserve Pond area.

4.2.1.1 Third Quarter (September) 2002 Monitoring Event

The groundwater quality data collected during the third quarter 2002 monitoring event for the Deep Overburden groundwater-bearing unit are presented in Table 4. Analytical results from the monitoring wells screened in the Deep Overburden indicated that the following parameter was above its respective primary drinking water MCL:

		Concentration by Well Location		
Parameter	MCL	P-5	MWD-5	MWD-8
Barium	2 mg/l	3.58 mg/l	4.06 mg/l	21.1 mg/l

The inorganic and metals parameters chloride and iron were detected at concentrations above their respective secondary drinking water MCLs. Chloride concentrations exceeded its secondary MCL of 250 milligrams per liter (mg/l) at Wells P-3 (565 mg/l), MWD-4 (280 mg/l), P-5 (402 mg/l), MWD-5 (290 mg/l), and MWD-8 (691 mg/l). An Iron concentration exceeded its secondary MCL of 0.3 mg/l at Well MWD-8 (2.74 mg/l).

Radionuclide activity concentrations and inorganic constituent concentrations for this monitoring event are in general agreement with historical data. Time trend analysis by location for radionuclides and inorganic constituents of interest are presented in Appendices C and D, respectively.

A blind duplicate sample identified as Duplicate was collected from Well MWD-8 (Table 4). The Duplicate sample's isotopic Th and Ra activity concentrations and inorganic constituent concentrations were in general agreement with the corresponding original sample.

4.2.1.2 Fourth Quarter (December) 2002 Monitoring Event

The groundwater quality data collected during the fourth quarter 2002 monitoring event for the Deep Overburden groundwater-bearing unit are presented in Table 5. Analytical results from the monitoring wells screened in the Deep Overburden indicated that the following parameter was above its respective primary drinking water MCL:

		Concentration by Well Location		
Parameter	MCL	P-5	MWD-5	MWD-8
Barium	2 mg/l	4.52 mg/l	4.91 mg/l	23.1 mg/l

The inorganic and metals parameters chloride and iron were detected at concentrations above their respective secondary drinking water MCLs. Chloride concentrations exceeded their secondary MCL of 250 mg/l at Wells P-3 (503 mg/l), MWD-4 (416 mg/l), P-5 (400 mg/l), MWD-5 (301 mg/l), and MWD-8 (673 mg/l). Iron concentrations exceeded their secondary MCL of 0.3 mg/l at Wells MWD-5 (0.520 mg/l), MWD-7 (0.666 mg/l), and MWD-8 (3.61 mg/l).

Radionuclide activity concentrations and inorganic constituent concentrations for this monitoring event are in general agreement with historical data. Time trend analysis by location for radionuclides and inorganic constituents of interest are presented in Appendices C and D, respectively.

A blind duplicate sample identified as Duplicate was collected from Well P-5 (Table 5). The Duplicate sample's isotopic Th and Ra-226 activity concentrations and inorganic constituent concentrations were in general agreement with the corresponding original sample. The Ra-228 activity concentration for the Duplicate sample was reported as 1.77 +/- 0.054 pCi/l whereas the Ra-228 activity concentration for the original sample was reported as 0 +/- 0.045 pCi/l.

5.0 Summary of Findings and Conclusions

Groundwater monitoring at the Kaiser facility has been conducted over a period of 14 consecutive quarters from September 1999 to the most recent event in December 2002. During the first two events, filtering of samples was delayed until after the samples were received by the analytical laboratory. However, based on the data obtained during the third quarterly event (March 2000), it was determined that the data collected during the first two events did not accurately reflect actual groundwater quality conditions. The incorporation of field filtering into the sampling program for the third quarterly event produced analytical results that were more characteristic of actual groundwater conditions by minimizing the potential for chemical change of the samples before laboratory filtration/analysis. As a result, field filtering was continued in place of laboratory filtering during the subsequent eleven quarterly monitoring events conducted from June 2000 through December 2002. The data for the first two events (September and December 1999) were deemed not usable for the establishment of a statistically representative groundwater quality data set for the site.

Radiological groundwater quality data collected during the third quarter (September) and fourth quarter (December) 2002 monitoring events were compared to MCLs based on USEPA drinking water standards. Analytical results were compared to the MCLs, as they are known regulatory standards. However, it should be noted that the site groundwater is not likely to ever be a drinking water source. Analytical results from these two events indicated that the MCLs for combined Ra-226 and Ra-228 and gross alpha activity (inferred from Th and Ra isotopic analysis) were not exceeded in any of the sampled on-site monitoring well locations. In addition, reported radiological parameter concentrations at the sidegradient and downgradient monitoring wells were consistent with those reported at the upgradient location.

A review and evaluation of the groundwater elevation and quality data obtained during the third and fourth quarter 2002 monitoring events and a perspective of historical information for the site allow for the following conclusions to be made.

- Groundwater within the Shallow Overburden/Dross Material water-bearing unit flows toward the north-northeast (Fulton Creek) away from the Retention Pond. The horizontal hydraulic gradient is approximately 0.02 foot per foot.

- Groundwater within the Deep Overburden water-bearing unit flows in an east/northeast direction following the axis of a bedrock valley located beneath the site. The average horizontal hydraulic gradient across the site is approximately 0.01 foot per foot, with steeper gradients occurring in the west and south areas along the side of the bedrock valley.

- Barium is routinely detected at concentrations above its respective primary MCL in samples collected from monitoring wells screened in the Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock groundwater-bearing units.

- The inorganic parameters chloride, fluoride, sulfate, and iron are sporadically detected at concentrations above their respective secondary MCLs in samples collected from monitoring wells screened in the Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock groundwater-bearing units.

- Analytical results for the groundwater samples collected during the two consecutive quarterly monitoring indicated that the radiological parameters of interest did not exceed their respective primary drinking water MCLs.

It is recommended that the following actions be continued regarding the groundwater and surface water monitoring program:

- Groundwater sampling on a quarterly basis.
- Surface water sampling on an annual basis.
- Groundwater and surface water monitoring report preparation on a semiannual basis.

Tables

Table 1
Monitoring Well Information
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Well ID	Boring Depth (feet, bgs) [1]	Well Screen Interval (feet, bgs)	Dross Material Interval (feet, bgs)
P-1	20	10-20	
P-2	28	18-28	
P-3	13	3-13	
P-4[3]	20	10-20	0-0.083
P-5	20	9-19	
P-7	22	12-22	
P-8	28	16.5-26.5	
P-10	22	12-22	
MWD-2	15	5-15	
MWS-4	10	4-9	0-5
MWD-4	20	10-20	2-2.4
MWS-5	12	7-12	1.5-11
MWD-5	28	16-26	1.5-11
MWS-6	14.5	4.5-14.5	9.5-10 [2]
MWD-6	30	19.5-29.5	9.5-10
MWD-7	20	10-20	
MWD-8	19	9-19	
MWD-9	20.5	9-19	
MWD-10	22	10-20	
MWS-11	10	5-10	4-10
MWD-11	24.5	14-24	4-9.5
ST-2	58	38-48	
ST-3	64	38-48	

Notes:

[1] bgs = below ground surface.

[2] Well is believed to be screened in dross, but not indicated in the boring log. However, this well is right next to MWD-6 which passes through a dross layer.

[3] Well was properly abandoned in March 2001.

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Table 2
Groundwater Elevation Summary
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Location	Sample Date							
	9/1/99	12/1/99	3/1/00	6/1/00	9/1/00	12/22/00	3/1/01	6/1/01
P-1	698 22	699.96	700.06	699.21	697.39	699.77	699.04	697.91
P-2	698.90	699 39	699 49	701.45	699 01	698 72	697 94	698 39
P-3	699.09	700.14	699 83	699 93	697 33	699.29	697 56	698 14
P-4	692.42	694.89	696.72	694 95	691.27	694.55	Abandoned	Abandoned
P-5	679.90	681.20	678.12	680.75	678.52	681.39	680 34	680 80
P-7	691.88	692 66	692 50	692 61	698 87	692 53	692.79	692 70
P-8	691.84	692.54	692 60	693.31	690.68	692.56	692.97	693 52
P-10	696.72	697.28	697.67	697.52	696 81	696 51	696 08	695 97
MWD-2	700.57	701.23	701.26	701 60	700.79	701.97	698.66	699.28
MWS-4	691.20	692.23	691.78	692 02	687.37	691.94	691.06	692 15
MWD-4	690.07	691.30	691.09	691.24	687 06	690 99	689.35	691 44
MWS-5	690 06	691.96	690 49	691.20	687 88	694 61	695.14	696 42
MWD-5	686.05	687.34	686 51	685.60	683.77	690.62	690.29	691 26
MWS-6	684.85	686.67	685.61	685.57	682 89	685 59	685.31	688 15
MWD-6	684.83	686 59	684 87	686 05	682 89	685.71	685.45	687.97
MWD-7	678 61	679.47	680.85	681.23	679.18	680 04	678 82	678 18
MWD-8	680 45	682.15	682.27	681.64	680.35	681.73	681.13	681 60
MWD-9	681.38	681.74	682.09	681 64	680 35	682 03	681.64	681 31
MWD-10	688 54	688.74	688.45	689 03	687.13	688.67	688.96	689.75
MWS-11	683.77	-(1)	683 68	683.71	683.64	683.55	683.62	683.78
MWD-11	682.82	683.84	683.53	683.05	683.64	683.26	683 03	684 03
ST-2	663.74	-	656.47	656.26	657 03	653.97	656.28	656.90
ST-3	680.20	680.62	680 43	679 91	679.81	680.70	680.12	679 48

See footnotes at end of table.

Table 2
(Continued)

Location	Sample Date					
	9/6/01	12/3/01	3/24/02	6/14/02	9/16/02	12/17/02
P-1	699 42	698 08	698 98	699.16	Abandoned	Abandoned
P-2	695 36	697 66	697.86	698 11	696 96	694.83
P-3	697.09	697 96	698.29	698 64	697 69	697 64
P-4	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
P-5	678.70	679 95	680 65	681 63	679 44	680 38
P-7	688.45	692 00	692.18	693 35	Abandoned	Abandoned
P-8	689 01	692.14	692.19	693.56	Abandoned	Abandoned
P-10	693 46	694.99	696 09	696 74	Abandoned	Abandoned
MWD-2	697.93	699 25	699.32	699.83	698.58	699.13
MWS-4	686 83	Dry	690 62	689 49	689 53	689 65
MWD-4	687 01	689 49	690.44	691 86	689 23	689 63
MWS-5	692.82	Dry	Dry	696.45	694 65	694 28
MWD-5	687.63	689 46	690 37	691.73	689.12	689.56
MWS-6	682 64	684.35	684 85	687.80	683.99	684 35
MWD-6	683.13	684.51	685.06	687.81	684.13	684 50
MWD-7	676 67	678 53	679 00	679.83	677.22	679.03
MWD-8	679 20	680 60	681.28	679 00	680 16	679 95
MWD-9	680 16	681.31	681 51	681.66	680 77	681 46
MWD-10	686 62	688 91	688 58	689.85	688 61	687 92
MWS-11	Dry	Dry	Dry	684.31	683.68	Dry
MWD-11	681.48	682 28	682.90	684.15	682.27	682.79
ST-2	657.36	656.86	656.95	656 21	656.70	Dry
ST-3	679.28	680 08	680.23	679 58	679 33	680 18

(1) Dash denotes data not available.

Table 3
Regulatory Limits for Groundwater
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Parameters	Units	Maximum Contaminant Level
pH	s.u.	*6.5-8.5* [1]
Specific Conductivity	umhos/cm	NA
Alkalinity	mg/l	NA
Chloride	mg/l	*250* [1]
Copper[5]	mg/l	1.3
Fluoride[2]	mg/l	4.0
Fluoride[2]	mg/l	*2* [1]
Nitrate	mg/l	10
Silica Dioxide	mg/l	NA
Sulfate	mg/l	*250* [1]
Barium	mg/l	2.0
Calcium	mg/l	NA
Iron	mg/l	*0.3* [1]
Magnesium	mg/l	NA
Potassium	mg/l	NA
Sodium	mg/l	NA
Zinc	mg/l	*5*
Radium-226	pCi/l	5 [3]
Radium-228	pCi/l	5[3]
Thorium-228	pCi/l	15[4]
Thorium-230	pCi/l	15[4]
Thorium-232	pCi/l	15[4]

Notes:

[1] *Italicized* value is a secondary MCL.

[2] Fluoride has both primary and secondary drinking water standards.

[3] MCL for Radium-226 and -228 combined is 5 pCi/l.

[4] Gross alpha particle activity (including Radium-226) is 15 pCi/l.

[5] Copper - action level of 1.3 mg/l.

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Table 4
Groundwater Quality Data
Deep Overburden
Third Quarter (September) 2002 Monitoring Event
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Parameter	Units	Sample Identification				
		P-2 Filtered	P-3 Filtered	MWD-4 Filtered	P-5 Filtered	MWD-5 Filtered
Field Measurements:						
pH, Field	pH units	7 24	6 91	7.00	7.31	7 94
Specific Conductance @ 25°C	µmhos/cm	1056	2000	1417 5	1773	1195
Turbidity	NTU	12 6	181.1	54 98	10 2	5.9
Dissolved Oxygen	mg/l	0 95	1.62	0 62	0 89	1.02
Temperature	°C	20 63	23 8	22 55	22.9	22 0
Laboratory Analysis:						
pH, Lab	pH units	6 83	6 81	6 81	7.17	7 68
Specific Conductance @ 25°C	µmhos/cm	1020	2270	1550	1860	1240
Radium-226	pCi/l	0 096±0 087	0 396±0 139	0 361±0.157	0 273±0 131	0.364±0 137
Radium-228	pCi/l	0.312±0.052	ND±0 049	0 548±0.052	0.768±0 053	0 784±0 053
Total Radium(1)	pCi/l	0.408	0 396	0.909	1 041	1 148
Thorium-228	pCi/l	0 048±0 090	0.033±0.072	0 128±0 111	0±0 110	0±0.164
Thorium-230	pCi/l	0±0.141	0±0 127	0±0.159	0±0.132	0±0 246
Thorium-232	pCi/l	0 038±0 070	0±0 053	0 012±0.063	0±0 108	0±0 151
Gross Alpha Activity(2)	pCi/l	0 182	0.429	0 501	0 273	0 364
Alkalinity	mg/l $CaCO_3$	568	280	313	222	107
Chloride	mg/l	12.6	565	280	402	290
Fluoride	mg/l	0.3	0.4	0.5	0 5	1 4
Nitrate	mg/l NO_3-N	<0.2	<0.2	<0.2	0 3	<0 2
Silica Dioxide	mg/l	2 7	2.3	2 2	1 6	0 9
Sulfate	mg/l	5 2	69 3	61 6	5 6	2.2
Barium	mg/l	0 917	0 293	0 098	3 58	4.06
Calcium	mg/l	16.8	274	147	63.9	42 5
Copper	mg/l	-(3)	<0 121	-	<0 011	-
Iron	mg/l	0.076	<0 066	<0 066	0 261	0.144
Magnesium	mg/l	14 2	62.9	70 5	28.8	21 7
Potassium	mg/l	<0 660	12 2	23 6	248	138
Sodium	mg/l	2.78	60 8	42 0	39 7	25 6
Zinc	mg/l	-	<0.198	-	<0 018	-

See footnotes at end of table.

Table 4
(Continued)

Parameter	Units	Sample Identification				
		MWD-7 Filtered	MWD-8 Filtered	MWD-8 (Dup) Filtered	MWD-9 Filtered	MWD-10 Filtered
Field Measurements:						
pH, Field	pH units	7 02	7.53	-	6 94	7 44
Specific Conductance @ 25°C	µmhos/cm	877 5	2175	-	935	1288
Turbidity	NTU	109 45	4.1	-	93 38	84.73
Dissolved Oxygen	mg/l	1.85	0.74	-	1 39	0 75
Temperature	°C	21.65	24.05	-	24.48	22 43
Laboratory Analysis:						
pH, Lab	pH units	6.71	7 31	7.41	6 84	6 99
Specific Conductance @ 25°C	µmhos/cm	762	2470	2440	882	1260
Radium-226	pCi/l	0.275±0.109	0 240±0.162	0 410±0 168	0 134±0 106	0 413±0 137
Radium-228	pCi/l	0±0.052	3.93±0.069	2 04±0 061	ND±0 049	ND±0 046
Total Radium(1)	pCi/l	0 275	4.17	2.45	0.134	0.413
Thorium-228	pCi/l	0 123±0 073	0.192±0 147	0±0.110	0±0 191	0 186±0 103
Thorium-230	pCi/l	0±0 116	0.078±0 212	0 112±0.196	0.156±0.243	0.183±0.162
Thorium-232	pCi/l	0.043±0 066	0 184±0 155	0±0 090	0±0 0141	0±0 116
Gross Alpha Activity(2)	pCi/l	0.441	0.694	0 522	0 29	0.782
Alkalinity	mg/l $CaCO_3$	229	155	156	217	279
Chloride	mg/l	76.9	691	686	128	222
Fluoride	mg/l	0.4	1.7	1.7	0 3	0 8
Nitrate	mg/l NO_3-N	<0 2	0.2	<0 2	<0.2	<0 2
Silica Dioxide	mg/l	1.5	1 2	1 2	1 8	1 7
Sulfate	mg/l	28.7	1.3	1.1	30.0	28.2
Barium	mg/l	1.34	21.1	21 3	0 408	0 990
Calcium	mg/l	68.9	68 9	71 9	97 3	89 3
Copper	mg/l	-	-	-	-	-
Iron	mg/l	0 069	2 74	2 65	0 077	0 092
Magnesium	mg/l	12.6	131	134	28 2	47.5
Potassium	mg/l	85 2	185	188	8 99	69 2
Sodium	mg/l	14.6	30 4	30 6	23 8	27.4
Zinc	mg/l	-	-	-	-	-

(1)Total Radium consists of the summation of Radium-226 and Radium-228 activity concentrations.
(2)Gross alpha particle activity inferred from Ra-226 and Thorium isotopic analysis.
(3)Dash denotes not analyzed.

Table 5
Groundwater Quality Data
Deep Overburden
Fourth Quarter (December) 2002 Monitoring Event
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

		Sample Identification				
Parameter	Units	P-2 Filtered	P-3 Filtered	MWD-4 Filtered	P-5 Filtered	P-5 (Dup) Filtered
Field Measurements:						
pH, Field	pH units	6 79	6.93	6.74	7.35	-(1)
Specific Conductance @ 25°C	µmhos/cm	1200	2000	1875	2050	-
Turbidity	NTU	28 3	19 95	29 65	1.73	-
Dissolved Oxygen	mg/l	1.46	2 32	2 63	3 67	-
Temperature	°C	17.65	14 9	19 45	17.33	-
Laboratory Analysis·						
pH, Lab	pH units	6 83	6 91	6 80	7.28	7 30
Specific Conductance @ 25°C	µmhos/cm	1030	2110	1990	1900	1900
Radium-226	pCi/l	0 070±0 097	0 426±0 239	0 248±0 221	0 992±0 375	0 721±0 294
Radium-228	pCi/l	0±0.047	0 81±0 049	0±0	0±0 045	1 77±0 054
Total Radium(2)	mg/l	0.07	1.236	0.248	0.992	2.491
Thorium-228	pCi/l	0 064±0 076	0.244±0.131	0.101±0.094	0 046±0.090	0.118±0 132
Thorium-230	pCi/l	0.946±0 215	0.079±0.199	0±0.101	0±0.108	0 026±0 196
Thorium-232	pCi/l	0.119±0 078	0 071±0 082	0±0 053	0 031±0 095	0 212±0 175
Gross Alpha Activity(3)	pCi/l	1.199	0.82	0 349	1.069	1 077
Alkalinity	mg/l $CaCO_3$	566	254	323	221	220
Chloride	mg/l	16 0	503	416	400	403
Fluoride	mg/l	0 3	0 4	0 5	0 5	0 6
Nitrate	mg/l NO_3-N	<0 2	<0.2	<0.2	<0 2	<0 2
Silica Dioxide	mg/l	3 8	2 9	3 3	2 3	2 3
Sulfate	mg/l	4.6	47 3	64 0	4.2	4 8
Barium	mg/l	0 899	0.179	0.127	4 52	4 45
Calcium	mg/l	192	250	199	86.1	64.0
Copper	mg/l	-	0 019	-	<0.011	-
Iron	mg/l	0 055	0 069	0 035	0 202	0 287
Magnesium	mg/l	13.9	54 6	96 2	34.6	35.6
Potassium	mg/l	0 504	9.84	26.7	282	295
Sodium	mg/l	28.4	56 3	56 2	41 8	43.3
Zinc	mg/l	-	0 022	-	<0 018	-

See footnotes at end of table.

