INVESTIGATION OF THE FEBRUARY 21, 1993 SODIUM HYDROXIDE SPILL OLIN NIAGARA FALLS PLANT

Prepared for:
Olin Chemicals
1186 Lower River Road
Charleston, Tennessee 37310
January, 1994

Woodward-Clyde

Woodward-Clyde Consultants
3571 Niagara Falls Boulevard
North Tonawanda, New York 14120
Project Number 92C2030-9

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January 13, 1994
92C2030-9

Mr. Michael J. Bellotti
Olin Chemicals
Lower River Road
Charleston, Tennessee 37310

Subject: Investigation of the February 21, 1993 Sodium Hydroxide Spill
Olin Niagara Falls Plant

Dear Mr. Bellotti:

Woodward-Clyde Consultants (WCC) is pleased to submit this report presenting the results of our investigation of the impact on groundwater of the sodium hydroxide spill which occurred February 21, 1993 at Olin's Niagara Falls Plant. If you have any questions or comments on the report, please contact the undersigned. We appreciate this opportunity to work with Olin.

Sincerely,

JFR for
Kelly R. McIntosh, P.E., P.HGW.
Consultant to Woodward-Clyde Consultants

James F Roetzer
James F. Roetzer, Ph.D.
Senior Associate

KRM/JFR:jee

Olinvsp.rep

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1.0 INTRODUCTION

On February 21, 1993, a spill of 50 percent sodium hydroxide (NaOH) solution occurred due to a leak from the 800,000 gallon Niachlor storage tank at the Olin Chemicals (Olin) Niagara Falls Plant. The volume spilled was estimated by Olin to be approximately 560 gallons. The spilled solution pooled at a low-lying unpaved area north of the tank. The solution was subsequently pumped out of the area and the soils were treated with sodium bisulfite to lower the pH. Approximately 10 cubic yards of affected soil were removed. The spill location is shown on Figure 1-1.

Since the spill occurred, Olin has been pumping overburden groundwater from two sumps which penetrate the overburden. The sumps are located on the north and south sides of the NaOH storage and handling facility (Caustic Area) just south of the Niachlor storage tank. The sumps were installed by Olin in 1990 for potential use in the event a spill of NaOH were to occur in the area. The groundwater recovered from the sumps since the spill has contained elevated levels of NaOH. The recovered water is collected in Olin's off-spec caustic tank and treated.

Woodward-Clyde Consultants (WCC) was retained by Olin Chemicals (Olin) to investigate potential impacts of the NaOH spill on groundwater. The investigation was conducted in accordance with the Work Plan dated May 26, 1993, prepared by WCC and approved by USEPA. The investigation and its results are described and interpreted herein.

2.0
WORK PERFORMED

In accordance with the Work Plan, the investigation focused on two areas where infiltration of sodium hydroxide (NaOH) solution may have occurred. These areas, shown on Figure 2-1, are:

1. The unpaved area north of the 800,000 gallon Niachlor storage tank where NaOH solution which overflowed the concrete curb surrounding the tank accumulated.

2. The vicinity of the NaOH storage and handling area (Caustic Area) just south of the 800,000 gallon storage tank where NaOH from the tank was pumped and held in a diked containment area during clean up of the spill. Some seepage into the ground through cracks in this containment area may have occurred.

The investigation consisted of three tasks:

Task 1: Installation and sampling of temporary overburden monitoring wells.

Task 2: Installation and sampling of one bedrock well.

Task 3: Continued recovery and sampling from the two groundwater sumps.

These tasks are described in detail in the following subsections.

2.1 TASK 1: INSTALLATION AND SAMPLING OF TEMPORARY OVERBURDEN MONITORING WELLS

Since the reported spill of NaOH solution occurred over a brief period, and since recovery was implemented quickly, the impacts were expected to be limited primarily to the overburden. Therefore, this investigation was focused primarily on the overburden. Temporary overburden monitoring wells were installed at six locations in the vicinity of the 800,000 gallon tank and the storage/handling area. The temporary overburden wells were used to monitor hydraulic head and groundwater pH. The wells were constructed by augering to bedrock, and installing a 2-inch diameter PVC screen and riser with a sandpack, bentonite seal and grout to the ground surface. The wells were completed with flush-mounted protective casings. Appendix A presents well construction diagrams for the temporary overburden wells. Appendix B presents geologic logs for the temporary overburden wells.

The six temporary well locations are shown on Figure 2-1. One well (OCW-1) was located north of the 800,000 gallon storage tank, within the low point in the unpaved area where the spilled NaOH solution temporarily accumulated. Continuous split-spoon soil samples for soil pH measurement were obtained during installation of this well. In accordance with the Work Plan, soil samples from the remaining wells were not analyzed. Two wells (OCW-2 and OCW-3) were located to the west of the Caustic Area and two wells (OCW-5 and OCW-6) were located east of the Caustic Area. These wells were located along a north-south line, approximately 20 to 25 feet from the containment curbs. One well (OCW-4) was located approximately 16 feet south of the Caustic Area.

After installation, the hydraulic head, pH and/or sodium hydroxide content of the well water was measured. The pH measurements were obtained using either pH paper or a calibrated pH meter. The NaOH determination was made by titration with standard acid. After the initial measurements, hydraulic head and pH and/or sodium hydroxide were measured for each well twice during the remainder of the investigation.

2.2 TASK 2: INSTALLATION OF ONE BEDROCK MONITORING WELL

One top-of-bedrock well (OCW-6BR), monitoring the upper 3 feet of the Lockport Dolomite, was installed at the location of the highest sodium hydroxide concentration measured in the overburden groundwater. In addition to hydraulic head measurement, this well was sampled for pH and/or sodium hydroxide determination twice during the course of the investigation. The bedrock well was installed in the upper 3 feet of bedrock using the methods presented in the RFI Work Plan (WCC, February 20,1990), except that the entire overburden zone was sealed off from the screened upper bedrock interval. Appendix A presents the well construction diagram for the bedrock temporary monitoring well.