Table 5
(Continued)

Parameter	Units	Sample Identification				
		MWD-5 Filtered	MWD-7 Filtered	MWD-8 Filtered	MWD-9 Filtered	MWD-10 Filtered
Field Measurements:						
pH, Field	pH units	7 80	6 83	7 53	6 89	7 06
Specific Conductance @ 25°C	µmhos/cm	1425	1050	2450	1025	1625
Turbidity	NTU	0 73	8.73	10 72	220 5	32 25
Dissolved Oxygen	mg/l	2.43	0.94	2.65	0.89	2.55
Temperature	°C	19 28	18 55	17 1	17 83	16 75
Laboratory Analysis:						
pH, Lab	pH units	7.68	6 91	7.42	6.94	7 07
Specific Conductance @ 25°C	µmhos/cm	1290	711	2530	835	1300
Radium-226	pCi/l	0 634±0 299	0 730±0 348	1 09±0 385	0 216±0 361	0±0.398
Radium-228	pCi/l	0±0 047	0±0 046	0 92±0 053	0±0 046	0±0 047
Total Radium(2)	mg/l	0.634	0.73	2.01	0.216	0
Thorium-228	pCi/l	0 050±0 170	0±0 056	0.121±0 119	0 198±0.124	0.061±0.105
Thorium-230	pCi/l	0±0.134	0 039±0 113	0 249±0 198	0±0 119	0 244±0 185
Thorium-232	pCi/l	0 025±0 120	0 021±0 083	0.144±0 134	0 198±0 113	0 034±0 090
Gross Alpha Activity(3)	pCi/l	0.709	0.79	1.604	0 612	0 339
Alkalinity	mg/l $CaCO_3$	105	188	164	212	264
Chloride	mg/l	301	87.5	673	117	239
Fluoride	mg/l	1.4	0 3	1 6	0.3	0 8
Nitrate	mg/l NO_3-N	<0 2	<0 2	<0 2	<0.2	<0.2
Silica Dioxide	mg/l	1 5	1.7	1.7	2 6	2 5
Sulfate	mg/l	<1	19 3	2.4	36 7	18 1
Barium	mg/l	4 91	1.09	23 1	0 260	1 06
Calcium	mg/l	46.3	62 4	74.1	99.2	88 8
Copper	mg/l	-	-	-	-	-
Iron	mg/l	0 520	0 666	3 61	0 068	0 048
Magnesium	mg/l	28 0	12 0	144	31.7	58 5
Potassium	mg/l	172	76.8	204	9 69	73 1
Sodium	mg/l	29 7	16.9	34.4	23.7	26 6
Zinc	mg/l	-	-	-	-	-

(1) Dash denotes not analyzed.
(2) Total Radium consists of the summation of Radium-226 and Radium-228 activity concentrations
(3) Gross alpha particle activity inferred from Ra-226 and Thorium isotopic analysis.

Figures

SCALE – FEET

0 2000

N

SITE LOCATION:
7311 EAST 41st STREET
TULSA, OKLAHOMA

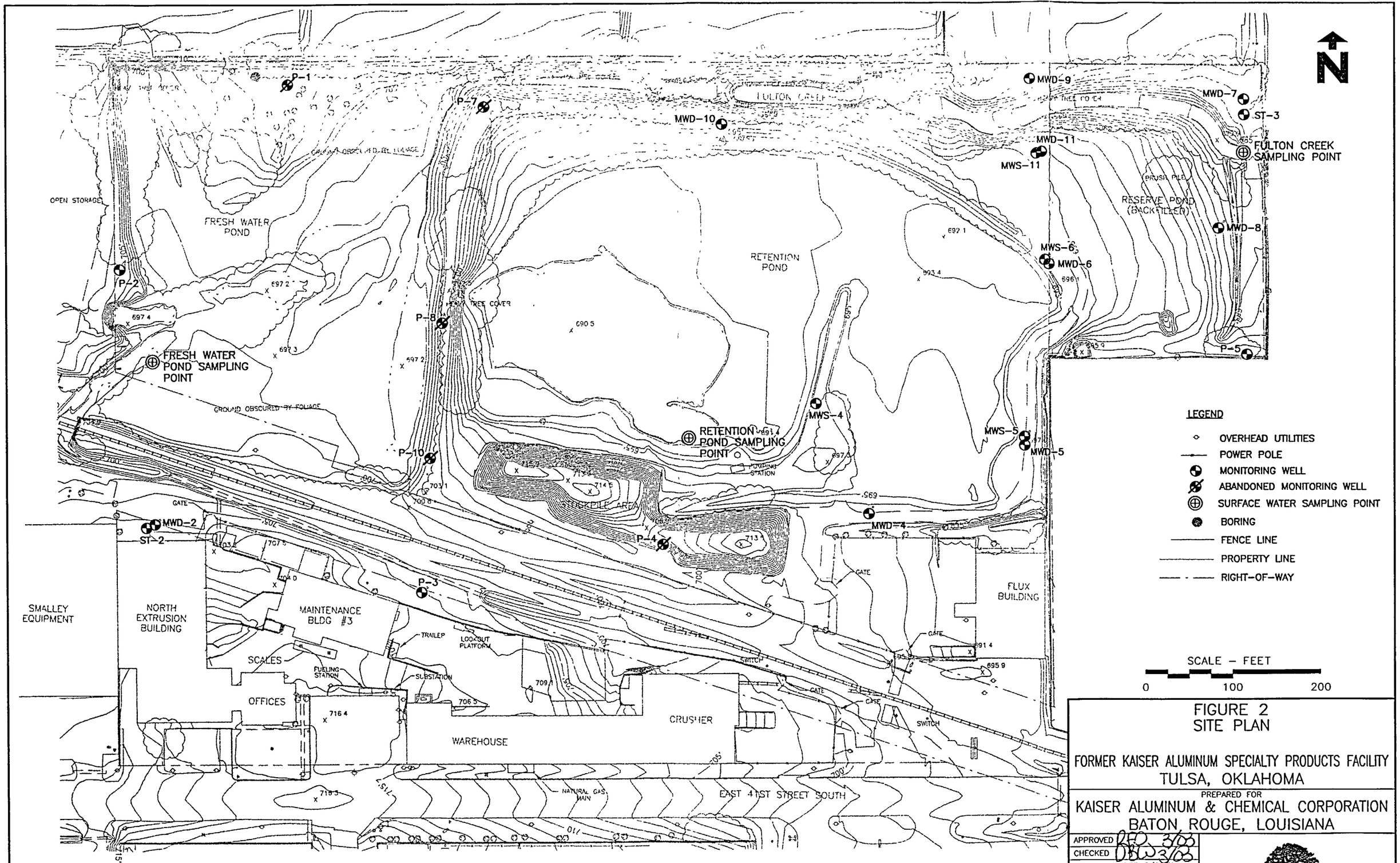
REFERENCE
USGS 7.5-MIN TOPOGRAPHIC QUADRANGLE
JENKS, OKLAHOMA
DATED 1952, PHOTOREVISED 1982

FIGURE 1
SITE LOCATION MAP
FORMER KAISER ALUMINUM
SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RHD 3/02
CHECKED	ASL 3/02
DRAWN	GJA 10/1/01
DRAWING NUMBER	5427039

Earth Sciences Consultants, Inc.



REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC; AUG 16 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 2
SITE PLAN

FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

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CHECKED	DBW 3/03
DRAWN	DEB 6/20/00
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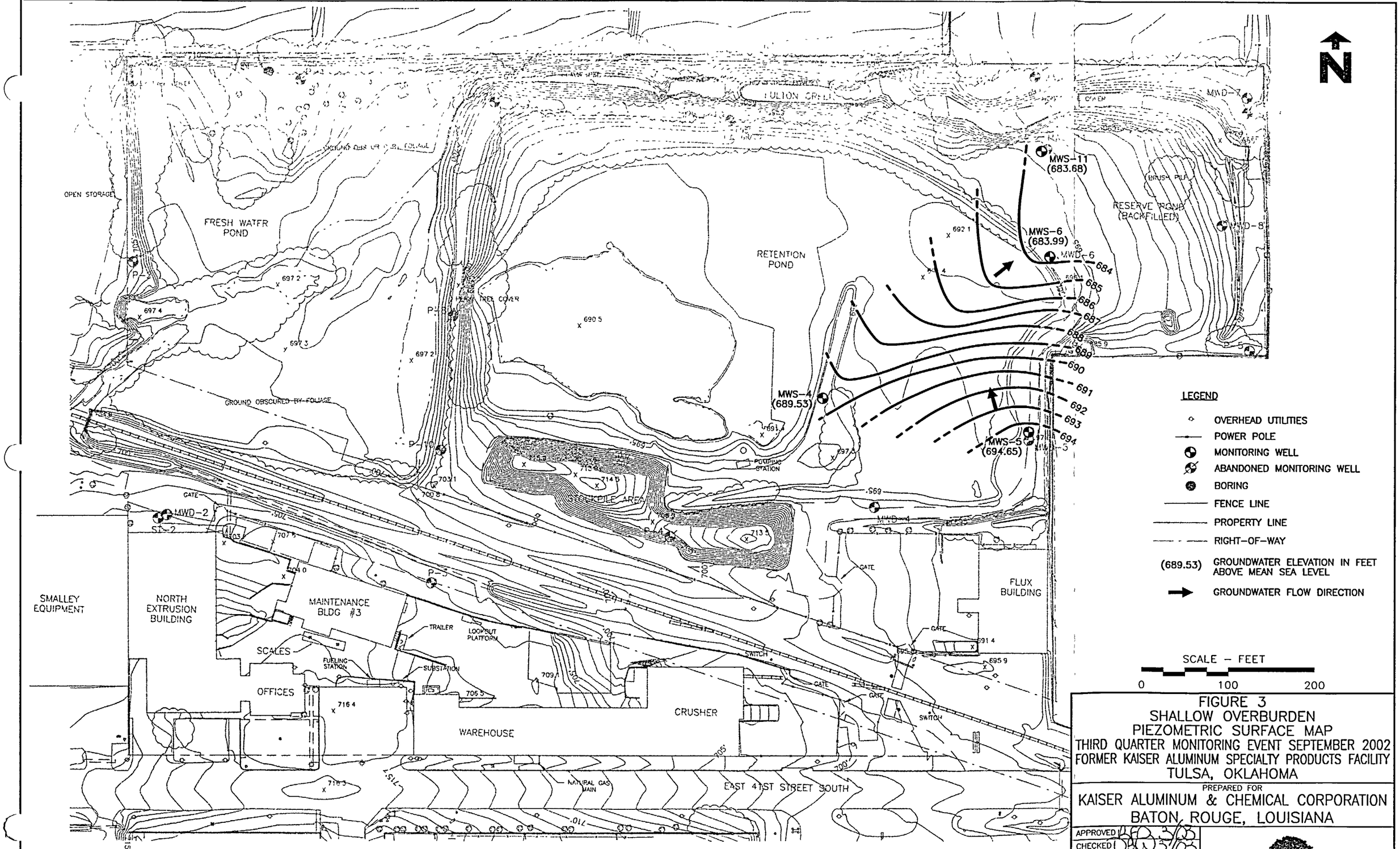
Earth Sciences Consultants, Inc.



REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

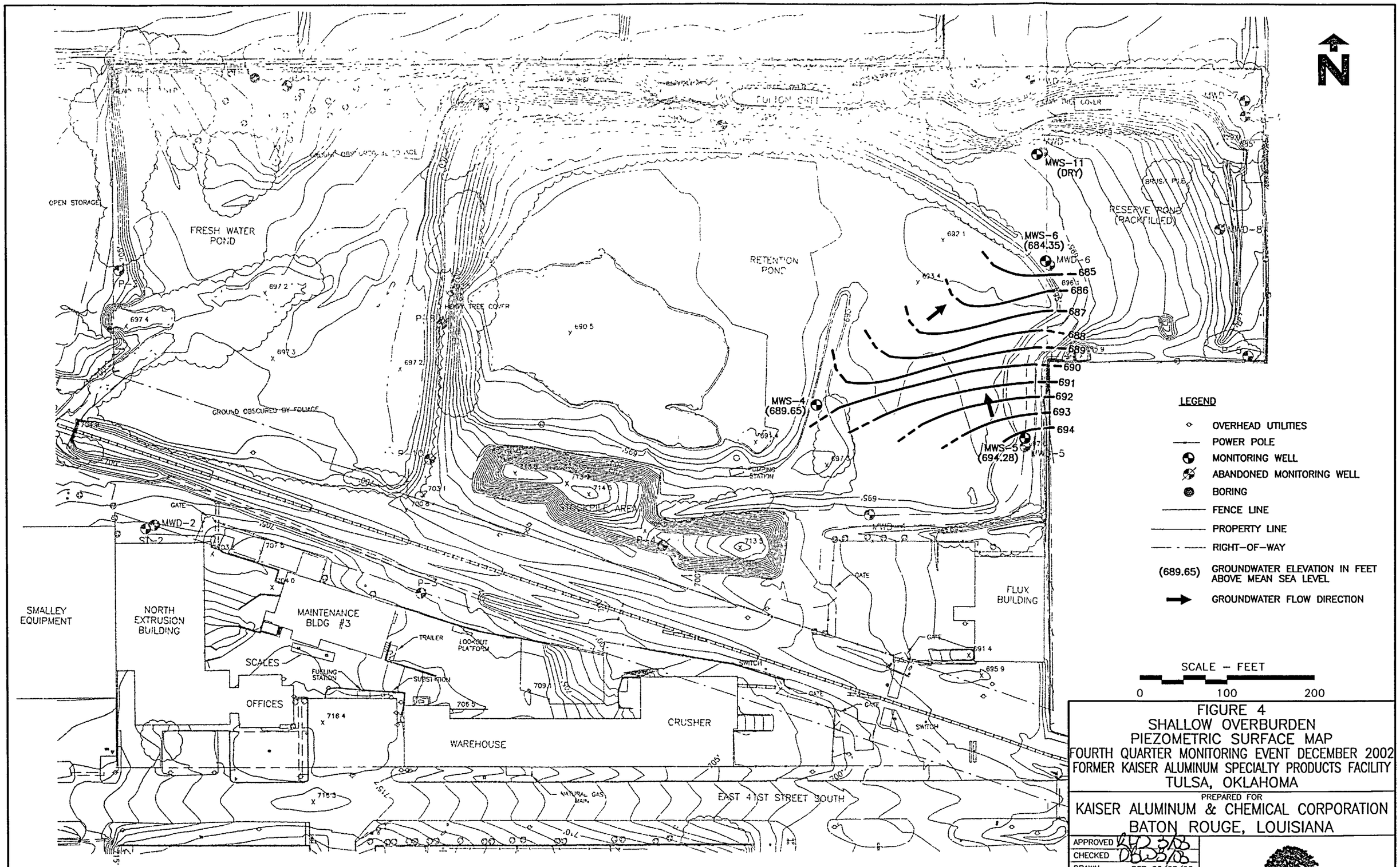
2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 3
SHALLOW OVERBURDEN
PIEZOMETRIC SURFACE MAP
THIRD QUARTER MONITORING EVENT SEPTEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	3/03
CHECKED	3/03
DRAWN	DEB 03/05/03
DRAWING NUMBER	5427300

Earth Sciences Consultants, Inc.



REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 4
SHALLOW OVERBURDEN
PIEZOMETRIC SURFACE MAP
FOURTH QUARTER MONITORING EVENT DECEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	
CHECKED	
DRAWN	DEB 03/05/03
DRAWING NUMBER	5427301

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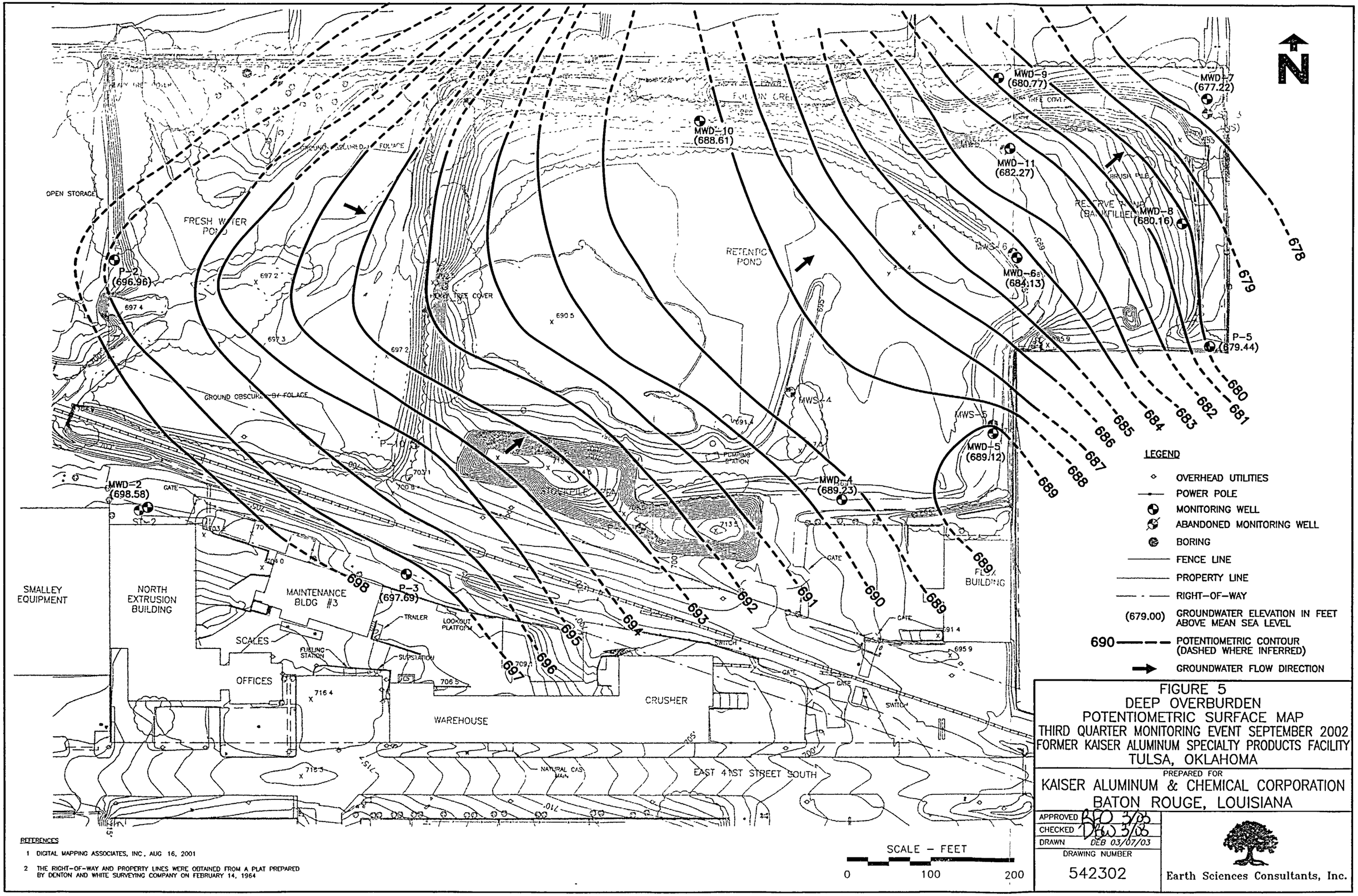


REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

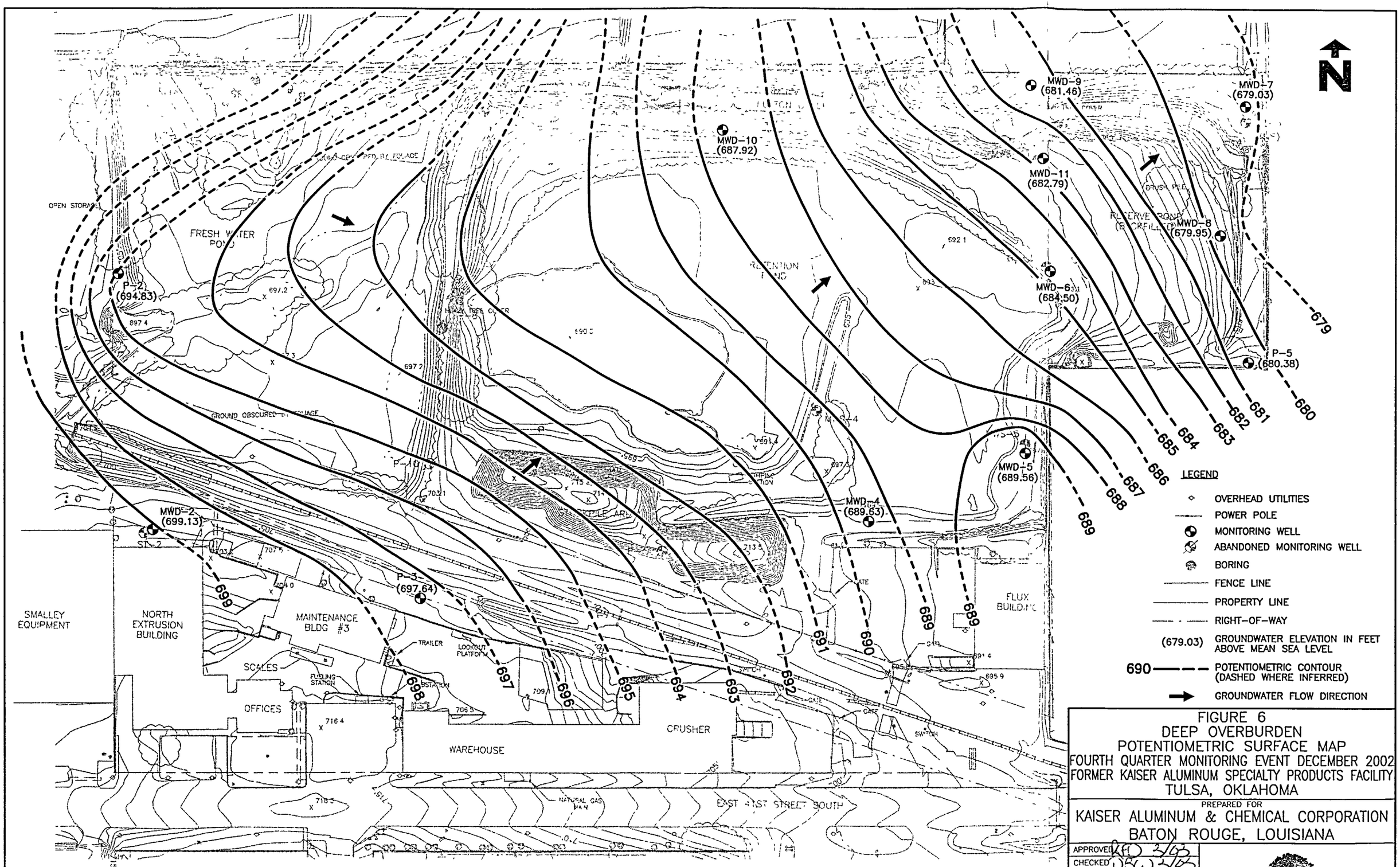
2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 5
DEEP OVERBURDEN
POTENTIOMETRIC SURFACE MAP
THIRD QUARTER MONITORING EVENT SEPTEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RFO 3/03
CHECKED	DEB 3/03
DRAWN	DEB 03/07/03
DRAWING NUMBER	542302

Earth Sciences Consultants, Inc.



REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 6
DEEP OVERBURDEN
POTENTIOMETRIC SURFACE MAP
FOURTH QUARTER MONITORING EVENT DECEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

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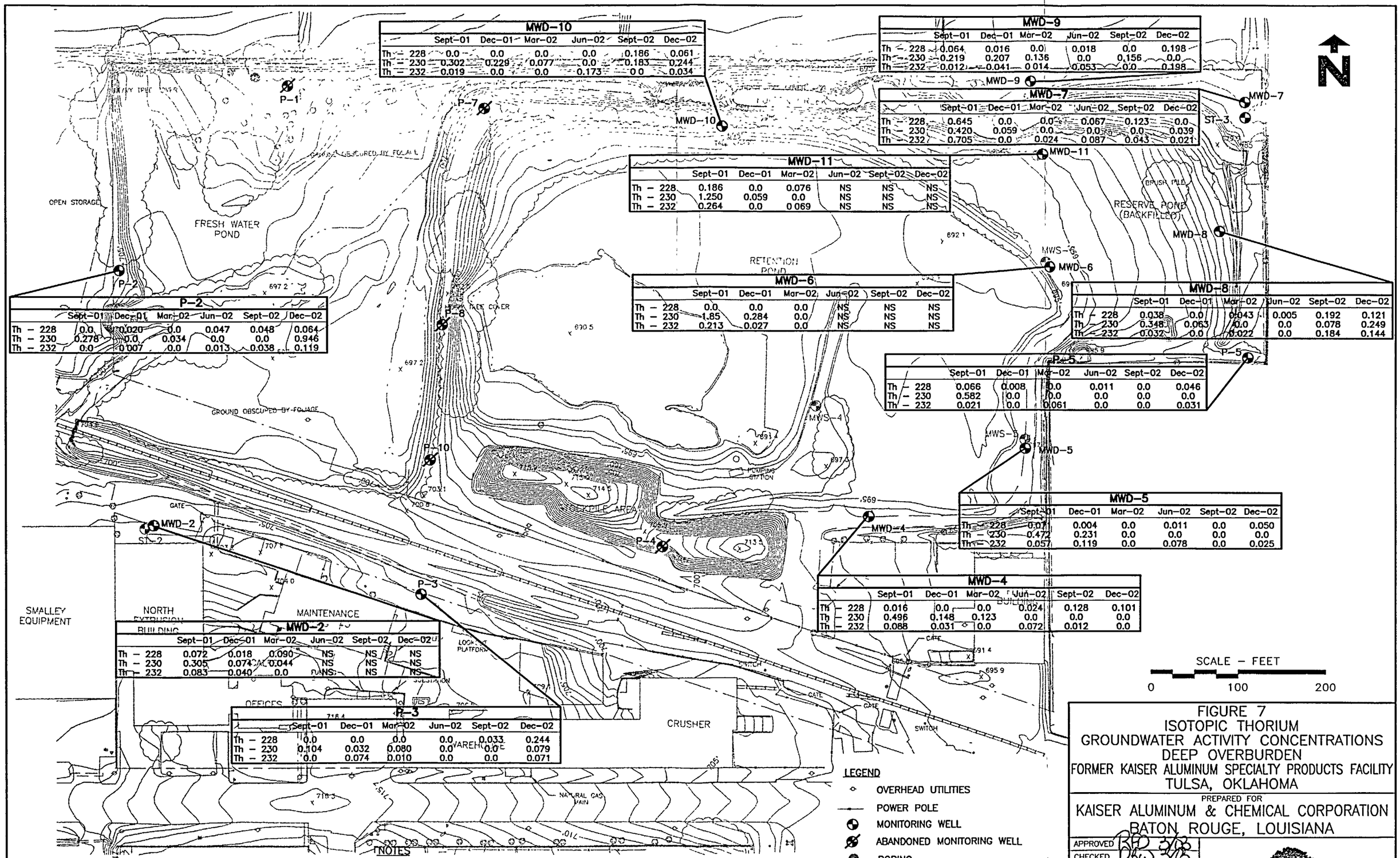
CHECKED	3/03
DRAWN	DEB 03/07/03
DRAWING NUMBER	5427303

Earth Sciences Consultants, Inc.



MWD-10	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.0	0.0	0.0	0.0	0.186	0.061
Th – 230	0.302	0.229	0.077	0.0	0.183	0.244
Th – 232	0.019	0.0	0.0	0.173	0.0	0.034

MWD-9	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.064	0.016	0.0	0.018	0.0	0.198
Th – 230	0.219	0.207	0.136	0.0	0.156	0.0
Th – 232	0.012	0.041	0.014	0.053	0.0	0.198

MWD-7	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.645	0.0	0.0	0.067	0.123	0.0
Th – 230	0.420	0.059	0.0	0.0	0.0	0.039
Th – 232	0.705	0.0	0.024	0.087	0.043	0.021

MWD-11	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.186	0.0	0.076	NS	NS	NS
Th – 230	1.250	0.059	0.0	NS	NS	NS
Th – 232	0.264	0.0	0.069	NS	NS	NS

MWD-6	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.0	0.0	0.0	NS	NS	NS
Th – 230	1.85	0.284	0.0	NS	NS	NS
Th – 232	0.213	0.027	0.0	NS	NS	NS

MWD-8	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.038	0.0	0.043	0.005	0.192	0.121
Th – 230	0.348	0.063	0.0	0.0	0.078	0.249
Th – 232	0.032	0.0	0.022	0.0	0.184	0.144

P-2	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.0	0.020	0.0	0.047	0.048	0.064
Th – 230	0.278	0.0	0.034	0.0	0.0	0.946
Th – 232	0.0	0.007	0.0	0.013	0.038	0.119

P-5	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.066	0.008	0.0	0.011	0.0	0.046
Th – 230	0.582	0.0	0.0	0.0	0.0	0.0
Th – 232	0.021	0.0	0.061	0.0	0.0	0.031

MWD-5	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.07	0.004	0.0	0.011	0.0	0.050
Th – 230	0.472	0.231	0.0	0.0	0.0	0.0
Th – 232	0.057	0.119	0.0	0.078	0.0	0.025

MWD-4	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.016	0.0	0.0	0.024	0.128	0.101
Th – 230	0.496	0.148	0.123	0.0	0.0	0.0
Th – 232	0.088	0.031	0.0	0.072	0.012	0.0

MWD-2	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.072	0.018	0.090	NS	NS	NS
Th – 230	0.305	0.074	0.044	NS	NS	NS
Th – 232	0.083	0.040	0.0	NS	NS	NS

P-3	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Th – 228	0.0	0.0	0.0	0.0	0.033	0.244
Th – 230	0.104	0.032	0.080	0.0	0.0	0.079
Th – 232	0.0	0.074	0.010	0.0	0.0	0.071

REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

NOTES

1. THE ACTIVITY CONCENTRATION VALUES ARE IN PICOCURIES PER LITER.
2. ANALYTICAL RESULTS ARE FOR FIELD FILTERED SAMPLES.
3. NS DENOTES WELL NOT SAMPLED.

LEGEND

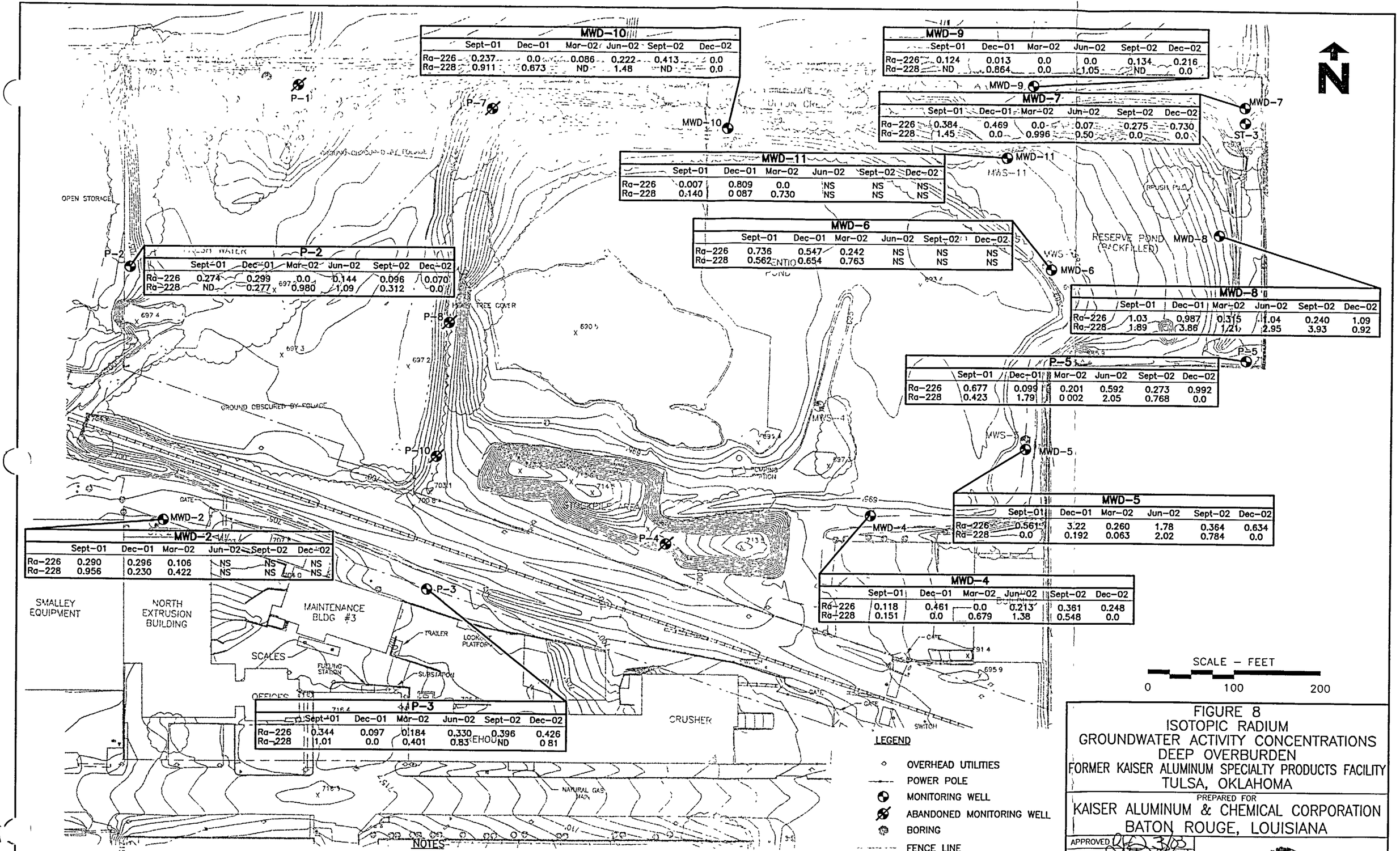
- OVERHEAD UTILITIES
- POWER POLE
- MONITORING WELL
- ABANDONED MONITORING WELL
- BORING
- FENCE LINE
- PROPERTY LINE
- RIGHT-OF-WAY

FIGURE 7
ISOTOPIC THORIUM
GROUNDWATER ACTIVITY CONCENTRATIONS
DEEP OVERBURDEN
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RED 3/03
CHECKED	DBW 3/03
DRAWN	DEB 03/07/03
DRAWING NUMBER	5427305

Earth Sciences Consultants, Inc.



MWD-10

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.237	0.0	0.086	0.222	0.413	0.0
Ra-228	0.911	0.673	ND	1.48	ND	0.0

MWD-9

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.124	0.013	0.0	0.0	0.134	0.216
Ra-228	ND	0.864	0.0	1.05	ND	0.0

MWD-7

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.384	0.469	0.0	0.07	0.275	0.730
Ra-228	1.45	0.0	0.996	0.50	0.0	0.0

MWD-11

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.007	0.809	0.0	NS	NS	NS
Ra-228	0.140	0.087	0.730	NS	NS	NS

MWD-6

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.736	0.547	0.242	NS	NS	NS
Ra-228	0.562	0.654	0.763	NS	NS	NS

MWD-8

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	1.03	0.987	0.315	1.04	0.240	1.09
Ra-228	1.89	3.86	1.21	2.95	3.93	0.92

P-2

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.274	0.299	0.0	0.144	0.096	0.070
Ra-228	ND	0.277	0.980	1.09	0.312	0.0

P-5

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.677	0.099	0.201	0.592	0.273	0.992
Ra-228	0.423	1.79	0.002	2.05	0.768	0.0

MWD-5

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.561	3.22	0.260	1.78	0.364	0.634
Ra-228	0.0	0.192	0.063	2.02	0.784	0.0

MWD-2

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.290	0.296	0.106	NS	NS	NS
Ra-228	0.956	0.230	0.422	NS	NS	NS

MWD-4

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.118	0.461	0.0	0.213	0.361	0.248
Ra-228	0.151	0.0	0.679	1.38	0.548	0.0

P-3

	Sept-01	Dec-01	Mar-02	Jun-02	Sept-02	Dec-02
Ra-226	0.344	0.097	0.184	0.330	0.396	0.426
Ra-228	1.01	0.0	0.401	0.83	ND	0.81

REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC., AUG 16, 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

NOTES

1. THE ACTIVITY CONCENTRATION VALUES ARE IN PICOCURIES PER LITER.
2. ANALYTICAL RESULTS ARE FOR FIELD FILTERED SAMPLES.
3. NS DENOTES WELL NOT SAMPLED.

FIGURE 8
ISOTOPIC RADIUM
GROUNDWATER ACTIVITY CONCENTRATIONS
DEEP OVERBURDEN
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED RLD 3/03
CHECKED DRW 3/03
DRAWN DEB 03/07/03
DRAWING NUMBER
5427304

Earth Sciences Consultants, Inc.

Appendix A

Work Plan and Relevant Procedures

Work Plan for Groundwater and Surface Water Monitoring

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

Work Plan for Groundwater and Surface Water Monitoring

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

COPY

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

APPROVAL

This plan has been approved by:

J. W. Vinzant
Project Manager

Date

Reviewed by:

L. Max Scott
Radiation Safety Officer

Date

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Figure 1 – Site Location Map (Dwg 5427039)
Figure 2 – Site Plan (Dwg 5427207)

Work Plan for
Groundwater and Surface Water Monitoring
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

1.0 Purpose and Objectives

The purpose of the work proposed in this plan is to obtain data on the concentration of radiological and selected chemical constituents in groundwater and surface water at the Former Kaiser Aluminum Specialty Products (Kaiser) facility located in Tulsa, Oklahoma (Figure 1).

Specifically, the following types of data will be obtained:

- Concentrations of radiological and chemical constituents of interest in surface water and groundwater upgradient from dross source materials.
- Concentrations of radiological and chemical constituents of interest in surface water and groundwater downgradient from dross source materials.
- Field measurements of pH, conductivity, and dissolved oxygen (DO) groundwater upgradient and downgradient from dross source materials.

These data will be used to address the following:

- Provide a basis for the evaluation of current risks associated with radiological materials present on the site; and
- Provide insight into the subsurface hydrologic flow regimes at the site.

2.0 Scope

This chapter of the work plan presents an overview of the Tulsa facility's groundwater and surface water monitoring locations, monitoring frequency, and analytical parameters.

2.1 Monitoring Locations

Three different groundwater-bearing units were identified beneath the Retention Pond and Reserve Pond Area at the facility: Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock. They will be monitored as listed below:

- Shallow Overburden/Dross Material: Wells MWS-4, MWS-5, MWS-6, and MWS-11
- Deep Overburden: Wells P-1, P-2, MWD-2, P-3, MWD-4, P-5, MWD-5, MWD-6, P-7, MWD-7, P-8, MWD-8, MWD-9, P-10, MWD-10, and MWD-11
- Shallow Bedrock: Wells ST-2 and ST-3

Three on-site surface water locations, the Fresh Water Pond, the Retention Pond, and Fulton Creek also will be routinely monitored. The 22 current monitoring well locations and the three surface water features are identified in Figure 2.

2.2 Monitoring Frequency

Groundwater and surface water monitoring for the Tulsa facility will be conducted on a quarterly and annual schedule. The monitoring schedule is presented below.

2.2.1 Quarterly Monitoring

The quarterly monitoring program consists of the following:

- Collection of water level measurements at the aforementioned 22 monitoring well locations.
- Sampling of nine monitoring wells including MWD-4, MWD-5, MWD-7, MWD-8, MWD-9, MWD-10, P-2, P-3, and P-5.

2.2.2 Annual Monitoring

The annual monitoring program consists of the following additions to the Quarterly Monitoring Program:

- Sampling of Wells ST-2 and ST-3.
- Sampling of three on-site surface water locations including the Fresh Water Pond, the Retention Pond, and Fulton Creek.

2.3 Groundwater and Surface Water Analytical Parameters

Analytical parameters are divided into a set of field-measured parameters and a set of laboratory-measured parameters. Following the static water level measurement, the following field-measured parameters will taken after each of the three well volumes purged at each well:

- Water temperature
- Turbidity
- pH
- Conductivity
- DO content

These parameters will be measured in the field in accordance with Procedure KAI-04, Procedure for Field Measurement of Chemical Parameters.

Upon completion of well purging, samples for the following laboratory-measured parameters will be collected:

- Metals – calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), and barium (Ba)
- Inorganics – chloride (Cl), fluoride (F), sulfate (SO_4), nitrate (NO_3), and silica dioxide (SiO_2)
- Field parameters – temperature, pH, conductivity, and alkalinity
- Radiological constituents
  - Isotopic Thorium (Th) (Th-228, Th-230, and Th-232)
  - Isotopic Radium (Ra) (Ra-226 and Ra-228)

The analytical parameters for surface water samples will be identical to those field- and laboratory-measured sets listed above. Additionally, surface water samples and groundwater samples from select

wells (P-2, P-3, and P-5) will be collected for copper and zinc analysis in accordance with the aforementioned monitoring schedules.