2.3 TASK 3: CONTINUED RECOVERY FROM THE TWO GROUNDWATER SUMPS

Periodic (level controlled) pumping from the groundwater sumps was performed for the duration of the investigation. The sump water was tested periodically by Olin for NaOH concentration.

3.0
RESULTS AND DISCUSSION

3.1 GROUNDWATER FLOW

As discussed in the Interim Report for the Olin Buffalo Avenue Plant RCRA Facility Investigation (RFI) (WCC, February 7, 1992), the saturated zone in the overburden is very thin, generally less than 3 feet. Because of the limited saturated zone in the overburden, the upper 2 to 3 feet of bedrock are included with the overburden and defined as the A-zone for the RFI groundwater investigation.

However, the present investigation is concerned with relatively recent spillage. Therefore, it is focussed primarily on characterization of the saturated zone of the overburden as a potential source of NaOH. There is little potential for horizontal migration in this zone. As discussed in the Interim Report, groundwater flow in the overburden is primarily downward to the more transmissive bedrock fracture zones within which horizontal flow more readily occurs. The purpose of the overburden well installations was to measure the NaOH concentrations in the overburden undiluted by bedrock groundwater flow.

The depth to bedrock encountered during the well installations ranged from 3.80 to 7.95 feet below ground surface (BGS). As expected, the saturated zones were very thin. No saturated zone was encountered in wells OCW-2 and OCW-3. Elsewhere, saturated zone thicknesses (measured August 31, 1993) ranged from 0.67 feet (OCW-5) to 2.76 feet (OCW-4).

Figure 3-1 illustrates the potentiometric surface for the overburden (water table) in the vicinity of the caustic area. Some horizontal groundwater flow in the area appears to be toward the two sumps, although the radius-of-influence from the sumps is not known.

The pumping rate for the sumps is not precisely known. Flow rates were estimated by Olin as follows:

	Estimated Flow Rate (Gallons Per Day)	
Date	**South Sump**	**North Sump**
April 28, 1993	1770	780
May 5, 1993	1110	550

From July through December 1993, the flow rates were much lower, probably due to the dewatering effects of pumping. The sporadic and intermittent nature of the level controlled pumping prevented accurate flow measurement during these months. On December 17, 1993, the sumps were monitored over a 5 hour period during which the pumps did not operate. No change in water level was recorded during this time, suggesting that dewatering has occurred in the vicinity of the sumps.

3.2 pH AND NaOH CONCENTRATION MEASUREMENTS

3.2.1 Soil

Soil pH measurements were obtained for split-spoon samples collected during drilling of OCW-1. This well is located in the center of the area where spilled NaOH solution temporarily pooled. This solution was pumped out and the soils were treated with sodium bisulfide to lower pH. Approximately 10 cubic yards of affected surficial soil was removed. The pH measurements were performed by Recra Environmental, Inc. of Amherst, New York, using Method 9045 (leachable pH).

The results are presented in Table 3-2. Soil pH ranged from approximately 10 to 11, indicating somewhat basic soil conditions but little residual NaOH solution.

3.2.2 Groundwater

Water pH measurements were obtained by Olin using a calibrated pH meter, and NaOH content was determined using titration with standard acid (HCl) to the phenolphthalein endpoint. In general, the pH results were one or more units lower than the theoretical pH derived based on the NaOH concentration. This discrepancy is likely attributable to two factors:

1. At high concentrations of NaOH, the ionic strength of the aqueous solution is correspondingly high. Calibration standards are designed for zero ionic strength, causing error in the pH measurement of highly caustic solutions.

2. The glass electrode membrane of the pH meter responds poorly at high pH.

At high NaOH concentration, both effects cause the pH measurement to be lower then the theoretical pH.

As described in Section 2.0 and the Work Plan, the six temporary overburden wells were installed and sampled for pH and NaOH content prior to selection of the bedrock well location. The results of these initial measurements are presented on Table 3-3. The highest pH and NaOH content was measured at OCW-6, located near the downgradient side of the diked Caustic Area. Based on this finding, the bedrock well was located in the vicinity of OCW-6 and was designated OCW-6BR.

At least two follow-up measurements for pH and NaOH content were obtained from each of the seven temporary monitoring wells. The results are shown on Table 3-4. NaOH concentration exceeded 1 percent in only two wells (OCW-6 and OCW-6BR). These wells are located within 25 feet of the north side of the diked Caustic Area. NaOH content and pH were also measured in selected RFI monitoring wells near the

Caustic Area. These results are listed in Table 3-5. All NaOH concentrations were below 1 percent. RFI monitoring wells penetrate the Lockport Dolomite which contains alkaline groundwater. Therefore, reported NaOH concentrations include some carbonate alkalinity (i.e. hydroxyl ions and carbonate ions both neutralize the titrant and are reported together as NaOH). At lower pHs, carbonate and bicarbonate alkalinity is likely the main contributor to the measured hydroxyl concentration, which is still reported as NaOH. Therefore, the reported NaOH concentrations may be lower than the actual NaOH concentrations.

NaOH concentration measurements for water samples from the two sumps are presented in Table 3-6. NaOH concentrations in sump water ranged from 1.3 to 6.0 percent for the south sump and from 1.9 to 13.4 percent for the north sump. Figure 3-2 shows these data graphed over time. No general trends over time are evident.

Figure 3-3 presents groundwater pH and NaOH concentrations measured on August 31, 1993 for the temporary monitoring wells and for A- and B-zone RFI wells in the vicinity. NaOH concentrations above 1 percent were measured in the two sumps, and in temporary monitoring wells OCW-6 and OCW-6BR. All other samples were below 1 percent.

3.3 DISCUSSION

The soils data for the unpaved area impacted by the NaOH spill shows little elevation of soil pH. Groundwater has been impacted, with NaOH concentrations above 1 percent in groundwater beneath the diked caustic area and northeast of the caustic area. It is possible that the elevated NaOH concentrations in groundwater are attributable to the February 21, 1993 spill and/or to handling losses over time associated with the caustic operations in the area. Olin has made several improvements to the caustic area operations to mitigate handling losses. This included replacement of the existing trench and sump collection system with a new trench and stainless-steel sump collection system

in 1991 and sealing of floor cracks and tank support foundations within the diked area in 1992.