Samples for laboratory analysis will be collected in accordance with Procedure KAI-03 (Groundwater Sampling Procedure) or Procedure KAI-07 (Surface Water Sampling Procedure). Groundwater and surface water samples will be field filtered using dedicated 0.45-micron filters during sample collection. The procedures for laboratory measurements will be supplied by the analytical laboratory.

3.0 Collection of Water Samples

This chapter presents a tabular summary of the sample bottle requirements, preservation methods, and maximum sample holding times for the proposed analytical parameters. Samples will be analyzed before the maximum allowable holding time deadline occurs.

Volumes, Type, and Number of Bottles

Parameter	Number of Bottles	Bottle Type	Volume	Preservation	Analysis	Maximum Holding Times
Inorganics and Field Parameters	1	Polyethylene	1 L	Cool – 4 degrees C, NO3 – H_2SO_4 to pH<2,	Cl, F, SO_4, SiO_2, NO_3, pH, conductivity, and alkalinity	pH – immediate; alkalinity – 14 days; NO_3 – 48 hours; Cl, F, SO_4, SiO_2 – 28 days
Metals	1	Polyethylene	250 ml	Cool – 4 degrees C, HNO_3 to pH<2	Ca, Mg, Na, K, Cu, Zn, Fe, and Ba	6 months
Thorium Isotopes	1	Polyethylene or Glass	3 L	Cool – 4 degrees C, HNO_3 to pH<2	Th-232, Th-230, and Th-228	6 months
Radium Isotopes	1	Polyethylene or Glass	3 L	Cool – 4 degrees C, HNO_3 to pH<2	Ra-226 and Ra-228	6 months

Samples will be placed in a shuttle (cooler) and chilled to 4 degrees Celsius (using ice) from the time of collection until their arrival at the analytical laboratory. Samples requiring additional preservation (acidification) may either be preserved in the field by the sampler or by the analytical laboratory upon receipt if same day sample collection/delivery is performed. Standard chain-of-custody protocol will be strictly adhered to during all phases of sample collection, transport, and delivery to the laboratory.

4.0 Quality Assurance/Quality Control

This chapter presents a general overview of the quality assurance (QA)/quality control program for groundwater and surface water monitoring at the Tulsa facility.

4.1 General

The quality of the data obtained as a result of the implementation of this plan will be determined primarily on how well procedures were followed and whether or not the instruments used were functioning properly and adequately calibrated prior to use. To ensure that the procedures are faithfully followed, personnel making measurements in the field or in the laboratory must review and understand procedures prior to the initiation of field or laboratory work. To ensure that the instruments are calibrated properly, calibration activities must be recorded on field logs/field notebook or logbook.

4.2 Applicable QA Procedures

The following QA procedures will be used in the performance of the work laid out in this work plan:

Procedure Number	Procedure Name
KAI-03	Groundwater Sampling Procedure
KAI-04	Procedure for Field Measurement of pH, Conductivity, and Dissolved Oxygen
KAI-06	QA Plan
KAI-07	Surface Water Sampling Procedure
GEN 21-3 (Rev. 3)	Laboratory QA Manual for Outreach Laboratory, Tulsa Oklahoma

5.0 Revisions to the Work Plan

The scope of this work plan may be revised from time to time to add or delete sampling points or parameters. Revisions to the plan may be made by issuing a revised plan or by addenda to the current plan. Revisions will be approved by the Kaiser Project Manager and reviewed by the Radiation Safety Officer.

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Figures

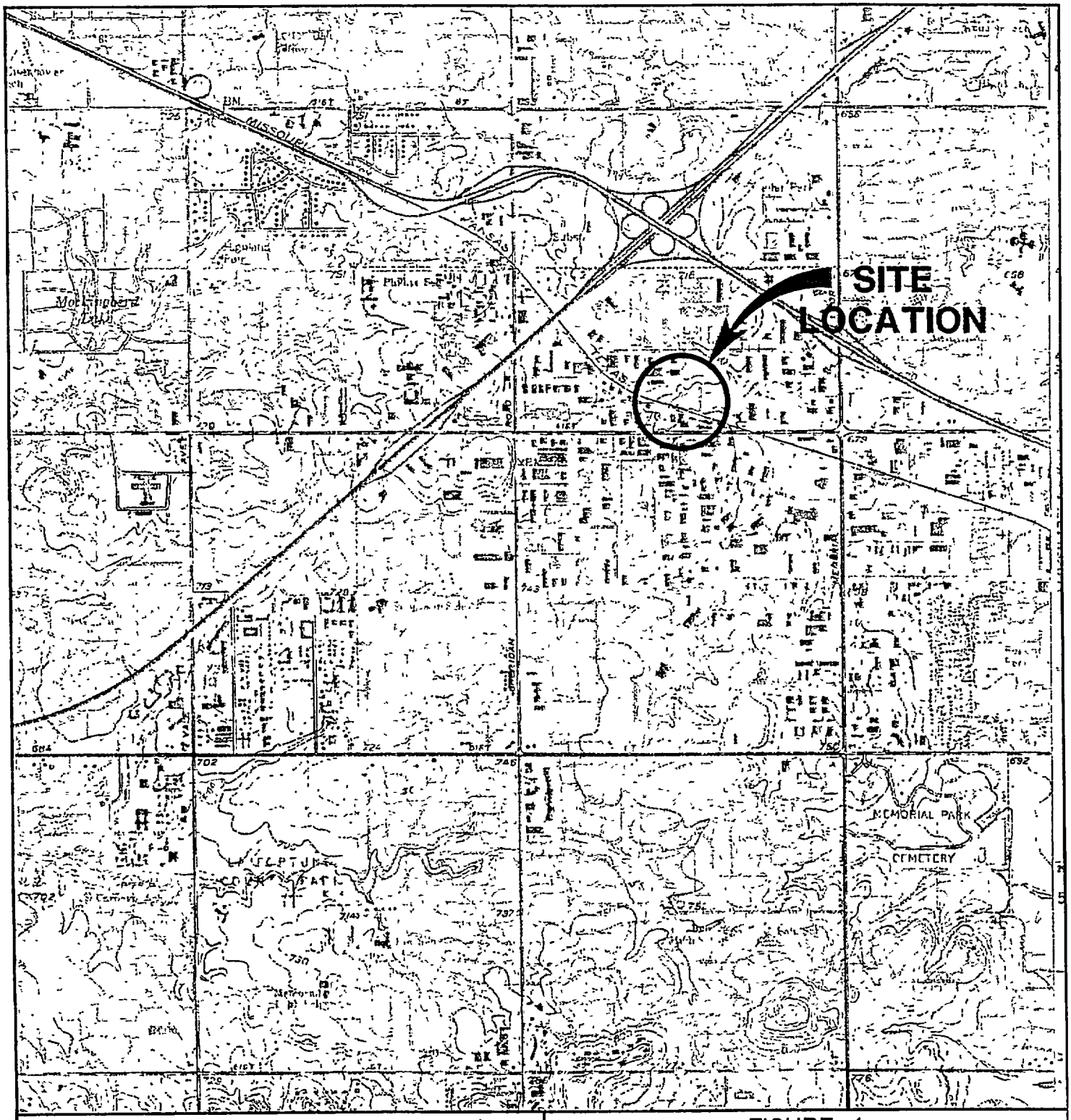

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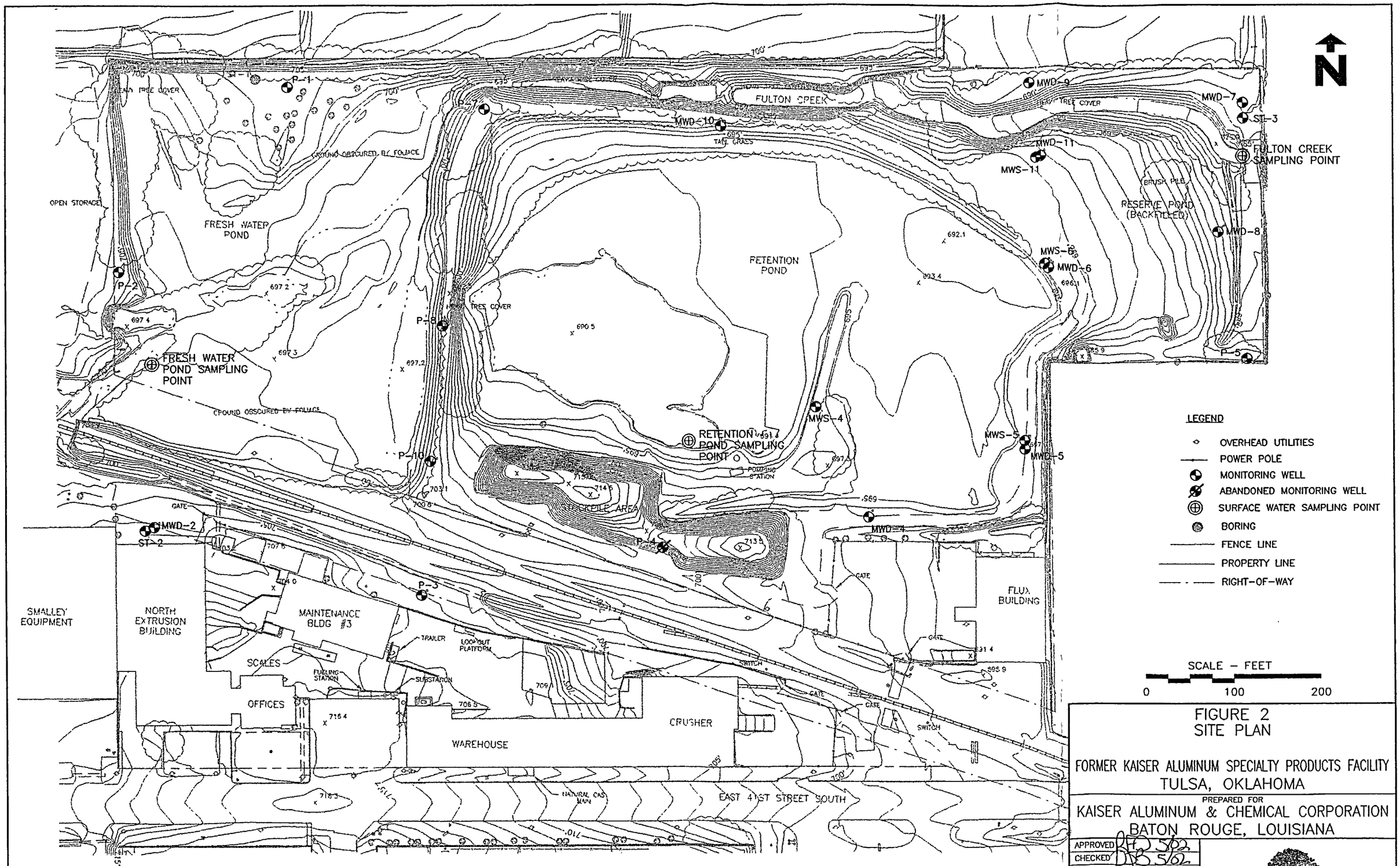
FIGURE 1
SITE LOCATION MAP
FORMER KAISER ALUMINUM
SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	11/2/01
CHECKED	11/2/01
DRAWN	GJA 10/1/01
DRAWING NUMBER	5427039

Earth Sciences Consultants, Inc.

REFERENCE
USGS 7.5-MIN TOPOGRAPHIC QUADRANGLE
JENKS, OKLAHOMA
DATED 1952, PHOTOREVISED 1982



REFERENCES

1 DIGITAL MAPPING ASSOCIATES, INC.; AUG 16, 2001

2 THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964

FIGURE 2
SITE PLAN

FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RH 5/02
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DRAWN	DEB 6/20/00
DRAWING NUMBER	5427207

Earth Sciences Consultants, Inc.

Surface Water Sampling Procedure
Procedure No. KAI-07

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

Surface Water Sampling Procedure
Procedure No. KAI-07

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

COPY

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

APPROVAL

This procedure has been approved by:

_____ _____
J. W. Vinzant Date
Project Manager

Reviewed by:

_____ _____
L. Max Scott Date
Radiation Safety Officer

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Surface Water Sampling Procedure
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

1.0 Purpose

To provide a procedure which field personnel will use to collect and document the collection of surface water samples and field geochemical measurements at the Former Kaiser Aluminum Specialty Products, Tulsa, Oklahoma facility (Kaiser) for water quality determinations.

2.0 Scope

This procedure should be used for the collection of surface water samples at the Kaiser-Tulsa site. The procedure is designed for the collection of water samples for inorganic and radiological analysis. The procedure includes instructions on the use of sampling protocols, on quality assurance/quality control (QA/QC) requirements, on the preservation and shipment of samples, and on the documentation of sampling operations. It includes appropriate checklists and data sheets.

3.0 Responsibilities

The users of this procedure are responsible for properly following this procedure. The field supervisor is responsible for ensuring that the appropriate equipment is available at the sampling site, that the equipment has been properly calibrated and decontaminated prior to initiation of the sampling activity, and that the personnel have been trained to use this procedure and other QA procedures as required for the field analyses to be performed. In addition, the field supervisor, is responsible for ensuring that the pertinent records (field notebooks, data sheets, chain-of-custody sheets, QA/QC records, analytical results) are turned over to Kaiser.

The users of this procedure, the water sampling team leader, and the Kaiser Site Administrator are responsible for ensuring that proper health and safety procedures are followed.

4.0 Equipment and Supplies

The following equipment and supplies, if necessary, should be assembled prior to initiating the sampling operation:

- Field Notebook - A field notebook dedicated to the Kaiser-Tulsa site must be obtained prior to the initiation of fieldwork. The field notebook can be either a hard bound engineering logbook, a three-ring binder, or other suitable numerically paginated notebook. This notebook will only be used to enter information relating to water sampling efforts in the field. The field notebooks are to be turned over to the Tulsa facility of Kaiser when the notebook is full or when the water sampling effort is terminated or completed.

- This procedure, water sampling field data forms, water sampling record, chain-of-custody forms, custody seals, the water sampling plan, water sampling purchase requests, and water analysis purchase requests to analytical laboratory.

- Sampling location map and field data from last sampling event.

- Sample Bottles - Sample bottles should be obtained from the laboratory which will perform the chemical and/or radiological analyses. Note that bottles obtained from an analytical laboratory for water samples for the analysis of metals or radiological parameters should be prepared to include an appropriate volume of preservation agent (i.e., nitric acid). A sufficient number of labels must be available for the bottles.

- Pens, pencils, magic markers, paper, masking tape, and Parafilm.

- The Kaiser-Tulsa procedure for field chemical measurements (KAI-04).

- A calibrated pH meter and NIST-traceable pH calibration buffer solutions (4.0, 7:0 and 10.0) that are within expiration dates printed on bottles (Cole-Palmer Instrument Co. [Cole Palmer] Catalog Nos. E-05942-22, E-05942-42, E-05942-62 or equivalent). Support equipment for pH probe, if required. Certification forms for the pH buffer solutions should be pasted in field notebook.

- A calibrated conductivity meter and NIST-traceable conductivity calibration solutions that are within expiration dates printed on bottles (Cole-Palmer Catalog Nos. E-01491-85, E-01482-54, E-01488-82 or equivalent). Support equipment for conductivity probe, if required. Certification forms for the conductivity solutions to be pasted in field notebook.

- A calibrated dissolved oxygen (DO) meter. Support equipment for DO probe, if required. Packets of zero-oxygen solution (Cole-Palmer Catalog No. 53024-51 or equivalent).

- A NIST-traceable thermometer readable to 0.1°C. Certification forms (NIST) for thermometer to be pasted in field notebook.

- Disposable beakers (100-500 ml).

- Water squirt bottles.
- Distilled water.
- An adequate source of power (e.g., 12 v) for instruments.
- Coolers and ice for sample shipment at $\leq 4^{o}C$.

5.0 Preparation for Collection of Water Samples in Field

Prior initiating field operations, the field crew supervisor must check that all the equipment listed in Section 4.0 of this procedure, as necessary, is available for transfer to the Kaiser-Tulsa site. The field supervisor will notify the Kaiser representative once all the necessary equipment is available for transfer.

The Kaiser representative will arrange for the chemical and/or radiological analyses to be performed by a qualified laboratory. The Kaiser representative will also establish the procedure by which the analytical results are transferred to Kaiser-Tulsa.

On the first day of sampling, the pH, conductivity, and DO meters will be calibrated prior to leaving the laboratory of the company doing the sampling. The required sampling equipment will subsequently be transferred to the Kaiser-Tulsa site.

6.0 Procedure for Sampling Surface Water

During a sampling event, collect all surface water samples on the same day. If water sample is not collectible (e.g., dry), record the reason why not as a record for the file. Collect water samples so as to contain the minimal amount of suspended solids. To achieve this, avoid sampling in turbulent flow and within 2 days after a rainfall event.

- Prepare working space for field chemical measurements. Ensure a sufficient number of sample bottles and labels are available.
- Fill the bottles requiring unfiltered water by submersing bottles in surface water body. Cap bottle and wrap tape around caps. Properly label bottle as detailed below and wrap clear tape or Parafilm around label. Place bottles in cooler with temperature $\leq 4°C$.
- If filtered samples are to be collected in the field (see Work Plan) use a vacuum filtering system with a disposable 0.45-micron filter. Note that each well requires a new filter. Fill the required number of bottles with filtered water and cap. Wrap tape on caps. Properly

label bottle as detailed below and wrap clear tape or Parafilm around label. Record number of bottles collected.

- Collect a duplicate set of water samples from one or more locations as instructed in Work Plan. Record number of bottles collected.

- Collect another sample in an appropriate container for measurement of field chemical parameters. Note any observations on water color, odor, and turbidity. Measure field chemical parameters using the procedure for field chemical measurements (KAI-04). Record results of measurements.

- After sampling operation is finished, complete chain-of-custody forms. Seal shipping containers with tape and custody seal. Tape envelope containing copy of chain-of-custody forms to shipping container.

- Review entries in field notebook and ensure that forms are properly filled out and legible.

7.0 Sample Labels, Seals for Shipments, and Chain-of-Custody Forms

Sample Labels - Write the following information on each sample bottle or its label using indelible ink:

- location sampled
- unique sample identification name or number
- type of analysis required
- whether sample is filtered or unfiltered
- whether the sample contains preservation agent or not
- date sampled
- name or initials of person collecting the sample

The sample label will be fastened with clear cellophane tape or Parafilm wrapped completely around the bottle.

Shipping Seal - If samples are to be shipped by common carrier to a contract laboratory, shipping seals will be used to ensure that samples have not been tampered with during shipment. The sample shuttles (e.g., coolers) should be sealed with nylon reinforced packing tape. In addition, a transparent shipping seal should be applied where the lid of the shuttle meets the bottom of the shuttle. This seal should be initialed by the sender.

Chain-of-Custody Forms - Sample shipments must be accompanied by chain-of-custody forms that have been properly filled out and signed. The chain-of-custody form will contain at minimum the project

name, the company that carried out the sampling, the name of the sampling personnel, locations sampled, date and time of sampling at each location, sample matrix (e.g., water, soil), number of bottles obtained at each location, analytical tests to be completed on each bottle, whether samples are unfiltered, were filtered and preserved in the field, or remain to be filtered and/or preserved at the laboratory, the signatures of individuals who released the samples and individuals who received the samples combined with the dates and times samples were released and received.

8.0 QA/QC

This procedure is a part of the QA Program instituted by Kaiser for the Remediation Project at the Tulsa site. In addition to the site QA Plan, this procedure references other QA procedures, including the procedure for field chemical measurements. These procedures should be consulted for QC and acceptance criteria.

To aid in assessment of the reliability and consistency of the sampling procedures described in this QA procedure, "trip blanks" and duplicate samples are analyzed with the unknown samples. The laboratory will supply a trip blank for each sampling period (e.g., quarter). This "blank" will consist of a bottle (supplied by the analytical laboratory) filled with distilled water. This bottle will be transported from the laboratory to the field and back to the laboratory to be analyzed with the other water samples. In addition, one set of duplicate samples of surface water from a randomly chosen well will be submitted to the laboratory for analysis of all the parameters of interest.

The results obtained on the "blank" and duplicates will be used in combination with laboratory QA/QC controls to evaluate the quality of the chemical and radiological data obtained as a result of the sampling program. The laboratory analyses are carried out under a separate QA procedure. This procedure should be consulted for laboratory QC and acceptance criteria.

The acceptance criteria for this procedure is that the steps in the procedure have been faithfully followed. Exceptions (i.e., instances in which the procedure has not been faithfully followed) must be evaluated individually to establish their significance with respect to the final analytical results. This evaluation can be conducted by Kaiser personnel with expertise relating to the exception and the quality of analytical data.