Except for Olin's non-contact cooling water production wells, there is no groundwater use in the area. Therefore, there is no significant risk to human health due to direct use of groundwater. As described in the Interim Report, shallow (A-zone) groundwater flow in this area appears to flow toward, and eventually discharge to, the Buffalo Avenue Diversion Sewer. The amount of groundwater infiltration from the plant is likely to be very small compared to the flow in the sewer, precluding substantive impact of groundwater infiltration on the pH of the sewer water.

4.0
CONCLUSIONS AND RECOMMENDATIONS

The pumping from the two groundwater sumps during the past 10 months has apparently dewatered much of the area of concern. WCC recommends that the sumps continue to be pumped as groundwater accumulates. After one year of continued pumping, the sumps should be resampled for pH and percent NaOH and their continued use should be evaluated.

Tables

TABLE 3-1

GROUNDWATER LEVEL MEASUREMENTS FROM TEMPORARY MONITORING WELLS
OLIN BUFFALO AVENUE PLANT

Monitoring Well	Top of Riser Elevation (feet)[1]	Depth to Water (feet) from 8-31-93	Groundwater Elevation (feet)[1]
Temporary Wells:			
OCW-1	570.79	3.42	567.37
OCW-2	572.27	Dry (bottom at 568.80)[1]	--
OCW-3	572.42	Dry (bottom at 569.01)[1]	--
OCW-4	571.83	4.77	567.06
OCW-5	571.92	4.81	567.11
OCW-6	571.17	4.22	566.95
OCW-6BR	571.26	7.45	563.81

(1) Referenced to U.S. Coast and Geodetic Survey - 1943
-- No measurement

TABLE 3-2

SOIL pH MEASUREMENTS FROM SPLIT-SPOON SAMPLES COLLECTED DURING INSTALLATION OF TEMPORARY MONITORING WELL OCW-1 OLIN BUFFALO AVENUE PLANT

Depth Below Ground Surface (feet)	Soil pH[1]
0-2	9.93
2-4	10.07
4-6	11.01

(1) Analyzed using Method 9045 (Leachable pH)

TABLE 3-3

INITIAL pH AND NaOH MEASUREMENTS FROM
TEMPORARY MONITORING WELLS
OLIN BUFFALO AVENUE PLANT

Temporary Monitoring Well	Initial Sampling Date	pH	% NaOH
OCW-1	7/16/93	12.5	1.10
OCW-2	7/14/93	Dry	Dry
OCW-3	7/14/93	Dry	Dry
OCW-4	7/16/93	12.28	1.36
OCW-5	7/15/93	11.80	0.058
OCW-6	7/15/93	13.59	7.58

TABLE 3-4

FOLLOW-UP pH AND NaOH MEASUREMENTS
FROM TEMPORARY MONITORING WELLS
OLIN BUFFALO AVENUE PLANT

Temporary Monitoring Well	First Round Sampling Date	pH	% NaOH	Second Round Sampling Date	pH	% NaOH	Third Round Sampling Date	pH	% NaOH
OCW-1	7/28/93	11.61	0.33	8/31/93	10.40	0.13	--	--	--
OCW-2	7/16/93	Dry	Dry	7/27/93	Dry	Dry	8/31/93	Dry	Dry
OCW-3	7/16/93	Dry	Dry	7/27/93	Dry	Dry	8/31/93	Dry	Dry
OCW-4	7/27/93	12.41	0.96	8/31/93	12.50	0.72	--	--	--
OCW-5	7/16/93	11.50	0.058	7/28/93	11.44	0.045	8/31/93	11.49	0.05
OCW-6	7/16/93	12.69	6.89	7/28/93	12.64	5.76	8/31/93	12.66	5.29
OCW-6BR	8/17/93	12.85	4.79	8/31/93	12.48	4.98	--	--	--

-- Not sampled

TABLE 3-5

SUPPLEMENTAL pH AND NaOH MEASUREMENTS FROM RFI MONITORING WELLS OLIN BUFFALO AVENUE PLANT

RFI Monitoring Well	Sampling Date	pH	% NaOH
OBA-1A	8/31/93	7.38	0.01
OBA-1B	8/31/93	7.90	0.02
OBA-2A	8/31/93	Dry	Dry
OBA-2B	8/31/93	8.41	0.04
OBA-6A	8/31/93	9.26	0.09
OBA-6B	8/31/93	12.45	0.72
OBA-7A	8/31/93	8.66	0.02
OBA-7B	8/31/93	11.90	0.57