9.0 Revisions and Alternate Procedures

This procedure may be revised from time-to-time to accommodate changed site conditions or facilitate sampling. Revisions may be issued as a revision to this procedure or as an addendum. All revisions will be evaluated to ensure data collected continues to be reliable. Revisions must be approved by the Kaiser Project Manager and reviewed by the Radiation Safety Officer (RSO). Alternate procedures may also be used on a project-specific basis. All alternate procedures must be approved by Kaiser Project Manager and reviewed by the RSO.

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Groundwater Sampling Procedure
Procedure No. KAI-03

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

Groundwater Sampling Procedure
Procedure No. KAI-03

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

COPY

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

APPROVAL

This procedure has been approved by:

J. W. Vinzant
Project Manager

Date

Reviewed by:

L. Max Scott
Radiation Safety Officer

Date

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Groundwater Sampling Procedure
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

1.0 Purpose

To provide a procedure which field personnel will use to collect and document the collection of groundwater samples and field geochemical measurements at the Former Kaiser Aluminum Specialty Products, Tulsa, Oklahoma facility (Kaiser) for water quality determinations.

2.0 Scope

This procedure should be used for the collection of groundwater samples at the Kaiser-Tulsa site. The procedure is designed for the collection of water samples for inorganic and radiological analysis. The procedure includes instructions on the use of pumps (or bailers under special circumstances), on sampling protocols, on sample filtration, on quality assurance/quality control (QA/QC) requirements, on the preservation and shipment of samples, and on the documentation of sampling operations. It includes appropriate checklists and datasheets.

3.0 Responsibilities

The users of this procedure are responsible for properly following this procedure. The field supervisor is responsible for ensuring that the appropriate equipment is available at the sampling site, that the equipment has been properly calibrated and decontaminated prior to initiation of the sampling activity, and that the personnel have been trained to use this procedure and other QA procedures as required for the field analyses to be performed. The field supervisor is also responsible for calculating the depth of placement for the pump in each well to be sampled. In addition, the field supervisor is responsible for ensuring that the pertinent records (data sheets, chain-of-custody sheets, QA/QC records, analytical results) are turned over to Kaiser.

The users of this procedure, the water sampling team leader, and the Kaiser Site Administrator are responsible for ensuring that proper health and safety procedures are followed.

4.0 Equipment and Supplies

The following equipment and supplies, if necessary, should be assembled prior to initiating the sampling operation:

- Field Notebook - A field notebook dedicated to the Kaiser-Tulsa site must be obtained prior to the initiation of fieldwork. The field notebook can be either a hard bound engineering logbook, a three-ring binder, or other suitable notebook. This notebook will only be used to enter information relating to water sampling efforts in the field. The field notebooks are to be turned over to the Tulsa facility of Kaiser when the notebook is full or when the water sampling effort is terminated or completed.

- This procedure, water sampling field data forms, water sampling record, chain-of-custody forms, custody seals, the water sampling plan, water sampling purchase requests, and water analysis purchase requests to analytical laboratory .

- Well construction data, well location map, and field data from last sampling event.

- Well keys.

- Pump or Bailer - Adjustable rate, submersible pump with either centrifugal, helical rotor, or bladder pump designed and constructed of stainless steel or Teflon. The brand and model number of the plump or bailer used should be recorded in the field notebook. The procedures for cleaning and decontamination of the pumping equipment are given below. Bailers, if used, should be bottom filling and can be disposable. Bailers with valves (i.e., stop cocks) greatly facilitate the transfer of water samples to the bottles from the bailer and should be used, if possible.

- Hoses and/or Tubes - Polyethylene, polypropylene, teflon-lined polyethylene or polyvinylchloride tubing will be used for all water sampling operations.

- Flow measurement supplies (e.g., graduated container and stop watch).

- Filters and Filtering Apparatus - When samples are to be filtered in the field, an in-line filter will generally be used (e.g., Cole-Palmer Instrument Co. [Cole Palmer] 1-800- 323-4340; Catalog No. E-29600-00). Adapters appropriate for interconnecting the different sized nipples and tubing may be required. When water samples are to be obtained by bailing, a vacuum filtering system can be used in the field. Disposable vacuum filter systems (Cole-Palmer Catalog No. E-29969-03) may be used with a hand-operated vacuum pump (Cole-Palmer Catalog No. E-79301-10).

- Sample Bottles - Sample bottles should be obtained from the laboratory which will perform the chemical and/or radiological analyses. Note that bottles obtained from an analytical laboratory for water samples for the analysis of metals or radiological parameters should be prepared to include an appropriate volume of preservation agent (i.e., nitric acid). A sufficient number of labels must be available for the bottles.

- Rope - Plastic sheeting.
- Pens, pencils, magic markers, paper, masking tape, and Parafilm.
- Electronic Water Level Meter - Water level measuring device capable of measuring water levels to within 0.01 foot accuracy.
- The Kaiser-Tulsa procedure for field chemical measurements (KAI-04).
- A calibrated pH meter and NIST-traceable pH calibration buffer solutions (4.0, 7.0, and 10.0) that are within expiration dates printed on bottles (Cole-Palmer Catalog Nos. E-05942-22, E-05942-42, E-05942-62 or equivalent). Support equipment for pH probe, if required. Certification forms for the pH buffer solutions should be pasted in field notebook.
- A calibrated conductivity meter and NIST-traceable conductivity calibration solutions that are within expiration dates printed on bottles (Cole-Palmer Catalog Nos. E-01491-85, E-01482-54, E-01488-82 or equivalent). Support equipment for conductivity probe, if required. Certification forms for the conductivity solutions to be pasted in field notebook.
- A calibrated dissolved oxygen (DO) meter. Support equipment for DO probe, if required (i.e., a 50-foot cable should be used to lower the DO probe into the monitoring well if the probe is not an in-line model). Packets of zero-oxygen solution (Cole-Palmer Catalog No. 53024-51 or equivalent).
- A NIST-traceable thermometer readable to 0.1°C. Certification forms (NIST) for thermometer to be pasted in field notebook.
- Disposable beakers (100-500 ml).
- Water squirt bottles.
- Distilled water - Up to 10 gallons of distilled water may be required.
- An adequate source of Power (e.g., 12 v) for pump and other instruments.
- Coolers and ice for sample shipment at ≤4°C.
- Drums - Fifty-five gallon drums or other suitable container for collecting and storing excess water.

5.0 Preparation for Collection of Water Samples in Field

Prior to initiating field operations, the field crew supervisor must check that all the equipment listed in Section 3.0 of this procedure, as necessary, is available for transfer to the Kaiser-Tulsa site. The field supervisor will notify the Kaiser representative once all the equipment is available for transfer.

The Kaiser representative will arrange for the chemical and/or radiological analyses to be performed by a qualified laboratory. The Kaiser representative will also establish the procedure by which the analytical results are transferred to Kaiser-Tulsa.

Prior to sampling, the pump and other reusable sampling equipment will be decontaminated and cleaned according to the procedure given below.

On the first day of sampling, the pH, conductivity, and DO meters will be calibrated prior to leaving the laboratory of the company doing the sampling. The required sampling equipment will subsequently be transferred to the Kaiser-Tulsa site.

6.0 Decontamination Procedure

With the exception of sample bottles, disposable products, including bailers and analytical equipment, equipment used in the monitoring well to collect measurements or to collect water samples, whether new or previously used, is assumed to be contaminated and should undergo the level of decontamination appropriate to its intended use and construction.

Equipment used to sample for metals and other inorganic constituents will be decontaminated as follows:

- Wash thoroughly with non-phosphate detergent in non-phosphate detergent and potable water.
- Rinse once with 1:1 nitric acid.
- Rinse several times with potable water.
- Rinse once with 1:1 hydrochloric acid.
- Rinse several times with potable water.
- Rinse several times with distilled or deionized water.
- Invert and air dry in a dust-free environment.
- Cap or wrap after drying.

Once equipment has been allowed to dry, package the equipment to protect it from dust. Plastic bags are appropriate for larger items, such as bailers and bladder pumps; Zip-Lock bags are appropriate for smaller items. Once packaged, a label stating the level of decontamination, date of decontamination and initials of the individual certifying decontamination should be affixed to the protective package so that the label must be torn to unpack it. In the field, do not use a piece of equipment if this seal was previously broken.

7.0 Prevention of Contamination Release

To avoid a release of potentially contaminated water, a protective layer of plastic sheeting will be spread around the monitor well to collect any spillage during purging and sampling operations. Plastic buckets (e.g., 5 gallon) will be used to collect rinse and decontamination water during field operations. At each groundwater monitoring well, a 55-gallon drum or other suitable container may be placed to store rinse, decontamination water and purge water from the well. The water purged from wells not completed in dross may be returned to the retention pond. For water purged from wells completed in dross (i.e., MWS-4, MWS-5, MWS-11), a sample of the water will be taken for analysis when the drum is nearly full. The water in these drums will be disposed according to the chemical/radiological characteristics identified in the analyses.

8.0 Water Level and Total Depth Measurements in a Monitoring Well

To ensure comparability of water level measurements and to reduce the potential for collecting turbid groundwater samples, water levels and depth to bottom of all wells should be measured in all wells prior to sampling any well. Put on clean latex gloves and proceed as follows at each well:

- Step 8.1 - Grasp the monitor well cap with both hands and gently remove. Care must be taken to not let the inside of the lid touch anything while removed from the well.

- Step 8.2 - Rinse the probe and the cable of the depth meter with deionized (DI) water and collect the rinse water. Slowly lower the depth indicator probe into the well until the meter indicates that water has been reached. Using the permanent measuring point designated on the casing, the depth at which the water was encountered will be mentally noted (the meter will be read to the nearest 0.01 ft.). The probe will be raised until it is no longer in the water and then will be lowered again until the meter indicates that water has been reached. The depth will be mentally noted. If the first and second values do not agree within 0.01 ft., repeat the steps above until the two readings agree within 0.01 ft. Once a stable depth to water has been confirmed, this value will be recorded in the field notebook.

- Step 8.3 - Slowly lower the depth probe into the well until it has hit bottom. Read and mentally note the depth where tension in the cable is relieved as the weighted end touches the bottom of the well. Slowly raise the probe above the bottom and then lower it again to the bottom to take an independent reading. If the two readings are within 0.1 ft., record the value; if not, take additional readings until a consistent result is obtained. Readings will be recorded to the nearest 0.01 ft. as measured from the permanent measuring point on the casing.

- Step 8.4 - Slowly remove the probe from the well and decontaminate using a triple rinse with deionized or distilled water. Collect rinse water.

- Step 8.5 - Store decontaminated probe with appropriate cover.
- Step 8.6 - Replace cap on well and lock.

9.0 Calculating Water Volumes to be Purged

If possible, three well volumes of water are to be purged from each well before sampling the well water. One well volume is equal to the amount of water held in the well bore and in the filter pack. A 10-foot filter pack will contain approximately 3.0 gallons of water (assuming 20 percent specific yield of the filter pack and a nominal well diameter). Two-inch diameter pipe will contain 0.163 gallons of water per foot of length. Therefore, the volume of water to be purged is calculated as follows:

[(TD-SWL) X 0.163 gal/ft X 3] + filter pack volume = purge volume

where

TD = Total depth and SWL = Static Water Level as measured in Step 8.2.

The purged water will be stored in a 55-gallon drum at the well location.

10.0 Procedure for Sampling Groundwater Using a Pump

General Instructions - As far as possible, sample wells upgradient from the retention pond area first, then wells not screened in dross and lastly, wells screened in dross. Whenever there is sufficient well water, purge at least three well volumes before sampling. If there is not enough water in a well to purge three well volumes, record this fact in the field notebook. Also record observations on any unusual condition in the well or of the well pad or if there is standing water around the wellhead.

- Step 10.1 - Prepare working space for field measurements. Make sure that a sufficient number of sampling bottles and labels are available.
- Step 10.2 - Determine volume of water to be purged using procedure in Section 9. Record result. Make sure that the source of power for pump is operational. Unwrap clean pump, hose and wiring and lay on plastic sheeting. Wear clean latex gloves to handle pump and tubing. Inspect pump and wiring for potential problems (dings, bare wire, etc.). Connect hose to pump. Mark wiring or tubing so that the pump can be placed at the appropriate depth in the well.

For wells in which the top of the standing water column is above the screened interval; the pump intake should be set above the screened interval. For wells in which the top of the standing water column lies within the screened interval, the pump intake should be placed at the midpoint of the screen, if possible. However, the pump intake should be placed, to the extent possible, no closer than 2 feet from the measured bottom of the well so as to minimize the agitation and suspension of sediment that may be present at the bottom of well.

Before sampling any wells, run laboratory-supplied distilled water through pump and hoses. Fill the bottles for "equipment/field blanks" of each type of laboratory analysis planned (e.g., metals, anions, radiological, etc.) from the end of the hose. Cap and seal the bottles. Label the bottles as "field blank" for each type of analysis required by the Work Plan. Drain pump and hoses after bottles have been filled. Record the number and type of bottles.

- Step 10.3 - Place protective plastic sheeting around well to be sampled. Unlock well. Grasp the monitor well cap with both hands and gently remove. Care must be taken to not let the inside of the lid touch anything while removed from the well.

- Step 10.4 - Place pump in well and slowly lower to mark on wiring or tubing (i.e., placement depth). Slowly lower electronic water level probe into well to allow for measurement of water level in well during pumping. If a pressure transducer is used, it can be placed into the well before placing pump, if desired. However, use of pressure transducer will also require placement of electronic water level probe for purposes of verifying/calibrating pressure transducer measurements. Record water level measurements. In addition, if using an in-well DO probe, the probe should be located below the pump intake.

- Step 10.5 - Start pump and begin purging well. Collect purge water in bucket or barrel. Adjust the pumping rate so as to prevent drawdown of water level below the intake of the pump (as set according to Step 10.2, above). Make sufficiently frequent water level measurements to ensure that the water level in the well does not drop below pump intake. Measure the pumping rate periodically using a graduated beaker and stop watch (or other suitable method) to determine time required to evacuate 2.5 well volumes. Once sufficient time has elapsed to evacuate 2.5 well volumes, slowly reduce the pumping rate as necessary to reduce the pumping rate to no more than 500 ml/min. Measure the pumping rate using a graduated beaker and stop watch (or other suitable method) to determine time required to evacuate the remaining 0.5 well volume. Continue evacuation until the time required to complete the evacuation of the required 3.0 well volumes elapses. Record the results of the purging operations.

  If it is not possible to evacuate three well volumes within one half hour while maintaining the specified well intake depth (i.e., water level height), lower the pump intake to mid point of the well screen and evacuate the well for one half hour at a purge rate of 500 ml/min or less (but not less than 100 ml/min). Measure the pumping rate periodically using a graduated beaker and stop watch (or other suitable method) to determine the flow rate. If it is not possible to maintain adequate water level in well with the reduced pumping rate (100 - 500 ml/min), pump well dry and collect sample using a bailer as soon as sufficient water has recovered in well to collect the required amount of water (see Section 11.0) along with any observations on color, odor or turbidity of the purged water.

- Step 10.6 - Sample purge water for field chemical measurements using a suitable container (e.g., empty distilled water container) after pumping each of the three well-bore volumes. Measure temperature, pH, conductivity, and turbidity in purged water using the Procedure for Measurement of Chemical Parameters (KAI-04). Record results. Measurements for DO should be taken within the monitoring well or within the in-line pumping network during purging.

- Step 10.7 - After the purging process has been completed, fill all bottles requiring unfiltered water (see Work Plan). Cap bottles and wrap tape around caps. Properly label bottle as detailed below and wrap clear tape or Parafilm around label. Place bottles in cooler with temperature 4°C. Record number of bottles collected.

- Step 10.8 - If filtered samples are to be collected in the field (see Work Plan), insert a new in-line filter at end of pump hose and let water run for several minutes into bucket or barrel. Note that each well requires a new filter. Fill the required number of bottles with filtered water and cap. Wrap tape on caps. Properly label bottle as detailed below and wrap clear tape or Parafilm around label. Record number of bottles collected.

- Step 10.9 - Collect a duplicate set of water samples from one or more wells as instructed in Work Plan. Follow instructions in Step 10.8. Record number of bottles collected.

- Step 10.10 - Remove pump and tubing from well. Discard filter, if one was used. If pump to be used at other wells at the site, clean pump and tubing by pumping 2 liters of distilled water through system. Rinse outside of pump and tubing with distilled water. Collect water and transfer to 55-gallon drum located at well pad. Wipe dry with Kimwipes or other tissues. Clean thermometer and other instruments and store properly.

- Step 10.11 - Close and lock well.

- Step 10.12 - After sampling operation is finished complete chain-of-custody forms. Seal shipping containers with tape and custody seal. Tape envelope containing copy of chain-of-custody forms to shipping container.

- Step 10.13 - Review entries in field notebook and ensure that required forms are properly filled out and legible.

11.0 Procedure for Sampling Groundwater Using a Bailer

- Step 11.1 - Prepare working space for field chemical measurements. Check calibration of instruments with standards and recalibrate as necessary. Record results. Ensure a sufficient number of sample bottles and labels are available.

- Step 11.2 - Place protective plastic sheeting around well to be sampled. Unlock well. Grasp the monitor well cap with both hands and gently remove. Care must be taken to not let the inside of the lid touch anything while removed from the well.

- Step 11.3 - Determine depth to water table with depth sounder. Record result.

- Step 11.4 - Put on latex gloves. Open top of protective plastic bag holding bailer and attach cord. Mark cord at distance to water level from top of surface casing. Remove bailer from protective plastic bag and lower bailer into well to top of water column. Slowly lower bailer below top of water column. After 5 minutes recover bailer.

- Step 11.5 - Fill the bottles requiring unfiltered water from bailer and cap. Wrap tape around caps. Properly label bottle as detailed below and wrap clear tape or Parafilm around label. Place bottles in cooler with temperature $\leq 4°C$. Record the number of bottles collected.

- Step 11. 6 - If filtered samples are to be collected in the field (see Work Plan), use a vacuum filtering system with a disposable 0.45-micron filter. Note that each well requires a new filter. Fill the required number of bottles with filtered water and cap. Wrap tape on caps. Properly label bottle as detailed below and wrap clear tape or Parafilm around label. Record number of bottles collected.

- Step 11.7 - Collect a duplicate set of water samples from one or more wells as instructed in Work Plan. Record number of bottles collected.

- Step 11.8 - Continue bailing and collect another sample in an appropriate container (e.g., empty distilled water bottle) for measurement of field chemical parameters. Note any observations on water color, odor and turbidity. Measure field chemical parameters using the procedure for field chemical measurements (KAI-04). Record results of measurements.

- Step 11.9 - After sampling process is complete at well, discard bailer and cord. Clean thermometer and other instruments and store properly.

- Step 11.10 - Close and lock well.

- Step 11.11 - After sampling operation is finished, complete chain-of-custody forms. Seal shipping containers with tape and custody seal. Tape envelope containing copy of chain-of-custody forms to shipping container.

- Step 11.12 - Review entries in field notebook and ensure that forms are properly filled out and legible.

12.0 Sample Labels, Seals for Shipments and Chain-of-Custody Forms

Sample Labels - Write the following information on each sample bottle or it's label using indelible ink:

- location sampled
- unique sample identification name or number
- type of analysis required
- whether sample is filtered or unfiltered
- date sampled
- whether sample contains preservation agent or not

- name or initials of person collecting the sample

The sample label will be fastened with clear cellophane tape or Parafilm wrapped completely around the bottle.

Shipping Seal - If samples are to be shipped by common carrier to a contract laboratory, shipping seals will be used to ensure that samples have not been tampered with during shipment. The sample shuttles (e.g., coolers) should be sealed with nylon reinforced packing tape. In addition, a transparent shipping seal should be applied where the lid of the shuttle meets the bottom of the shuttle. This seal should be initialed by the sender.

Chain-of-Custody Forms - Sample shipments must be accompanied by chain-of-custody forms that have been properly filled out and signed. The chain-of-custody form will contain at a minimum the project name, the company that carried out the sampling, the names of the sampling personnel, locations sampled, date and time of sampling at each location, sample matrix (e.g., water, soil), number of bottles obtained at each location, analytical tests to be completed on each bottle, whether samples are unfiltered, were filtered and preserved in the field, or remain to be filtered and/or preserved at the laboratory, the signatures of individuals who released the samples and individuals who received the samples combined with the dates and times samples were released and received.

13.0 QA/QC

This procedure is a part of the QA Program instituted by Kaiser for the Remediation Project at the Tulsa site. In addition to the site QA Plan, this procedure references other QA procedures, including the procedure for field chemical measurements. These procedures should be consulted for QC and acceptance criteria. This procedure incorporates instructions for determinations of water levels and well depths.