TABLE 3-6

PERCENT NaOH RESULTS FOR CAUSTIC AREA SUMP WATER SAMPLES OLIN BUFFALO AVENUE PLANT

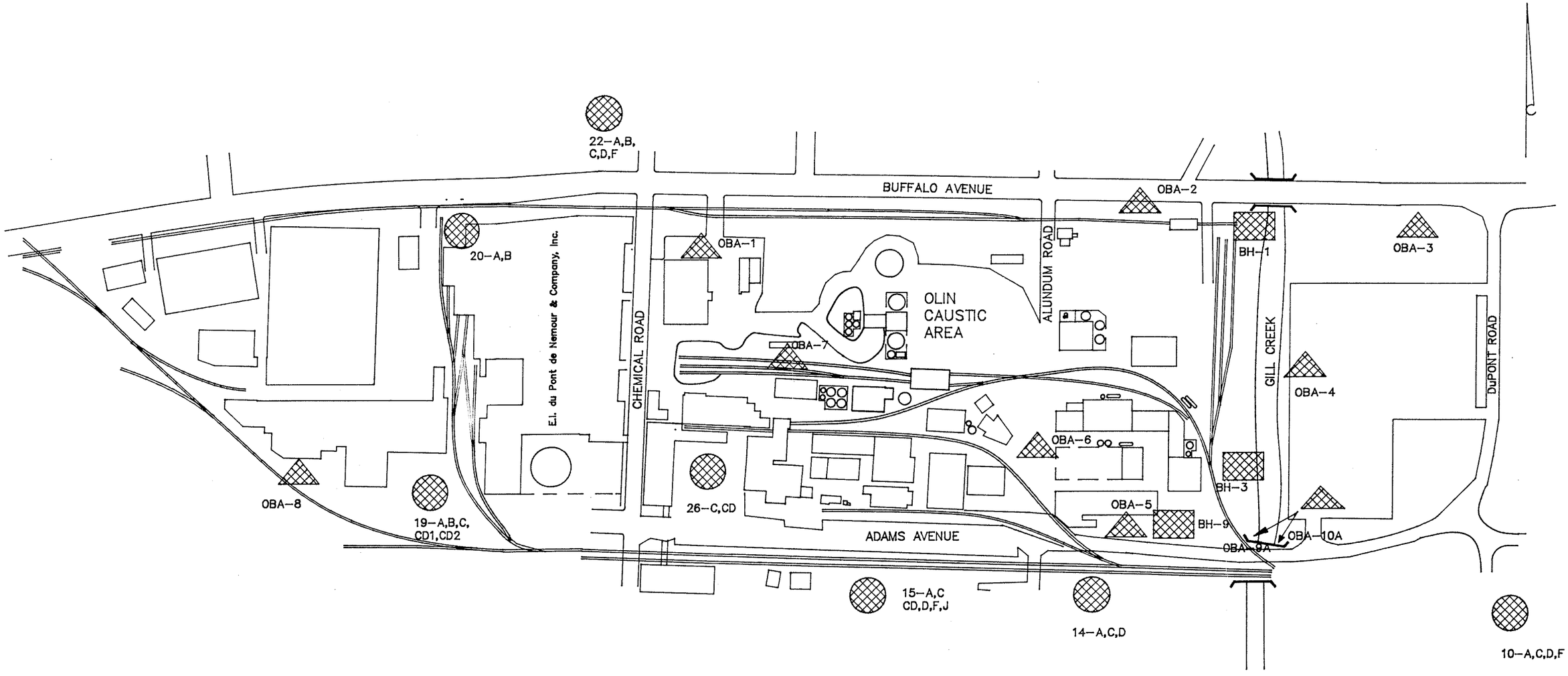
	NaOH Content (%)	
Sample Date	**South Sump**	**North Sump**
3/11/93	5.3	--
3/12/93	3.3	9.9
3/15/93	3.2	--
3/16/93	4.5	13.4
3/18/93	2.8	7.8
3/23/93	3.6	3.8
3/29/93	2.2	4.0
3/30/93	3.0	--
4/1/93	2.4	--
4/2/93	1.8	--
4/5/93	1.4	4.3
4/15/93	3.5	--
4/18/93	--	2.6
4/18/93	6.0	--

TABLE 3-6 (continued)

PERCENT NaOH RESULTS FOR CAUSTIC AREA SUMP WATER SAMPLES OLIN BUFFALO AVENUE PLANT

	NaOH Content (%)	
Sample Date	**South Sump**	**North Sump**
4/28/93	1.5	3.4
4/30/93	2.1	1.9
5/5/93	2.2	4.2
6/29/93	2.7	--
7/16/93	3.8	--
8/24/93	3.29	3.25
8/25/93	3.60	4.43
8/31/93	5.99	9.27
9/8/93	3.1	7.59
9/23/93	4.95	8.85
10/5/93	1.26	5.41

Figures



LEGEND

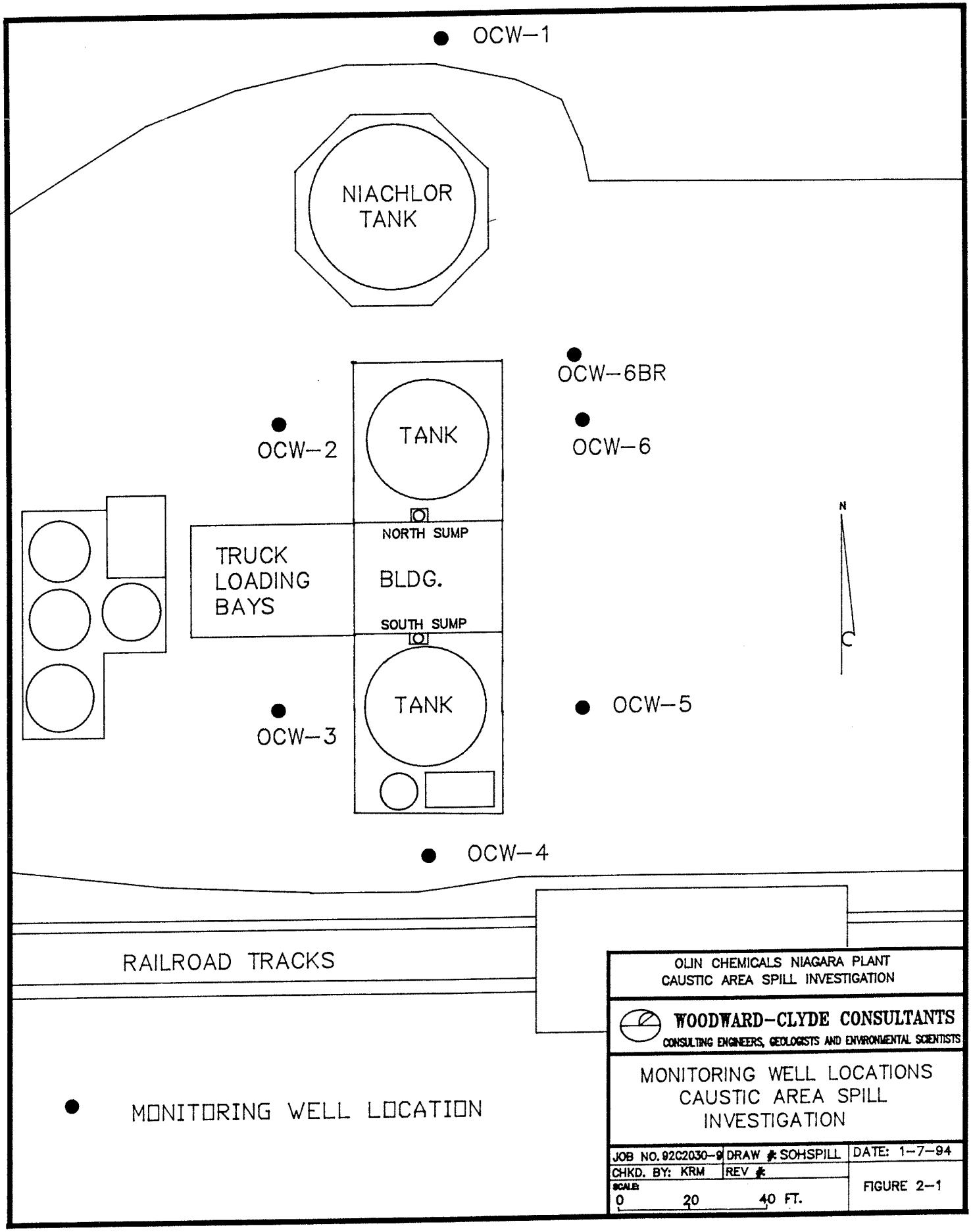
- EXISTING HARZA MONITORING WELLS
- OLIN MONITORING WELL LOCATIONS
- DUPONT MONITORING WELLS