To aid in assessment of the reliability and consistency of the sampling procedures described in this QA procedure, "trip blanks," "equipment/field blanks" and duplicate samples are analyzed with the unknown samples. The laboratory will supply a "trip blank" for each sampling period (e.g., quarter). This "blank" will consist of a bottle (supplied by the analytical laboratory) filled with distilled water. This bottle will be transported from the laboratory to the field and back to the laboratory to be analyzed with the other water samples. The laboratory will also supply sufficient distilled water of known purity to produce an

"equipment/field blank." This distilled water will be run through all the sampling equipment (i.e., pump, hose, filter) and collected in the same type of bottles in which the groundwater samples are collected. In addition, one set of duplicate samples of groundwater from a randomly chosen well will be submitted to the laboratory for analysis of all the parameters of interest.

The results obtained on these "blanks" and duplicates will be used in combination with laboratory QA/QC controls to evaluate the quality of the chemical and radiological data obtained as a result of the sampling program. The laboratory analyses are carried out under a separate QA procedure. This procedure should be consulted for laboratory QC and acceptance criteria.

The acceptance criteria for this procedure is that the steps in the procedure have been faithfully followed. Exceptions (i.e., instances in which the procedure has not been faithfully followed) must be evaluated individually to establish their significance with respect to the final analytical results. This evaluation can be conducted by those Kaiser-Tulsa personnel with expertise relating to the exception and the quality of analytical data.

14.0 Revisions and Alternate Procedures

The procedure may be revised from time-to-time to accommodate changed site conditions or facilitate sampling. Revisions may be issued as a revision to this procedure or as an addendum. All revisions will be evaluated to ensure data collected continues to be reliable. Revisions must be approved by the Kaiser Project Manager and reviewed by the Radiation Safety Officer (RSO). Alternate procedures may also be used on a project-specific basis. All alternate procedures must be approved by Kaiser Project Manager and reviewed by the RSO.

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Procedure for Field Measurement of Chemical Parameters
Procedure No. KAI-04

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

Kaiser Aluminum & Chemical Corporation
Baton Rouge, Louisiana

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

Procedure for Field Measurement of Chemical Parameters
Procedure No. KAI-04

Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

COPY

Project No. 5427J
August 2000, Revision 1
June 2002, Revision 2

APPROVAL

This procedure has been approved by:

J. W. Vinzant Project Manager	Date

Reviewed by:

L. Max Scott Radiation Safety Officer	Date

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Procedure for Field Measurement of Chemical Parameters
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma

1.0 Purpose

To provide procedures which field personnel will use to measure selected chemical parameters in water samples obtained from wells and surface water locations at the Former Kaiser Aluminum Specialty Products, Tulsa, Oklahoma facility (Kaiser). These measurements are to be made in the field.

2.0 Scope

This procedure should be used to measure the field conductivity, pH, dissolved oxygen (DO) concentration, and turbidity of waters related to sampling of the waters for ~~the analysis at~~ inorganic and/~~or~~ radiological analysis in a laboratory. This procedure must be used in conjunction with Procedure KAI-03, Groundwater Sampling Procedure or Procedure KAI-07, Surface Water Sampling Procedure.

3.0 Responsibilities

The users of this procedure are responsible for properly following this procedure. The field supervisor is responsible for ensuring that the appropriate equipment is available at the sampling site, that the equipment has been properly decontaminated and calibrated prior to initiation of the sampling activity, that the personnel have been trained in the use of this procedure and other quality assurance (QA) procedures as required for the field analyses to be performed, and that the pertinent records (field notebooks, data sheets, analytical results, QA/QC records) are turned over to the Kaiser Site Administrator.

The users of this procedure, the water sampling team leader, and the Kaiser Site Administrator are responsible for proper health and safety procedures are followed.

4.0 Equipment and Supplies

The following equipment and supplies, if necessary, should be assembled prior to initiating the field measurements:

- Field Notebook - A field notebook dedicated to the Kaiser-Tulsa site must be obtained prior to the initiation of fieldwork. The field notebook can be either a hard bound engineering logbook, a three-ring binder, or other suitable notebook. The field notebooks are to be turned over to the Tulsa facility of Kaiser when the notebook is full or when the water sampling effort is terminated or completed.

- This procedure, water sampling field data forms, water sampling record, water sampling plan, and water sampling purchase requests.

- A temperature-compensated pH meter and NIST-traceable pH calibration buffer solutions (4.0, 7.0, and 10.0) that are within expiration dates printed on bottles (Cole-Palmer Instrument Co. [Cole-Palmer] Catalog Nos. E-05942-22, E-05942-42, E-05942-62 or equivalent). Support equipment for pH probe, including manufacturers instruction manual. The meter must be calibrated in the laboratory prior to use in the field. Certification forms for the pH buffer solutions should be pasted in field notebook.

- A temperature-compensated Conductivity meter (e.g., Hanna Instruments: Catalog No. HI 9635; or Hach Co.: Catalog No.50150-00 or equivalent) and NIST-traceable conductivity calibration solutions that are within expiration dates printed on bottles (Hanna Instruments Catalog Nos. H17031L and HI 7033L; or Hach Co.: Catalog; Nos. 23075-42, 14400-42, and 2105-42 or equivalent). Support equipment for conductivity probe, including manufacturers instruction manual. The meter must be calibrated in the laboratory prior to use in the field. Certification forms for the conductivity solutions to be pasted in field notebook.

- A calibrated DO meter (e.g., Hanna Instruments: Catalog No. HI 9142; or Hadl Co.: Catalog No. 50175-00 or equivalent). Support equipment for DO probe, including manufacturers instruction manual. Packets of zero-oxygen solution (Hanna Instruments: Catalog No. HI7040L or Cole-Palmer: Catalog No. 53024-51 or equivalent).

- A calibrated turbidity meter (e.g., Hanna Instruments: Catalog No. HI 93703K1T; or Hach Co.: Catalog No. 52600-00 or equivalent). Turbidity standard solutions (Hanna Instruments: Catalog No. H193703-0 and HI 93703-10; or Hach Co.: Catalog Nos. 26598-42 and 26601-42 or equivalent). Support equipment for turbidity meter, including manufacturers instruction manual.

- A NIST-traceable thermometer readable to 0.1°C. Certification forms (NIST) for thermometer to be pasted in field notebook.

- Disposable beakers (100-500 ml).

- Water squirt bottles.

- Distilled water - Up to 10 gallons of distilled water may be required.

5.0 Procedure - General

- Water samples for field measurements should be collected in clean containers (e.g., empty distilled water bottles).

- Instruments for measurement of the chemical parameters are to be calibrated in the laboratory prior to use in the field. The date and time of such calibrations shall be recorded in the field notebook.

- Data obtained in the field are to be recorded.

6.0 Procedure – Field Measurement of Conductivity

A temperature-compensated conductivity meter is required for this measurement. The reason for this requirement is that the conductivity of a solution is temperature dependent. To allow comparison of different conductivity measurements, these measurements should be normalized to the same temperature. A temperature compensated meter automatically does this. Because conductivity measurement instruments and instrument operation instructions may vary with each manufacturer, the analyst is advised to read and use the instructions for instrument operation that are provided by the manufacturer. The meter used in the field should be calibrated in the laboratory prior to field use.

- Step 6.1 - Attach electrode and cable to meter, as necessary. Thoroughly rinse electrode with distilled water. Blot dry with tissue. Note that any water or other materials remaining on electrode may influence the subsequent reading.

- Step 6.2 - Steps 6.3 through 6.5 should be performed only at the first and last samples on a given day.

- Step 6.3 - Pour sufficient conductivity standard solution in a clean beaker so that the electrode can be fully submersed in solution. Use the conductivity standard solution that is closest in value to the conductivity of the water samples to be measured, if known. This will be called the reference solution.

- Step 6.4 - Submerse electrode in the reference solution for at least 30 seconds and adjust scale on meter to achieve highest resolution. Agitate the solution by stirring with the electrode. Record meter reading. If the reading on the reference solution is within 2 percent of accepted value (NIST referenced) continue on with Step 6.5. If reading on the reference solution is not within 2 percent of the accepted value, recalibrate the meter using at least two calibration solutions and the instructions for calibration supplied by the manufacturer. Retest the reference solution and record the results. If meter cannot be property calibrated, replace electrode and recalibrate meter. Retest reference solution and record results.

- Step 6.5 - Thoroughly rinse electrode with distilled water. Blot dry with tissue.

- Step 6.6 - Pour a sufficient volume of sample water into a clean beaker so that the electrode will be submersed. Submerse electrode in beaker and record meter readings and units (e.g., µS/cm and °C).

- Step 6.7 - Thoroughly rinse electrode with distilled water. Blot dry with tissue.

- Step 6.8 - After last measurement of the day, reanalyze the reference solution. Record results in the field notebook. If the measured conductivity is not within 2 percent of the accepted value, rinse electrode and repeat measurement. If the measured conductivity is still not within 2 percent of the accepted value, record this information in field notebook. Properly store electrode, cable, and meter.

7.0 Procedure – Field Measurement of pH

A temperature-compensated pH meter is required for this measurement. The reason for this requirement is that the pH of a solution is temperature dependent. To allow comparison of different pH measurements, these measurements should be normalized to the same temperature. A temperature-compensated meter automatically does this. Because pH measurement instruments and instrument operation instructions may vary with each manufacturer, the analyst is advised to read and use the instructions for instrument operation that are provided by the manufacturer. The meter used in the field shall be calibrated in the laboratory prior to field use. Record date and time of calibration in field notebook.

- Step 7.1 - Attach electrode and cable to meter, as necessary. Remove electrode from storage container and thoroughly rinse electrode with distilled water. Blot dry with tissue. Note that any water or other materials remaining on electrode may influence the subsequent reading. When electrode is not in use, keep electrode submersed in storage solution.

- Step 7.2 - Steps 7.3 through 7.5 should be performed only at the first and last wells to be sampled on a given day.

- Step 7.3 - Pour a sufficient volume of the pH 7.0 or 10.0 buffer solution in a clean beaker so that the electrode can be fully submersed in solution. Use the buffer Solution that is closest in value to the pH of the water samples to be measured, if known. This will be called the reference solution.

- Step 7.4 - Thoroughly rinse electrode with distilled water. Blot dry with tissue. Submerse electrode in the reference solution for at least 60 seconds. Agitate the solution by stirring with the electrode. Record meter readings (pH and temperature). If the reading on the reference solution is within 0.1 pH units of the accepted value (NIST referenced), continue on with Step 7.5. If the reading on the reference solution is not within 0.1 pH units of the accepted value, recalibrate the meter in the field using three pH buffer solutions (e.g., 4.0, 7.0, and 10.0) and the instructions for calibration supplied by the manufacturer. Retest the reference solution and record the results. If the meter cannot be properly calibrated, install new pH electrode and recalibrate meter. Retest the reference solution and record results.

- Step 7.5 - Thoroughly rinse the electrode with distilled water. Blot dry with tissue.

- Step 7.6 - Pour a sufficient volume of sample water into a clean beaker so that the electrode will be submersed. Submerse the electrode in the beaker for at least 60 seconds and record meter readings.

- Step 7.7 - Thoroughly rinse the electrode with distilled water. Blot dry with tissue. Return the electrode to the storage solution after measurement at each well.

- Step 7.8 - After the last measurement of the day, reanalyze the reference solution. Record the results in the field notebook. Place the electrode in the storage solution and properly store the cable and the meter.

8.0 Procedure - Field Measurement of DO

A temperature-compensated DO meter is required for this measurement. The reason for this requirement is that the DO content of a solution is temperature dependent. To allow comparison of different DO measurements, these measurements should be normalized to the same temperature. A temperature-compensated meter automatically does this. Because DO measurement instruments and instrument operation instructions may vary with each manufacturer, the analyst is advised to read and use the instructions for instrument operation that are provided by the manufacturer.

DO electrodes are generally calibrated using two reference points, a zero-oxygen solution and the oxygen content of water-saturated air. The oxygen content of water-saturated air is a function of the local (absolute) atmospheric pressure. Therefore, the local (absolute) atmospheric pressure must be known within +/- 2 percent. This information can be obtained from a local weather station or with a barometer. The absolute barometric pressure at the Kaiser-Tulsa site should average approximately 742 mmHg.

- Step 8.1 - Attach electrode and cable to meter, as necessary. (Note, for groundwater sampling a sufficiently long cable should be used in order to lower the probe beneath the water table in the monitoring well). Ensure that the electrode storage container contains water saturated air. This can be accomplished by putting a flattened pad of tissue paper at the bottom of the container and wetting the pad with water. The pad must not touch the electrode membrane surface.

- Step 8.2 - Steps 8.3 through 8-4 should be performed only at the first and last wells to be sampled on a given day.

- Step 8.3 - Remove the electrode from the storage container and blot dry. Open a packet of zero-oxygen solution and immerse electrode membrane in solution. The meter reading should tend towards zero. Zero the meter if a zero value is not obtained directly within 2 to 3 minutes.

- Step 8.4 - Determine the reference concentration for oxygen in water-saturated air at the local atmospheric pressure. This concentration can be obtained from a knowledge of the local atmospheric pressure and the tables provided in the instructions for use of the instrument. Put the electrode into the storage container and adjust the meter reading to this reference concentration. Record temperature (°C) and DO concentration (mg/l) reading on meter.

- Step 8.5 - Remove the electrode from the storage container and blot dry with tissue.

- Step 8.6 - For groundwater sampling, lower the probe into the monitoring well to a depth sufficient enough to ensure that the probe is submersed. Slowly raise and lower the probe within the water column being careful to not raise it out of the water column. Continue for at least 60 seconds and record temperature and DO readings. For surface water sampling, pour a sufficient volume of sample water into a clean beaker so that the electrode will be submersed. Submerse electrode in beaker and stir water with electrode for at least 60 seconds. Record temperature and DO concentration readings.

- Step 8.7 - Remove electrode from beaker, rinse with distilled water. Return electrode to storage container. Check meter reading to ensure that reference concentration is measured. If reference concentration is not displayed on meter, check membrane on electrode for imperfections and check electrode electrolyte level. Replace membrane and/or add electrolyte as required. Recalibrate the meter as described in Steps 8.3 and 8.4. If the meter cannot be properly calibrated, replace the instrument.

- Step 8.8 - After the last measurement of the day, place the electrode in the storage container and properly store the cable and the meter.

9.0 Procedure - Field Measurement of Turbidity

Turbidity is measured in terms of formazine turbidity units (FTUs) or the equivalent nephelometric turbidity units. Turbidity meters operate on the principle of light transmission. Standard solutions are used to calibrate turbidity meters. Because turbidity measurement instruments and instrument operation instructions may vary with each manufacturer, the analyst is advised to read and use the instructions for instrument operation that are provided by the manufacturer. The meter used in the field shall be calibrated in the laboratory prior to field use. Record date and time of calibration in field notebook. The information desired from the turbidity measurements includes the trend in turbidity with increased purging and the turbidity of the unfiltered samples taken for laboratory analysis.

- Step 9.1 - This step should be performed only at the first and last wells to be sampled on a given day. Prepare the turbidity meter for use by checking the calibration. Fill a measurement cuvet to the required level with the non-zero turbidity standard (e.g., 10 FTU). Insert the cuvet in the instrument, read the meter and record the result. If the meter reading is within 0.5 FTU of the accepted value continue on to Step 9.2. If the meter reading is not

within 0.5 FTU of the accepted value, recalibrate the meter according to the manufacturers' instructions. If the meter cannot be properly calibrated before the first measurements are made, replace the instrument. If the meter cannot be properly calibrated after the last measurement of the day, record this fact in the field notebook.

- Step 9.2 - Pour the required volume of purge water into a clean cuvet. Insert the cuvet into the instrument, read the meter and record the result.

- Step 9.3 - After the last measurement of the day, retest the reference solution and record the result in the field notebook. Clean the cuvets with cleaning solution (Hanna Instruments: Catalog No. HI 93703-50 or equivalent) and special tissues (Hanna Instruments: Catalog No. HI 731318 or equivalent). Properly store meter, cuvets, and standards.

10.0 QA/QC

This procedure is a part of the QA Program instituted by Kaiser for the Remediation Project at the Tulsa site. In addition to the site QA Plan, this procedure references other procedures including the procedure for groundwater sampling (KAI-03) and the procedure for surface water sampling (KAI-07).

The acceptance criteria for this procedure is that the steps in the procedure have been faithfully followed, that calibration standards were not expired, the instruments were in calibration while in use in the field as reflected by the analysis of reference samples, and that the data obtained have been accurately recorded in the field notebook. Exceptions (e.g., instances in which the procedure has not been faithfully followed) must be evaluated individually to establish their significance with respect to the final analytical results. This evaluation can be conducted by those members of the Project Team with expertise relating to the exception and the quality of analytical data.

11.0 Revisions and Alternate Procedures

The procedure may be revised from time to time to accommodate changed site conditions or facilitate sampling. Revisions may be issued as a revision to this procedure or as an addendum. All revisions will be evaluated to ensure data collected continues to be reliable. Revisions must be approved by the Kaiser Project Manager and reviewed by the Radiation Safety Officer (RSO). Alternate procedures may also be used on a project-specific basis. All alternate procedures must be approved by Kaiser Project Manager and reviewed by the RSO.

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Appendix B

Laboratory Analytical Data Reports and Field Documentation

Appendix B-1

Analytical Data Reports and Field Documentation

Third Quarter 2002 Monitoring Event

Outreach Laboratory
311 North Aspen
Broken Arrow OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020714
Date Reported.	10/15/02
Date Received	9/16/02
Page Number:	1 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20020714-01**						
Client ID:	**MWD-10 FILTERED**						
Date Sampled:	**9/16/02 1:50:00 PM**						
Matrix:	**Water**						
	Radiochemical Analyses						
Ra-226	SM 7500 Ra (M)	0.413 +/- 0.137	pCi/l	0.165	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	ND +/- 0.046	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.116	pCi/l	0.208	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0.183 +/- 0.162	pCi/l	0.338	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0.186 +/- 0.103	pCi/l	0.112	9/20/02	9/23/02	SD
	Inorganics Analyses						
Alkalinity	EPA 310.1	279	mg/l	2		9/19/02 8:40:00 AM	RT
Chloride	EPA 325.3	222	mg/l	2		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120.1	1260	uMHO/cm	20		9/16/02 5:19:00 PM	RT
Fluoride	EPA 340.2	0.8	mg/l	0.2	9/18/02 11:20:00 AM	9/20/02 11:30:00 AM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/17/02 2:30:00 PM	9/17/02 4:15:00 PM	RT
pH	EPA 150.1/9040A	6.99	SI			9/16/02 5:10:00 PM	RT
Silica Dioxide	EPA 370.1	1.7	mg/l	0.5	9/19/02	10/3/02 10:30:00 AM	RT
Sulfate	EPA 375.4	28.2	mg/l	1		9/24/02 9:00:00 AM	RT
Temperature	EPA 170.1	23.4	degrees C			9/16/02 5:10:00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
411 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020714
Date Reported:	10/15/02
Date Received	9/16/02
Page Number:	2 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
		Metals Analyses					
Barium	EPA 6010B	0.990	mg/l	0.003	9/19/02	9/24/02	RE
Calcium	EPA 6010B	89.3	mg/l	0.053	9/19/02	9/24/02	RE
Iron	EPA 6010B	0 092	mg/l	0.006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	47.5	mg/l	0.006	9/19/02	9/24/02	RE
Potassium	EPA 6010B	69.2	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	27.4	mg/l	0.429	9/19/02	9/26/02	RE

Lab ID: 20020714-02
Client ID: P-2 FILTERED
Date Sampled: 9/16/02 3:35:00 PM
Matrix: Water

		Radiochemical Analyses					
Ra-226	SM 7500 Ra (M)	0.096 +/- 0.087	pCi/l	0.151	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0.312 +/- 0.052	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0.038 +/- 0.070	pCi/l	0.106	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.141	pCi/l	0.346	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 048 +/- 0.090	pCi/l	0.140	9/20/02	9/23/02	SD
		Inorganics Analyses					
Alkalinity	EPA 310 1	568	mg/l	4		9/19/02 8:40 00 AM	RT
Chloride	EPA 325.3	12.6	mg/l	1		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120.1	1020	uMHO/cm	20		9/16/02 5:19.00 PM	RT
Fluoride	EPA 340.2	0.3	mg/l	0.2	9/18/02 1:15:00 PM	9/20/02 11:30.00 AM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/17/02 2:30:00 PM	9/17/02 4:15.00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020714
Date Reported.	10/15/02
Date Received.	9/16/02
Page Number:	3 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
pH	EPA 150.1/9040A	6.83	SI			9/16/02 5:13:00 PM	RT
Silica Dioxide	EPA 370.1	2.7	mg/l	0.5	9/19/02	10/3/02 10:30:00 AM	RT
Sulfate	EPA 375.4	5.2	mg/l	1		9/24/02 9.00.00 AM	RT
Temperature	EPA 170.1	21.2	degrees C			9/16/02 5:13:00 PM	RT
Metals Analyses							
Barium	EPA 6010B	0.917	mg/l	0.003	9/19/02	9/24/02	RE
Calcium	EPA 6010B	16.8	mg/l	0.583	9/19/02	9/26/02	RE
Iron	EPA 6010B	0.076	mg/l	0.006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	14.2	mg/l	0.006	9/19/02	9/24/02	RE
Potassium	EPA 6010B	BDL	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	2.78	mg/l	0.429	9/19/02	9/26/02	RE

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020714
Date Reported:	10/15/02
Date Received:	9/16/02
Page Number:	4 of 4

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Alkalinity	BDL	105.0			1.4	99.5	101.0	0.9	9/19/02
Barium	BDL	88.0				98.0	94.0	2.8	9/24/02
Calcium	BDL	87.0				DO	DO	5.7	9/24/02
Chloride	BDL	100.0			0.4	99.7	101.0	0.5	9/23/02
Conductivity	BDL	98.5							9/16/02
Fluoride	BDL	94.4			4.5	93.8	93.8	0.0	9/20/02
Iron	0.084	91.0				103.0	100.0	2.8	9/24/02
Magnesium	BDL	82.0				DO	DO	5.2	9/24/02
Nitrate (N)	BDL	103.0			4.9	100.0	99.8	0.2	9/17/02
pH		100.0			0.0				9/16/02
pH		100.0			0.0				9/16/02
Potassium	BDL	116.0				DO	DO	2.2	9/26/02
Ra-226	0+/-0	104.0	100.0	4.1	15.4	92.0	86.5		10/8/02
Ra-228	0.1+/-0.1	102.0	99.4	2.2	NC	105.0	101.0	4.0	10/4/02
Silica Dioxide	BDL	94.1			0.0	105.0	106.0	0.3	10/3/02
Sodium	BDL	96.0				DO	DO		9/24/02
Sulfate	BDL	105.0			2.5	104.0	105.0	0.7	9/24/02
Tantalum	BDL	92.4				76.8	77.7	1.1	
Th-228	0.1+/-0.1	96.2	96.2	0.0	NC	101.0	96.3	4.3	9/23/02
Th-230	0+/-0.1	92.8	95.6	3.0	NC	89.5	98.9	9.8	9/23/02
Th-232	.01+/-0.1	99.1	89.4	10.2	NC	79.7	101.0	23.9	9/23/02

QA Approval: _____

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

11 North Aspen
roken Arrow, OK 74012
hone: (918) 251-2515
ax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company A&M Engineering
Name Irfan Tuser
Address
City Tulsa State Zip
Phone 918-665-6575 Fax #

Bill To:
Company Same
Name
Address
City State Zip

ANALYSIS REQUESTED

PO # 1
PROJECT # 1556-020
PROJECT NAME Kaisel Qtrly
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY)
SAMPLER Jon Kuhn (Signature)

See Attached

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)									REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	MW0-10	9-16-02	13:40	Liq	2	P										Please Preserve in Lab
	P-2	9-16-02	15:35	Liq	2	P										"

RELINQUISHED BY _____ DATE _____ TIME _____ RECEIVED BY _____ DATE _____ TIME _____

RELINQUISHED BY: Jon Kuhn DATE 9-16-02 TIME 15:55 RECEIVED BY: [signature] DATE 9/16/02 TIME 1555

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory)

SAMPLE RETURN/DISPOSAL: All non hazardous aqueous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 20020714

Sample Condition Upon Receipt Good
Custody Seals Intact Y N
Cooler Temperature NA

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported	10/15/02
Date Received	9/17/02
Page Number.	1 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20020720-01						
Client ID:	MWD-7 FILTERED						
Date Sampled:	9/17/02 10:13:00 AM						
Matrix:	Water						
	Radiochemical Analyses						
Ra-226	SM 7500 Ra (M)	0.275 +/- 0.109	pCi/l	0.138	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0 +/- 0.052	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 043 +/- 0.066	pCi/l	0 101	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.116	pCi/l	0.314	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0.123 +/- 0 073	pCi/l	0.081	9/20/02	9/23/02	SD
	Inorganics Analyses						
Alkalinity	EPA 310 1	229	mg/l	2		9/19/02 8 40.00 AM	RT
Chloride	EPA 325.3	76.9	mg/l	1		9/23/02 10.00.00 AM	RT
Conductivity	EPA 120 1	762	uMHO/cm	2		9/17/02 5:10.00 PM	RT
Fluoride	EPA 340.2	0.4	mg/l	0.2	9/18/02 3:10 00 PM	9/20/02 11:30.00 AM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30.00 PM	9/24/02 3:15:00 PM	RT
pH	EPA 150.1/9040A	6.71	SI			9/17/02 4:53.00 PM	RT
Silica Dioxide	EPA 370.1	1.5	mg/l	0.5	9/19/02	10/3/02 10.30.00 AM	RT
Sulfate	EPA 375.4	28.7	mg/l	1		9/24/02 9:00 00 AM	RT
Temperature	EPA 170.1	18.0	degrees C			9/17/02 4.53:00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received:	9/17/02
Page Number:	2 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
		Metals Analyses					
Barium	EPA 6010B	1.34	mg/l	0.003	9/19/02	9/24/02	RE
Calcium	EPA 6010B	68.9	mg/l	0.053	9/19/02	9/24/02	RE
Iron	EPA 6010B	0.069	mg/l	0 006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	12.6	mg/l	0.006	9/19/02	9/24/02	RE
Potassium	EPA 6010B	85.2	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	14.6	mg/l	0.039	9/19/02	9/24/02	RE

Lab ID: 20020720-02
Client ID: MWD-8 FILTERED
Date Sampled: 9/17/02 11:30:00 AM
Matrix: Water

		Radiochemical Analyses					
Ra-226	SM 7500 Ra (M)	0.240 +/- 0.162	pCi/l	0.291	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	3.93 +/- 0.069	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0.184 +/- 0.155	pCi/l	0.196	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0.078 +/- 0.212	pCi/l	0.463	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0.192 +/- 0.147	pCi/l	0.172	9/20/02	9/23/02	SD
		Inorganics Analyses					
Alkalinity	EPA 310.1	155	mg/l	2		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	691	mg/l	5		9/23/02 10:00.00 AM	RT
Conductivity	EPA 120.1	2470	uMHO/cm	20		9/17/02 5:10:00 PM	RT
Fluoride	EPA 340.2	1.7	mg/l	0.3	9/19/02 12:25:00 PM	9/20/02 11:30:00 AM	RT
Nitrate (N)	EPA 352.1	0.2	mg/l	0.2	9/24/02 1:30:00 PM	9/24/02 3:15:00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received:	9/17/02
Page Number:	3 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
pH	EPA 150.1/9040A	7.31	SI			9/17/02 4:55:00 PM	RT
Silica Dioxide	EPA 370.1	1.2	mg/l	0.5	9/19/02	10/3/02 10 30:00 AM	RT
Sulfate	EPA 375.4	1.3	mg/l	1		9/24/02 9.00:00 AM	RT
Temperature	EPA 170.1	24.2	degrees C			9/17/02 4:55:00 PM	RT
Metals Analyses							
Barium	EPA 6010B	21.1	mg/l	0.003	9/19/02	9/26/02	RE
Calcium	EPA 6010B	68.9	mg/l	0 053	9/19/02	9/24/02	RE
Iron	EPA 6010B	2.74	mg/l	0 006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	131	mg/l	0 066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	185	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	30.4	mg/l	0.429	9/19/02	9/26/02	RE

Lab ID: 20020720-03
Client ID: MW-9 FILTERED
Date Sampled: 9/17/02 1:50:00 PM
Matrix: Water

Radiochemical Analyses							
Ra-226	SM 7500 Ra (M)	0.134 +/- 0.106	pCi/l	0.185	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	ND +/- 0.049	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.141	pCi/l	0.283	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0.156 +/- 0.243	pCi/l	0.495	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 +/- 0.191	pCi/l	0.349	9/20/02	9/23/02	SD
Inorganics Analyses							
Alkalinity	EPA 310.1	217	mg/l	2		9/19/02 8:40:00 AM	RT
Chloride	EPA 325.3	128	mg/l	1		9/23/02 10.00·00 AM	RT

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client	Kaiser Aluminum
Client Project.	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received	9/17/02
Page Number:	4 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Conductivity	EPA 120.1	882	uMHO/cm	2		9/17/02 5:10.00 PM	RT
Fluoride	EPA 340.2	0.3	mg/l	0.2	9/19/02 8:00:00 AM	9/20/02 11:30 00 AM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0 2	9/24/02 1:30.00 PM	9/24/02 3:15.00 PM	RT
pH	EPA 150 1/9040A	6.84	SI			9/17/02 4:57:00 PM	RT
Silica Dioxide	EPA 370.1	1.8	mg/l	0.5	9/19/02	10/3/02 10:30.00 AM	RT
Sulfate	EPA 375.4	30.0	mg/l	1		9/24/02 9.00.00 AM	RT
Temperature	EPA 170.1	24.8	degrees C			9/17/02 4:57.00 PM	RT
Metals Analyses							
Barium	EPA 6010B	0.408	mg/l	0 003	9/19/02	9/24/02	RE
Calcium	EPA 6010B	97.3	mg/l	0.053	9/19/02	9/24/02	RE
Iron	EPA 6010B	0.077	mg/l	0.006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	28.2	mg/l	0.006	9/19/02	9/24/02	RE
Potassium	EPA 6010B	8 99	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	23.8	mg/l	0.429	9/19/02	9/26/02	RE

Lab ID: 20020720-04
Client ID: P-5 FILTERED
Date Sampled: 9/17/02 3:50:00 PM
Matrix: Water

Radiochemical Analyses							
Ra-226	SM 7500 Ra (M)	0.273 +/- 0.131	pCi/l	0.207	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0.768 +/- 0.053	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.108	pCi/l	0 207	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.132	pCi/l	0.395	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 +/- 0.110	pCi/l	0.207	9/20/02	9/23/02	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client.	Kaiser Aluminum
Client Project	QUARTERLY
Lab Number:	20020720
Date Reported.	10/15/02
Date Received	9/17/02
Page Number:	5 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
		Inorganics Analyses					
Alkalinity	EPA 310.1	222	mg/l	2		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	402	mg/l	5		9/23/02 10.00.00 AM	RT
Conductivity	EPA 120.1	1860	uMHO/cm	20		9/17/02 5:10 00 PM	RT
Fluoride	EPA 340.2	0.5	mg/l	0.2	9/19/02 10.20 00 AM	9/20/02 11.30 00 AM	RT
Nitrate (N)	EPA 352.1	0.3	mg/l	0.2	9/24/02 1:30.00 PM	9/24/02 3:15.00 PM	RT
pH	EPA 150.1/9040A	7.17	SI			9/17/02 5:00:00 PM	RT
Silica Dioxide	EPA 370.1	1.6	mg/l	0.5	9/19/02	10/3/02 10.30 00 AM	RT
Sulfate	EPA 375.4	5.6	mg/l	1		9/24/02 9.00:00 AM	RT
Temperature	EPA 170.1	21.4	degrees C			9/17/02 5:00.00 PM	RT
		Metals Analyses					
Barium	EPA 6010B	3.58	mg/l	0.003	9/19/02	9/24/02	RE
Calcium	EPA 6010B	63.9	mg/l	0.053	9/19/02	9/24/02	RE
Iron	EPA 6010B	0.261	mg/l	0.006	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	28.8	mg/l	0.006	9/19/02	9/24/02	RE
Potassium	EPA 6010B	248	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	39.7	mg/l	0.429	9/19/02	9/26/02	RE
Copper	EPA 6010B	BDL	mg/l	0.011	9/19/02	9/24/02	RE
Zinc	EPA 6010B	BDL	mg/l	0.018	9/19/02	9/24/02	RE

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow OK 74012
(918) 251-2515
FAX (918) 251-0008

Client	Kaiser Aluminum
Client Project	QUARTERLY
Lab Number.	20020720
Date Reported	10/15/02
Date Received	9/17/02
Page Number:	6 of 9

Analytical Report

Lab ID: 20020720-05
Client ID: TRIP BLANK
Date Sampled: 9/17/02
Matrix: Water

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Radiochemical Analyses							
Ra-226	SM 7500 Ra (M)	0 +/- 0.089	pCi/l	0.244	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0.459 +/- 0.052	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 011 +/- 0.121	pCi/l	0 206	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.174	pCi/l	0.420	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 +/- 0.109	pCi/l	0.195	9/20/02	9/23/02	SD
Inorganics Analyses							
Alkalinity	EPA 310.1	BDL	mg/l	1		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	BDL	mg/l	1		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120 1	2.5	uMHO/cm	2		9/18/02 4.05.00 PM	RT
Fluoride	EPA 340 2	BDL	mg/l	0.2	9/19/02 8:00:00 AM	9/20/02 11:30:00 AM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30.00 PM	9/24/02 3:15:00 PM	RT
pH	EPA 150.1/9040A	5.36	SI			9/18/02 3:34:00 PM	RT
Silica Dioxide	EPA 370.1	BDL	mg/l	0.5	9/19/02	10/3/02 10:30.00 AM	RT
Sulfate	EPA 375.4	BDL	mg/l	1		9/24/02 9:00:00 AM	RT
Temperature	EPA 170.1	25.4	degrees C			9/18/02 3:34:00 PM	RT
Metals Analyses							

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
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FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received.	9/17/02
Page Number:	7 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Barium	EPA 6010B	BDL	mg/l	0.033	9/19/02	9/26/02	RE
Calcium	EPA 6010B	BDL	mg/l	0.583	9/19/02	9/24/02	RE
Iron	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	BDL	mg/l	0.660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	BDL	mg/l	0.429	9/19/02	9/26/02	RE

Lab ID: 20020720-06
Client ID: DUPLICATE FILTERED
Date Sampled: 9/17/02
Matrix: Water

		Radiochemical Analyses					
Ra-226	SM 7500 Ra (M)	0.410 +/- 0.168	pCi/l	0.248	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	2.04 +/- 0.061	pCi/l	0 469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.090	pCi/l	0.179	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0.112 +/- 0.196	pCi/l	0.422	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 +/- 0.110	pCi/l	0.196	9/20/02	9/23/02	SD
		Inorganics Analyses					
Alkalinity	EPA 310.1	156	mg/l	2		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	686	mg/l	5		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120.1	2440	uMHO/cm	20		9/17/02 5:10.00 PM	RT
Fluoride	EPA 340.2	1.7	mg/l	0.3	9/19/02 12:25:00 PM	9/20/02 12:25.00 PM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30:00 PM	9/24/02 3:15:00 PM	RT
pH	EPA 150.1/9040A	7.41	SI			9/17/02 5:09:00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
oken Arrow OK 74012
918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received.	9/17/02
Page Number.	8 of 9

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Silica Dioxide	EPA 370 1	1.2	mg/l	0.5	9/19/02	10/3/02 10:30:00 AM	RT
Sulfate	EPA 375.4	1.1	mg/l	1		9/24/02 9.00:00 AM	RT
Temperature	EPA 170.1	25.9	degrees C			9/17/02 5:09:00 PM	RT
		Metals Analyses					
Barium	EPA 6010B	21.3	mg/l	0 033	9/19/02	9/26/02	RE
Calcium	EPA 6010B	71.9	mg/l	0.583	9/19/02	9/24/02	RE
Iron	EPA 6010B	2.65	mg/l	0.066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	134	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	188	mg/l	0 660	9/19/02	9/26/02	RE
Sodium	EPA 6010B	30.6	mg/l	0.429	9/19/02	9/26/02	RE

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QUARTERLY
Lab Number:	20020720
Date Reported:	10/15/02
Date Received:	9/17/02
Page Number:	9 of 9

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Alkalinity	BDL	105 0			1.4	99.5	101.0	0.9	9/19/02
Barium	BDL	88.0				98.0	94.0	2.8	9/24/02
Calcium	BDL	87.0				DO	DO	5.7	9/24/02
Chloride	BDL	100.0			0.4	99.7	101.0	0.5	9/23/02
Conductivity	BDL	99.3			0 0				9/17/02
Conductivity	BDL	99.0			0 0				9/18/02
Fluoride	BDL	94.4			4.5	93.8	93.8	0.0	9/20/02
Iron	0.084	91.0				103.0	100.0	2.8	9/24/02
Magnesium	BDL	82.0				DO	DO	5.2	9/24/02
Nitrate (N)	BDL	101.0			1.3	103.0	97.1	3.7	9/24/02
pH		100.0			0.1				9/17/02
pH		100.0			0.4				9/18/02
Potassium	BDL	116.0				DO	DO	2.2	9/26/02
Ra-226	0+/-0	104.0	100.0	4.1	15.4	92.0	86.5		10/8/02
Ra-228	0.1+/-0.1	102.0	99.4	2.2	NC	105.0	101.0	4.0	10/4/02
Silica Dioxide	BDL	94.1			0.0	105.0	106.0	0.3	10/3/02
Sodium	BDL	96.0				DO	DO		9/24/02
Sulfate	BDL	105.0			2.5	104.0	105.0	0 7	[illegible]
Th-228	0.1+/-0.1	96.2	96 2	0.0	NC	101.0	96.3	4.3	9/23/02
Th-230	0+/-0.1	92.8	95.6	3.0	NC	89.5	98.9	9.8	9/23/02
Th-232	.01+/-0.1	99.1	89.4	10.2	NC	79.7	101.0	23.9	9/23/02

QA Approval: _____

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

11 North Aspen
oken Arrow, OK 74012
hone: (918) 251-2515
ax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company A&M Engineering
Name Irfan Taner
Address
City Tulsa State OK Zip
Phone 918-665-6575 Fax #

Bill To:
Company
Name Same
Address
City State Zip

ANALYSIS REQUESTED

'O #
'ROJECT # 1556-020
'ROJECT NAME Kaiser Ptaly
EQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY)
AMPLER Signature

See Attached

Please Preserve in Lab

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE PLASTIC OR GLASS	PRESERVATIVE # 1. HNO_3 pH<2 2. Ice <4°C 3. HCl pH<2 4. H_2SO_4 pH<2 5. NaOH pH>11									REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	MWD-7	9-17-02	10:13	Liq	2	P										Filtered
	MWD-8	9-17-02	11:30	Liq	2	P										Filtered
	MW 9	9-17-02	13:50	Liq	2	P										Filtered
	P-5	9-17-02	15:50	Liq	2	P					CLTZN					Filtered
	Trip Blank	9-17-02		Liq	2	P										
	Duplicate	9-17-02		Liq	2	P										Filtered

RELINQUISHED BY ____ DATE ____ TIME ____ RECEIVED BY ____ DATE ____ TIME ____

RELINQUISHED BY: ____ DATE 9-17-02 TIME 16:17 RECEIVED BY ____ DATE 9/17/02 TIME 1617

Signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company incomplete legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory)

SAMPLE RETURN/DISPOSAL: All non hazardous aqueous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense

FOR LABORATORY USE ONLY: 20020720
Sample Condition Upon Receipt Good
Custody Seals Intact Y N
Cooler Temperature NA

Outreach Laboratory
North Aspen
en Arrow OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	QTRLY
Lab Number.	20020721
Date Reported.	10/15/02
Date Received	9/18/02
Page Number:	1 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20020721-01						
Client ID:	P-3 FILTERED						
Date Sampled:	9/18/02 10:05:00 AM						
Matrix:	Water						
	Radiochemical Analyses						
Ra-226	SM 7500 Ra (M)	0.396 +/- 0.139	pCi/l	0.187	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	ND +/- 0 049	pCi/l	0 469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0 053	pCi/l	0.122	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.127	pCi/l	0 394	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0.033 +/- 0.072	pCi/l	0.109	9/20/02	9/23/02	SD
	Inorganics Analyses						
Alkalinity	EPA 310.1	280	mg/l	2		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	565	mg/l	5		9/23/02 10.00.00 AM	RT
Conductivity	EPA 120.1	2270	uMHO/cm	20		9/18/02 4:05.00 PM	RT
Fluoride	EPA 340.2	0 4	mg/l	0.2	9/19/02 10:20 00 AM	9/20/02 12:25.00 PM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0 2	9/24/02 1:30:00 PM	9/24/02 3:15:00 PM	RT
pH	EPA 150.1/9040A	6.81	SI			9/18/02 3:38:00 PM	RT
Silica Dioxide	EPA 370.1	2.3	mg/l	0.5	9/19/02	10/3/02 10:30:00 AM	RT
Sulfate	EPA 375.4	69.3	mg/l	4		9/24/02 9:00:00 AM	RT
Temperature	EPA 170 1	27.6	degrees C			9/18/02 3:38:00 PM	RT
	Metals Analyses						