OLIN CHEMICALS NIAGARA PLANT
RCRA FACILITY INVESTIGATION

WOODWARD–CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

SITE PLAN SHOWING LOCATION OF
CAUSTIC AREA AND MONITORING WELLS

Job No.: 88C2346–12	Drawing No.	Date: 1–8–94
Checked by:	Rev. No.:	FIGURE 1–1
Scale: 0 — 200 Feet		

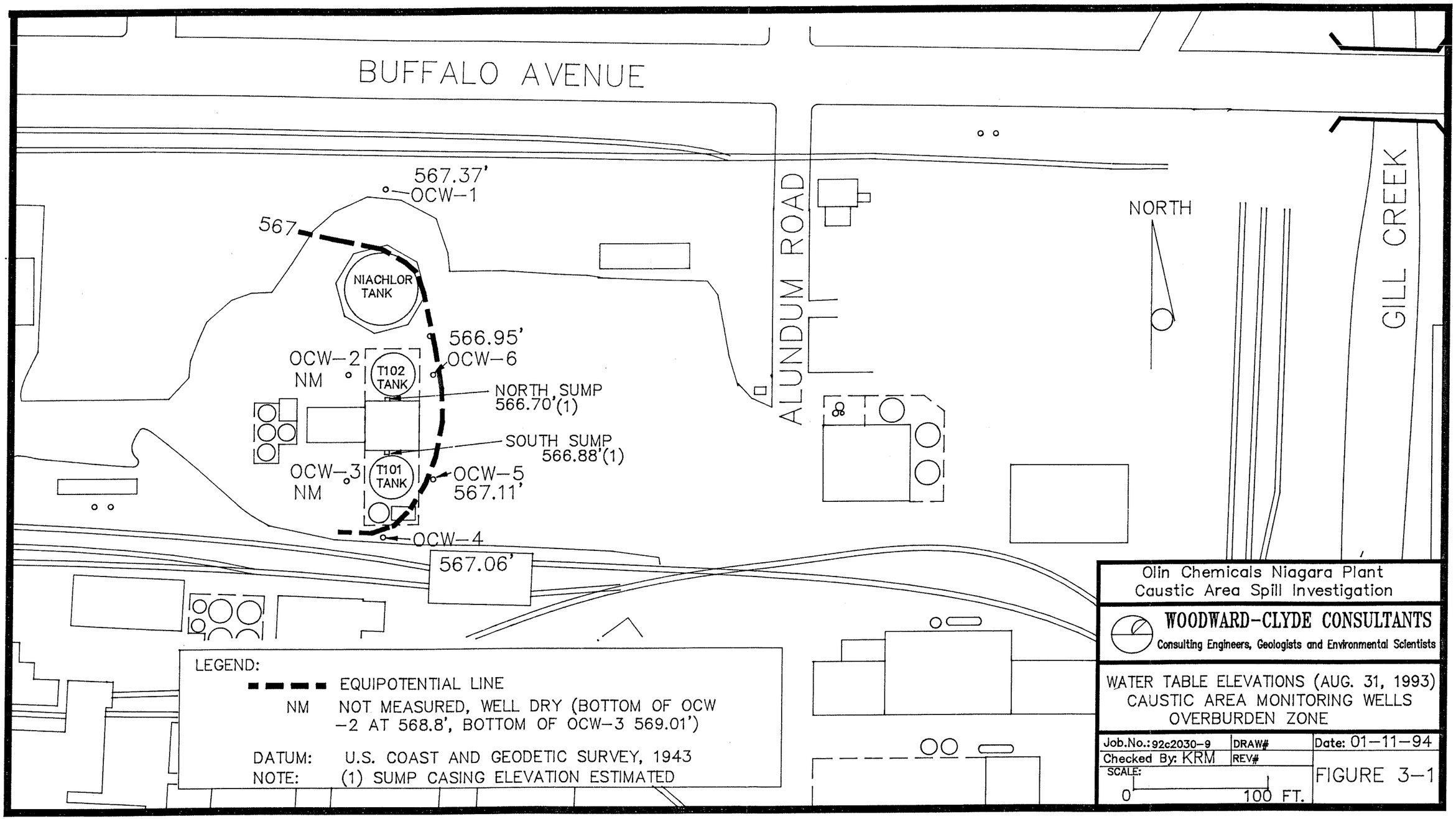


OLIN CHEMICALS NIAGARA PLANT
CAUSTIC AREA SPILL INVESTIGATION

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

MONITORING WELL LOCATIONS
CAUSTIC AREA SPILL
INVESTIGATION

JOB NO. 92C2030-9	DRAW # SOHSPILL	DATE: 1-7-94
CHKD. BY: KRM	REV #	FIGURE 2-1
SCALE: 0 20 40 FT.		



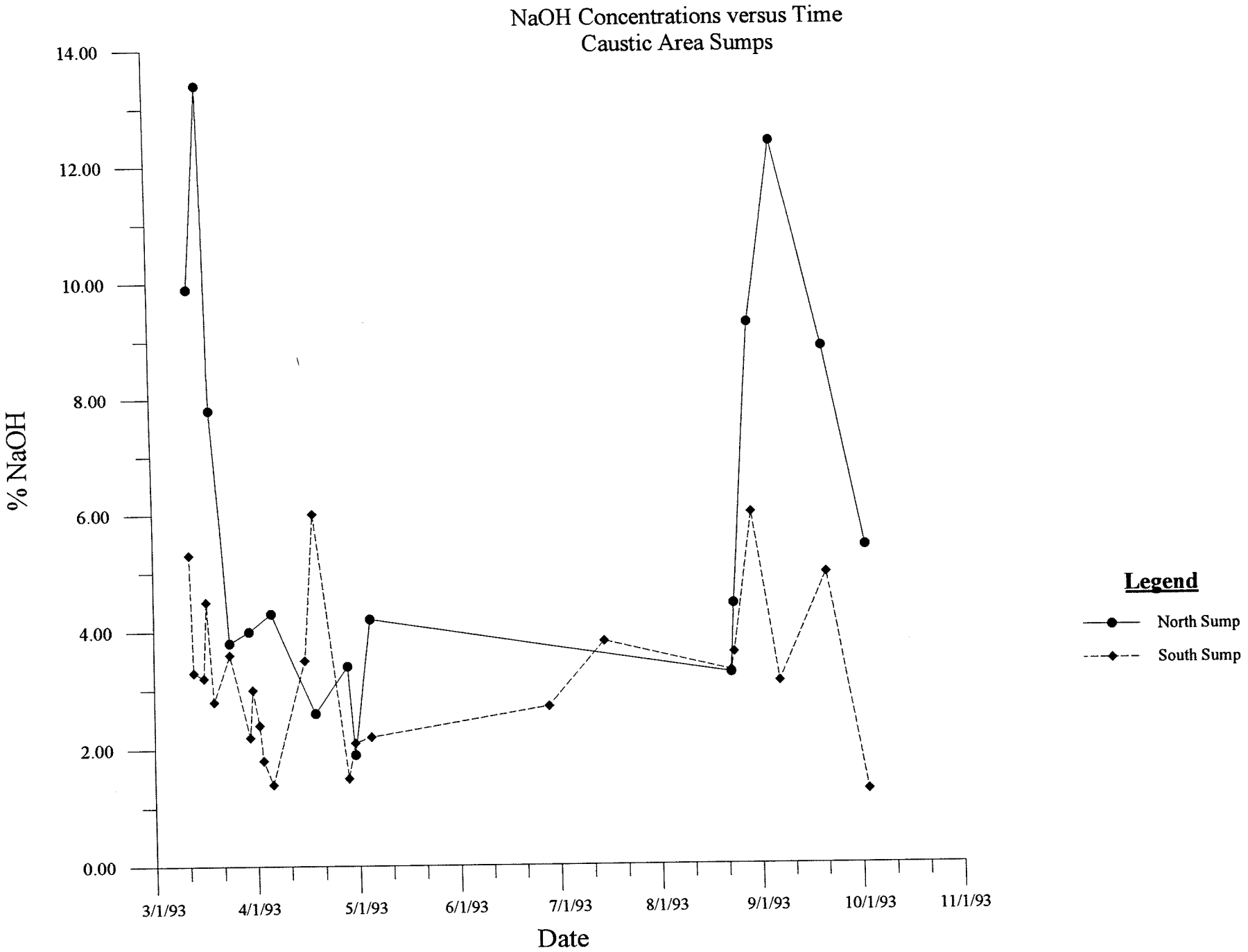
Olin Chemicals Niagara Plant
Caustic Area Spill Investigation

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

WATER TABLE ELEVATIONS (AUG. 31, 1993)
CAUSTIC AREA MONITORING WELLS
OVERBURDEN ZONE

Job.No.: 92c2030-9	DRAW#	Date: 01-11-94
Checked By: KRM	REV#	
SCALE: 0 100 FT.		FIGURE 3-1

FIGURE 3-2


NaOH Concentrations versus Time
Caustic Area Sumps
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
% NaOH
3/1/93
4/1/93
5/1/93
6/1/93
7/1/93
8/1/93
9/1/93
10/1/93
11/1/93
Date
Legend
North Sump
South Sump