BDL = Below Detection Limit

Outreach
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North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client	Kaiser Aluminum
Client Project:	QTRLY
Lab Number:	20020721
Date Reported	10/15/02
Date Received	9/18/02
Page Number:	2 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Barium	EPA 6010B	0.293	mg/l	0.033	9/19/02	9/24/02	RE
Calcium	EPA 6010B	274	mg/l	0.583	9/19/02	9/24/02	RE
Iron	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	62.9	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	12.2	mg/l	0.660	9/19/02	9/24/02	RE
Sodium	EPA 6010B	60.8	mg/l	0.429	9/19/02	9/24/02	RE
Copper	EPA 6010B	BDL	mg/l	0.121	9/19/02	9/24/02	RE
Zinc	EPA 6010B	BDL	mg/l	0.198	9/19/02	9/24/02	RE

Lab ID: 20020721-02
Client ID: MWD-4 FILTERED
Date Sampled: 9/18/02 11:43:00 AM
Matrix: Water

Radiochemical Analyses							
Ra-226	SM 7500 Ra (M)	0.361 +/- 0.157	pCi/l	0.233	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0.548 +/- 0.052	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0.012 +/- 0.063	pCi/l	0.104	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.159	pCi/l	0.400	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0.128 +/- 0.111	pCi/l	0.139	9/20/02	9/23/02	SD
Inorganics Analyses							
Alkalinity	EPA 310.1	313	mg/l	2		9/19/02 8:40:00 AM	RT
Chloride	EPA 325.3	280	mg/l	3		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120.1	1550	uMHO/cm	20		9/18/02 4:05:00 PM	RT
Fluoride	EPA 340.2	0.5	mg/l	0.2	9/19/02 10:20:00 AM	9/20/02 12:25:00 PM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30:00 PM	9/24/02 3:15:00 PM	RT

BDL = Below Detection Limit

Outreach Laboratory
[illegible]rth Aspen
B[illegible] Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project.	QTRLY
Lab Number.	20020721
Date Reported	10/15/02
Date Received	9/18/02
Page Number:	3 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
pH	EPA 150 1/9040A	6.81	SI			9/18/02 3:41:00 PM	RT
Silica Dioxide	EPA 370.1	2.2	mg/l	0.5	9/19/02	10/3/02 10 30 00 AM	RT
Sulfate	EPA 375.4	61.6	mg/l	4		9/24/02 9 00 00 AM	RT
Temperature	EPA 170 1	25 2	degrees C			9/18/02 3:41:00 PM	RT
	Metals Analyses						
Barium	EPA 6010B	0.098	mg/l	0.033	9/19/02	9/24/02	RE
Calcium	EPA 6010B	147	mg/l	0.583	9/19/02	9/24/02	RE
Iron	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	70.5	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	23 6	mg/l	0 660	9/19/02	9/24/02	RE
Sodium	EPA 6010B	42.0	mg/l	0.429	9/19/02	9/24/02	RE

Lab ID: 20020721-03
Client ID: MWD-5 FILTERED
Date Sampled: 9/18/02 1:20:00 PM
Matrix: Water

	Radiochemical Analyses						
Ra-226	SM 7500 Ra (M)	0.364 +/- 0.137	pCi/l	0.185	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	0.784 +/- 0.053	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.151	pCi/l	0.281	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0 +/- 0.246	pCi/l	0.628	9/20/02	9/23/02	SD
Th-228	LANL ER 200 M	0 +/- 0.164	pCi/l	0.294	9/20/02	9/23/02	SD
	Inorganics Analyses						
Alkalinity	EPA 310 1	107	mg/l	1		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	290	mg/l	3		9/23/02 10:00 00 AM	RT

BDL = Below Detection Limit

Outreach Laboratory
orth Aspen
n Arrow, OK 74012
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FAX (918) 251-0008

Client	Kaiser Aluminum
Client Project	QTRLY
Lab Number:	20020721
Date Reported	10/15/02
Date Received.	9/18/02
Page Number.	4 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Conductivity	EPA 120.1	1240	uMHO/cm	20		9/18/02 4:05:00 PM	RT
Fluoride	EPA 340.2	1.4	mg/l	0.3	9/19/02 12.25:00 PM	9/20/02 12:25:00 PM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30.00 PM	9/24/02 3:15.00 PM	RT
pH	EPA 150.1/9040A	7.68	SI			9/18/02 3:46:00 PM	RT
Silica Dioxide	EPA 370.1	0.9	mg/l	0.5	9/19/02	10/3/02 10:30.00 AM	RT
Sulfate	EPA 375.4	2.2	mg/l	1		9/24/02 9:00.00 AM	RT
Temperature	EPA 170.1	23.4	degrees C			9/18/02 3.46.00 PM	RT
Metals Analyses							
Barium	EPA 6010B	4.06	mg/l	0.033	9/19/02	9/24/02	RE
Calcium	EPA 6010B	42.5	mg/l	0 583	9/19/02	9/24/02	RE
Iron	EPA 6010B	0 144	mg/l	0 066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	21.7	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	138	mg/l	0.660	9/19/02	9/24/02	RE
Sodium	EPA 6010B	25.6	mg/l	0.429	9/19/02	9/24/02	RE

Lab ID: 20020721-04
Client ID: EQUIP BLANK FILTERED
Date Sampled: 9/18/02
Matrix: Water

Radiochemical Analyses							
Ra-226	SM 7500 Ra (M)	0.109 +/- 0.141	pCi/l	0.268	10/7/02	10/8/02	RE
Ra-228	EPA 904/9320	ND +/- 0.048	pCi/l	0.469	9/20/02	10/4/02	SD
Th-232	LANL ER 200 M	0 +/- 0.109	pCi/l	0.193	9/20/02	9/23/02	SD
Th-230	LANL ER 200 M	0.003 +/- 0 209	pCi/l	0 473	9/20/02	9/23/02	SD

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project.	QTRLY
Lab Number:	20020721
Date Reported:	10/15/02
Date Received:	9/18/02
Page Number:	5 of 6

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Th-228	LANL ER 200 M	0 016 +/- 0.135	pCi/l	0.226	9/20/02	9/23/02	SD
Inorganics Analyses							
Alkalinity	EPA 310 1	BDL	mg/l	1		9/19/02 8:40.00 AM	RT
Chloride	EPA 325.3	BDL	mg/l	1		9/23/02 10:00:00 AM	RT
Conductivity	EPA 120.1	2.5	uMHO/cm	2		9/18/02 4:05:00 PM	RT
Fluoride	EPA 340.2	BDL	mg/l	0.2	9/19/02 8:00:00 AM	9/20/02 12:25:00 PM	RT
Nitrate (N)	EPA 352.1	BDL	mg/l	0.2	9/24/02 1:30:00 PM	9/24/02 3:15 00 PM	RT
pH	EPA 150 1/9040A	5.80	SI			9/18/02 3:49:00 PM	RT
Silica Dioxide	EPA 370.1	BDL	mg/l	0.5	9/19/02	10/3/02 10:30.00 AM	RT
Sulfate	EPA 375.4	BDL	mg/l	1		9/24/02 9.00.00 AM	RT
Temperature	EPA 170.1	23.1	degrees C			9/18/02 3:49.00 PM	RT
Metals Analyses							
Barium	EPA 6010B	BDL	mg/l	0.033	9/19/02	9/24/02	RE
Calcium	EPA 6010B	BDL	mg/l	0.583	9/19/02	9/24/02	RE
Iron	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Magnesium	EPA 6010B	BDL	mg/l	0.066	9/19/02	9/24/02	RE
Potassium	EPA 6010B	BDL	mg/l	0.660	9/19/02	9/24/02	RE
Sodium	EPA 6010B	BDL	mg/l	0.429	9/19/02	9/24/02	RE

BDL = Below Detection Limit

Outreach Laboratory
lorth Aspen
en Arrow, OK 74012
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Client:	Kaiser Aluminum
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QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Alkalinity	BDL	105.0			1.4	99.5	101.0	0.9	9/19/02
Barium	BDL	88.0				98.0	94.0	2.8	9/24/02
Calcium	BDL	87.0				DO	DO	5.7	9/24/02
Chloride	BDL	100.0			0.4	99.7	101.0	0.5	9/23/02
Conductivity	BDL	99.0			0.0				9/18/02
Fluoride	BDL	94.4			4.5	93.8	93.8	0.0	9/20/02
Iron	0.084	91.0				103.0	100.0	2.8	9/24/02
Magnesium	BDL	82.0				DO	DO	5.2	9/24/02
Nitrate (N)	BDL	101.0			1.3	103.0	97.1	3.7	9/24/02
pH		100.0			0.4				9/18/02
Potassium	BDL	116.0				DO	DO	2.2	9/26/02
a-226	0+/-0	104.0	100.0	4.1	15.4	92.0	86.5		10/8/02
Ra-228	0.1+/-0.1	102.0	99.4	2.2	NC	105.0	101.0	4.0	10/4/02
Silica Dioxide	BDL	94.1			0.0	105.0	106.0	0.3	10/3/02
Sodium	BDL	96.0				DO	DO		9/24/02
Sulfate	BDL	105.0			2.5	104.0	105.0	0.7	9/24/02
Th-228	0.1+/-0.1	96.2	96.2	0.0	NC	101.0	96.3	4.3	9/23/02
Th-230	0+/-0.1	92.8	95.6	3.0	NC	89.5	98.9	9.8	9/23/02
Th-232	.01+/-0.1	99.1	89.4	10.2	NC	79.7	101.0	23.9	9/23/02

QA Approval: _____

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

11 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: A & M Engineering
Name: Erlan Tanner
Address: 10010 E 16th St.
City: Tulsa State: OK. Zip: 74128
Phone: 918-665-6575 Fax #: 918-665-6576

Bill To:
Company:
Name: SAME
Address:
City: State: Zip:

ANALYSIS REQUESTED

PO #:
PROJECT #: 1556-020
PROJECT NAME: Kaiser Qtrly
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY):
SAMPLER: Signature

PRESERVATIVE #:
1. HNO_3 pH<2
2. Ice <4°C
3. HCl pH<2
4. H_2SO_4 pH<2
5. NaOH pH>11

See Attached

Please Prepreserve in Lab

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE (PLASTIC OR GLASS)	PRESERVATIVE #								REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	P-3	9/18/02	10:05	Liq.	2	P									Filtered
	MWD-4	9/18/02	11:43	Liq.	2	P									Filtered
	MWD-5	9/18/02	13:20	Liq.	2	P									Filtered
	~~Trip Blank~~	~~9/18/02~~		~~Liq.~~	~~1~~	~~P~~									~~Filtered~~
	Equipment Blank	9/18/02		Liq.	2	P									Filtered

RELINQUISHED BY: [signature] DATE 9/18/02 TIME 14:08 RECEIVED BY: [signature] DATE TIME

RELINQUISHED BY: DATE TIME RECEIVED BY: [signature] DATE 9/18/02 TIME 14:10

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non hazardous aqueous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 200 0721

Sample Condition Upon Receipt: G

Custody Seals Intact: Y N

Cooler Temperature: Ambient

QUARTERLY CHECKLIST			Date: 9/16/17/18		
Groundwater Monitoring Locations					
Former Kaiser Aluminum Specialty Products Facility			Sampled/Collected By: Jon / TY.		
Tulsa, Oklahoma					
Well Identification	Groundwater Level Measurement:	Depth to Groundwater (feet)	Sample Collection:	Sample Collected: (check)	Comments / Other:
~~P-1~~	~~X~~				
P-2	X	11.1	X	✓	31.52
P-3	X	9.45	X	✓	16.32
P-5	X	12.51	X	✓	TD. 23.28
~~P-7~~	~~X~~				
~~P-8~~	~~X~~				
~~P-10~~	~~X~~				
MWD-2	X	9.90			
MWS-4	X	9.82.			
MWD-4	X	11.01	X	✓	TD. 24.23
MWS-5	X	5.47			
MWD-5	X	10.64	X	✓	TD 25.93
MWS-6	X	15.56			
MWD-6	X	15.49			
MWD-7	X	12.61	X	✓	TD 24.08
MWD-8	X	7.99	X	✓	TD 22.28
MWD-9	X	12.09	X	✓	TD 22.0
MWD-10	X	11.89	X	✓	TD. 23.7
MWS-11	X	13.85			13.96 TD
MWD-11	X	15.56			TD 28.78
ST-2	X	51.96			Dry
ST-3	X	10.75			
Duplicate Sample	NA	NA	X	✓	Location Collected: MWD-8
Equipment/Field Blank	NA	NA	X	✓	
Trip Blank	NA	NA	X	✓	

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 1 OF 2

PROJECT NAME: Kaiser Aluminum Quarterly PROJECT NUMBER: 1556-020

SUPERVISOR NAME: Jon TECHNICIAN NAME: TY

WEATHER: clear AMBIENT AIR TEMP (°C): 92°F

LAST PRECIP. DATE: 9-17-18

Location (WELL NO.)	P-5	MWD-4	MWD-5	
Condition of Well	Good	Good	Good	
Water Depth (WD) (ft)	12.51	11.01	10.64	
Total Well Depth (TWD)(ft)	23.28	24.23	25.93	
Depth of Pump Intake (ft)	17'	19'	20'	
Volume to purge (gal)	8.8	10.04	11.07	
Initial Purging Rate (gal/min)	600 ml	600 ml	600 ml	
Time Required to Purge Initial 2 ½ Well Volumes	30 min	30 min	30 min.	
Time Initial Purging Begins	15:00	10:54	12:23	
Time Initial Purging Complete	15:30	11:24	12:55	
Final Purging Rate	500 ml	500 ml	500 ml	
Time Required to Purge Final ½ Well Volume	20 min	20 min	20 min	
Time Final Purging Begins	15:30	11:24	12:55	
Time Final Purging Ends	15:50	11:44	13:15	
Notes:	Sample Filtered	Sample Filtered	Sample Filtered	

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 2 OF 2

Location (WELL NO.)	P-5	MWD-4	MWD-5	
Temp (°C) of Purge Well	25.0 23.9	24.7 23.6	25.0 23.4	
	21.4 21.3	20.9 21.0	19.7 19.9	
pH During Purging Instrument ID._____	7.04 7.34	7.00 6.99	8.11 7.93	
	7.40 7.45	7.09 6.93	7.99 7.72	
Conductivity During Purging µS/cm	1750 1780	1430 1420	1220 1120	
	1780 1780	1420 1400	1220 1220	
Dissolved Oxygen (mg/l) During Purging	.63 .71	.52 .72	.93 1.06	
	.98 1.24	.63 .61	1.11 .98	
Turbidity of Sampled Water	14.1 10.3	2.4 100	8.5 4.4	
	11.2 5.2	57.3 60.2	6.7 4.0	
Sampling Method	Pump	Pump	Pump	
Time Sampling Begins	15:50	11:43	13:20	
Time Sampling Completed	16:00	11:53	13:30	
Color of Sampled Water	Clear	Clear	Clear	
Odor of Sampled Water	None	Slight	Sulfur	
Results of Measurement of pH of Buffer Solutions				
Results of Measurement of Conductivity Standards				
Results of Measurements of Dissolved Oxygen in Air				

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 1 OF 2

PROJECT NAME: Kaiser Aluminum Quarterly PROJECT NUMBER: 1556-020

SUPERVISOR NAME: Jon TECHNICIAN NAME: Ty

WEATHER: Partly Cloudy AMBIENT AIR TEMP (°C): 78° F

LAST PRECIP. DATE: 9-16-18-02.

Location (WELL NO.)	P3	MWD-10		
Condition of Well	Good	Good		
Water Depth (WD) (ft)	9.45	11.89		
Total Well Depth (TWD)(ft)	16.32	23.70		
Depth of Pump Intake (ft)	13	19'		
Volume to purge (gal)	6.85	9.3		
Initial Purging Rate (gal/min)	600 ml	600ml		
Time Required to Purge Initial 2 ½ Well Volumes	went dry.	33 min.		
Time Initial Purging Begins	11:01	12:53		
Time Initial Purging Complete	11:40	13:26		
Final Purging Rate	went dry.	500ml.		
Time Required to Purge Final ½ Well Volume		14 min.		
Time Final Purging Begins		13:26		
Time Final Purging Ends		13:40		
Notes:	Sample Filtered	Sample filtered		

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 2 OF 2

Location (WELL NO.)	P-3	MW0-10		
Temp (°C) of Purge Well	24.5 23.5	22.5 21.9		
	23.1 24.1	24.1 21.2		
pH During Purging Instrument ID ____	6.64 6.89	7.09 7.79		
	7.06 7.03	7.60 7.28		
Conductivity During Purging µS/cm	2000 2000	1300 1300		
	2000 2000	1250 1300		
Dissolved Oxygen (mg/l) During Purging	.79 1.60	.57 .67		
	2.31 1.78	.88 .88		
Turbidity of Sampled Water	4.8 23.5	166.4 83.2		
	96.1 600	66.7 22.6		
Sampling Method	Pump	Pump		
Time Sampling Begins	16:05	13:40		
Time Sampling Completed	10:10	13:59		
Color of Sampled Water	Clear	Clear		
Odor of Sampled Water	Lite Sulfur	None.		
Results of Measurement of pH of Buffer Solutions				
Results of Measurement of Conductivity Standards				
Results of Measurements of Dissolved Oxygen in Air				

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 1 OF 2

PROJECT NAME: Kaiser Aluminum Quarterly

PROJECT NUMBER: 1556-020

SUPERVISOR NAME: Jon

TECHNICIAN NAME: Ty

WEATHER: Clear.

AMBIENT AIR TEMP (°C): 80°F

LAST PRECIP.

DATE: 9-16-02 9-17-02

Location (WELL NO.)	P-2	MWD-7	MWD-9	MWD-8
Condition of Well	Good	Good	Good	Good
Water Depth (WD) (ft)	11.1	12.61	12.09	7.99
Total Well Depth (TWD)(ft)	31.52	24.08	23.0	22.28
Depth of Pump Intake (ft)	27'	19'	18'	17.5'
Volume to purge (gal)	13.6	9.17	8.90	10.57
Initial Purging Rate (gal/min)	600 ml	600ml	600ml	600ml
Time Required to Purge Initial 2 ½ Well Volumes	50min	33min	30min	50 min
Time Initial Purging Begins	14:30	09:07	13:00	10:20
Time Initial Purging Complete	15:20	09:40	13:30	11:10
Final Purging Rate	500ml	500ml	500ml	500ml
Time Required to Purge Final ½ Well Volume	10 min	33 min.	30min	20 min.
Time Final Purging Begins	15:20	09:40	13:20	11:10
Time Final Purging Ends	15:30	10:13	13:50	11:30
Notes:	Sample Filtered	Sample Filtered	Sample Filtered	Sample Filtered

FIELD QUALITY SAMPLING AND ANALYSIS DATA SHEET
SHEET 2 OF 2

Location (WELL NO.)	P-2	MW-7	MW-9	MW-8	Duplicate	
Temp (°C) of Purge Well	23.2 20.1	21.7 21.2	24.2 25	25 25	25	25
	19.6 19.6	21.4 22.3	24.5 24.2	23.1 23.1	22.8	23.1
pH During Purging Instrument ID ____	7.76 6.92	6.84 6.99	7.07 7.07	7.70 7.58	7.60	7.48
	7.09 7.18	6.95 7.28	6.82 6.81	7.43 7.42	7.42	7.42
Conductivity During Purging µS/cm	1100 1050	780 950	970 970	2200 2150	2150	2150
	1050 1025	800 980	900 900	2180 2170	2180	2180
Dissolved Oxygen (mg/l) During Purging	.42 .91	1.54 2.01	1.15 1.57	.41 1.13	.71	.71
	1.20 1.28	2.31 1.52	1.45 1.40	.69 .73	.64	.63
Turbidity of Sampled Water	13.0 14.8	171.2 180.3	113.2 135.0	6.0 3.6	5.4	4.2
	12.0 10.6	26.8 54.5	63.9 61.4	3.8 3.0	3.2	3.0
Sampling Method	Pump	Pump	Pump	Pump	Pump.	
Time Sampling Begins	15:35	10:13	13:50	11:30	11:30	
Time Sampling Completed	15:45	10:23	13:58	11:40	11:40	
Color of Sampled Water	Clear	Clear	Clear	Clear	Clear.	
Odor of Sampled Water	None	Slight Sulfur	Lite Sulfur	lite Sulfur	lite Sulfur	
Results of Measurement of pH of Buffer Solutions						
Results of Measurement of Conductivity Standards						
Results of Measurements of Dissolved Oxygen in Air						