BUFFALO AVENUE

ADAMS AVENUE

CHEMICAL ROAD

ALUNDUM ROAD

GILL CREEK

DuPONT ROAD

NORTH

WELL	pH	% NaOH
OCW-1	10.40	0.13%

WELL	pH	% NaOH
OCW-2	DRY	DRY

WELL	pH	% NaOH
OCW-3	DRY	DRY

WELL	pH	% NaOH
OCW-4	12.50	0.72%

WELL	pH	% NaOH
OCW-5	11.49	0.05%

WELL	pH	% NaOH
OCW-6	12.66	5.29%

WELL	pH	% NaOH
OCW-6BR	12.48	4.98%

WELL	pH	% NaOH
OBA-1A	7.38	0.01%
OBA-1B	7.90	0.02%

WELL	pH	% NaOH
OBA-2A	DRY	DRY
OBA-2B	8.41	0.04%

WELL	pH	% NaOH
OBA-6A	9.26	0.09%
OBA-6B	12.45	0.72%

WELL	pH	% NaOH
OBA-7A	8.66	0.02%
OBA-7B	11.90	0.57%

NORTH SUMP	pH	% NaOH
	12.65	9.27%

SOUTH SUMP	pH	% NaOH
	12.55	5.99%

NIACHLOR TANK

T102 TANK

T101 TANK

Olin Chemicals Niagara Plant
Caustic Area Spill Investigation

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists

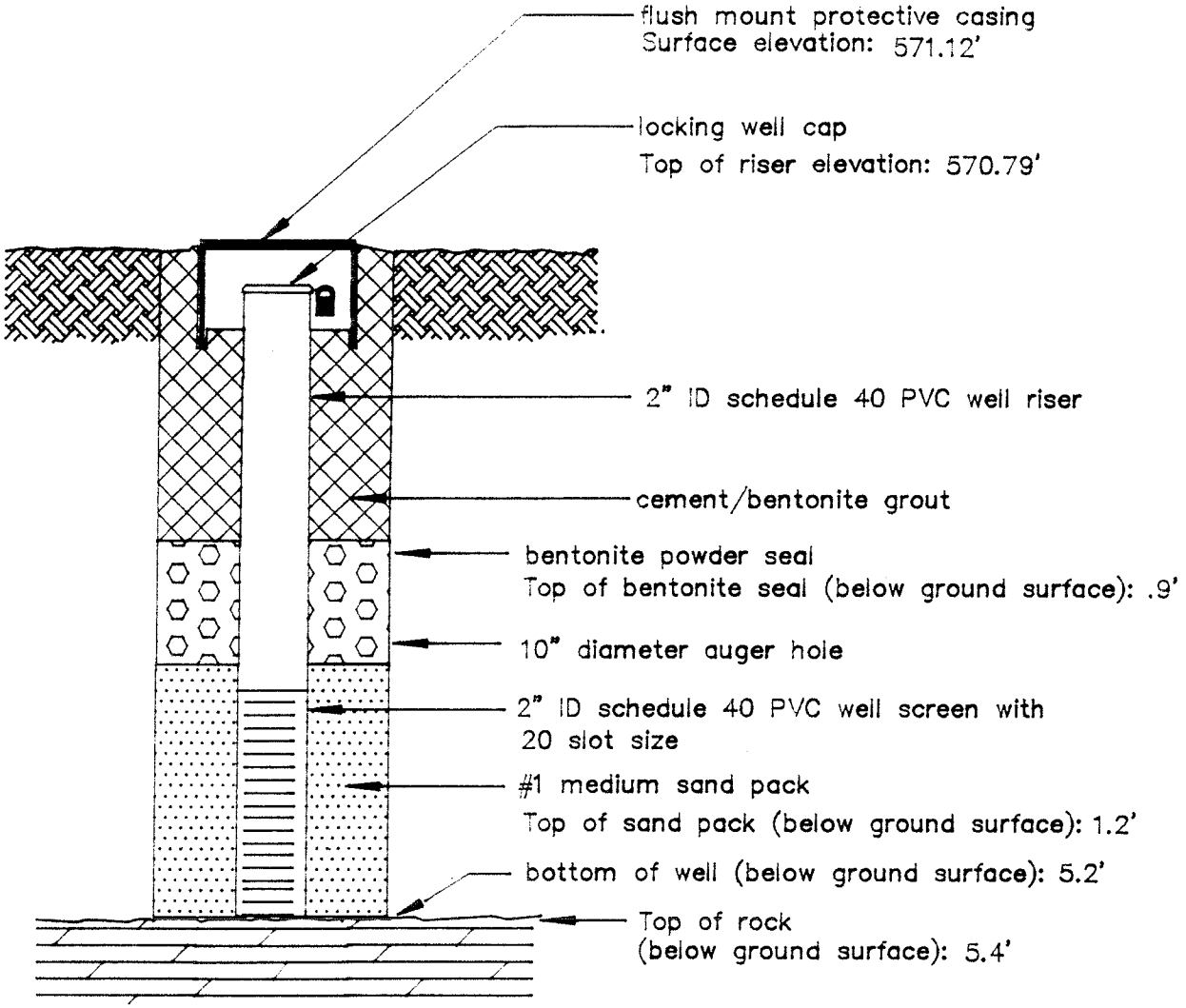
pH AND PERCENT NaOH MEASUREMENTS FOR CAUSTIC AREA MONITORING WELLS (AUGUST 31, 1993)

Job.No.: 92c2030-9	DRAW#	Date: 10-1-93
Checked By: KRM	REV#	
SCALE: 0 200 Feet		FIGURE 3-3

Appendix A

Olin Chemicals
Olin Caustic Area Wells

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OCW-1

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92C2030-9	DATE: 10-4-93	FIGURE NO:

Olin Chemicals
Olin Caustic Area Wells

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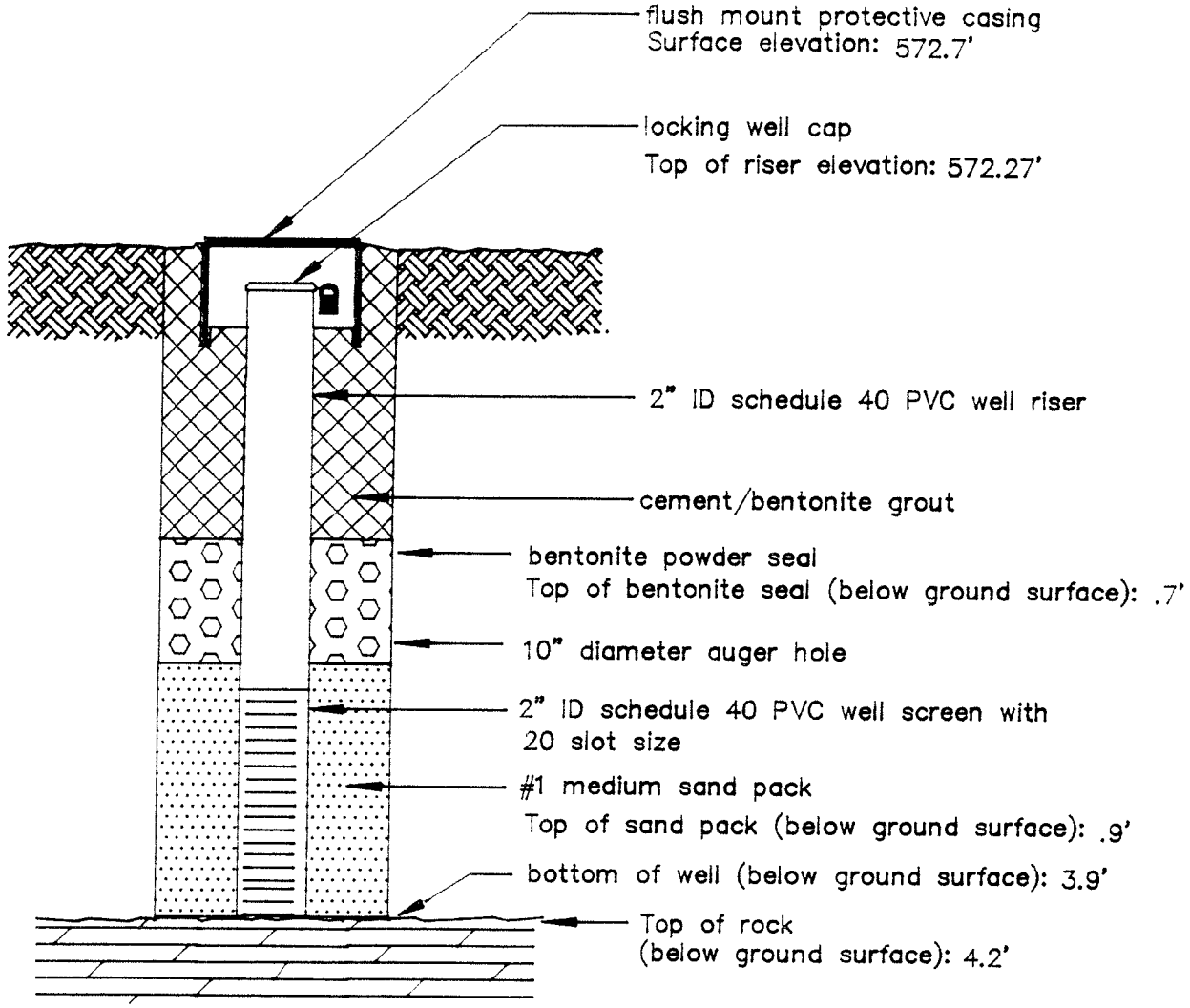

OCW-2

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92C2030-9	DATE: 10-4-93	FIGURE NO:

Olin Chemicals
Olin Caustic Area Wells

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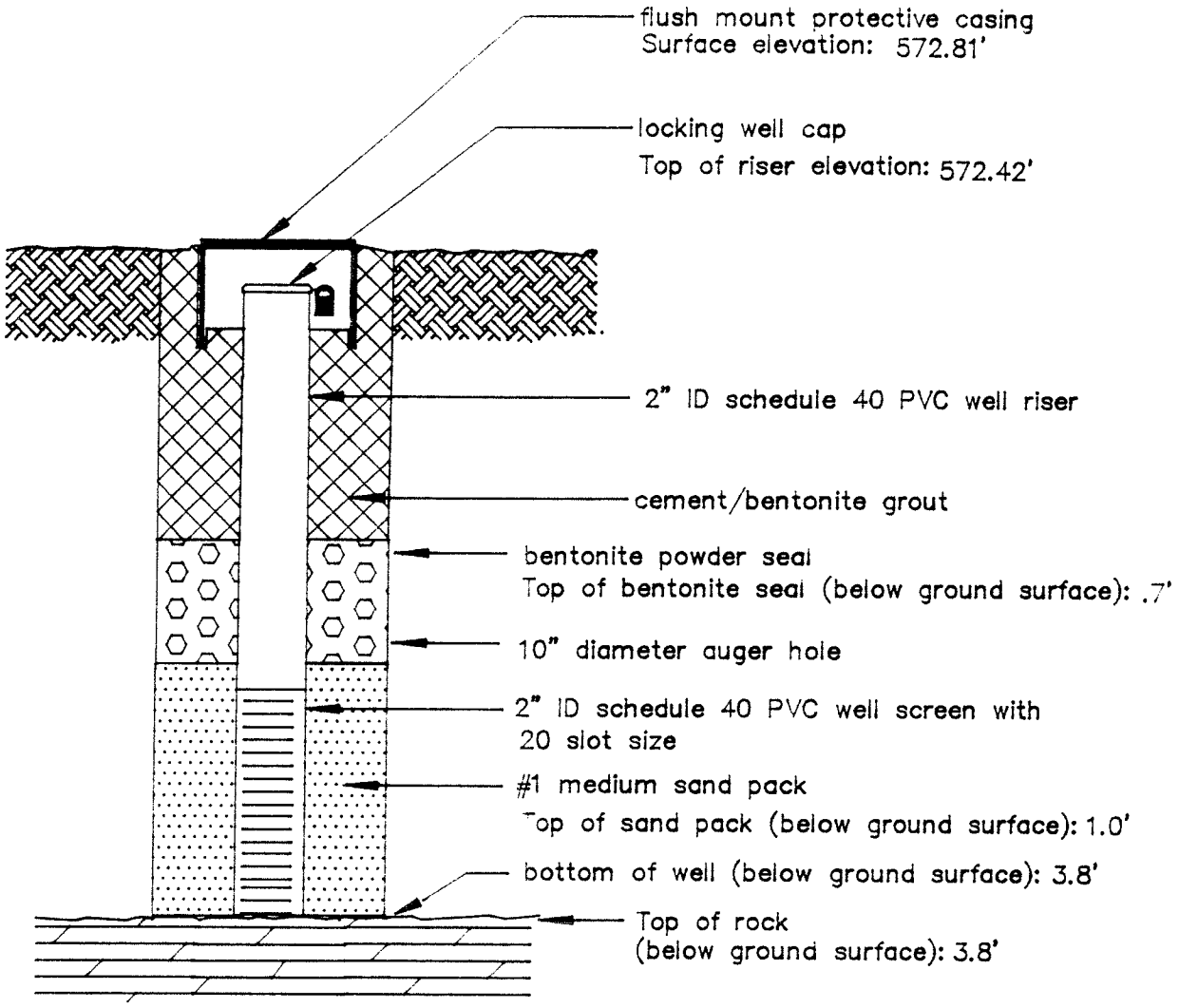

OCW-3

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92C2030-9	DATE: 10-4-93	FIGURE NO:

Olin Chemicals
Olin Caustic Area Wells

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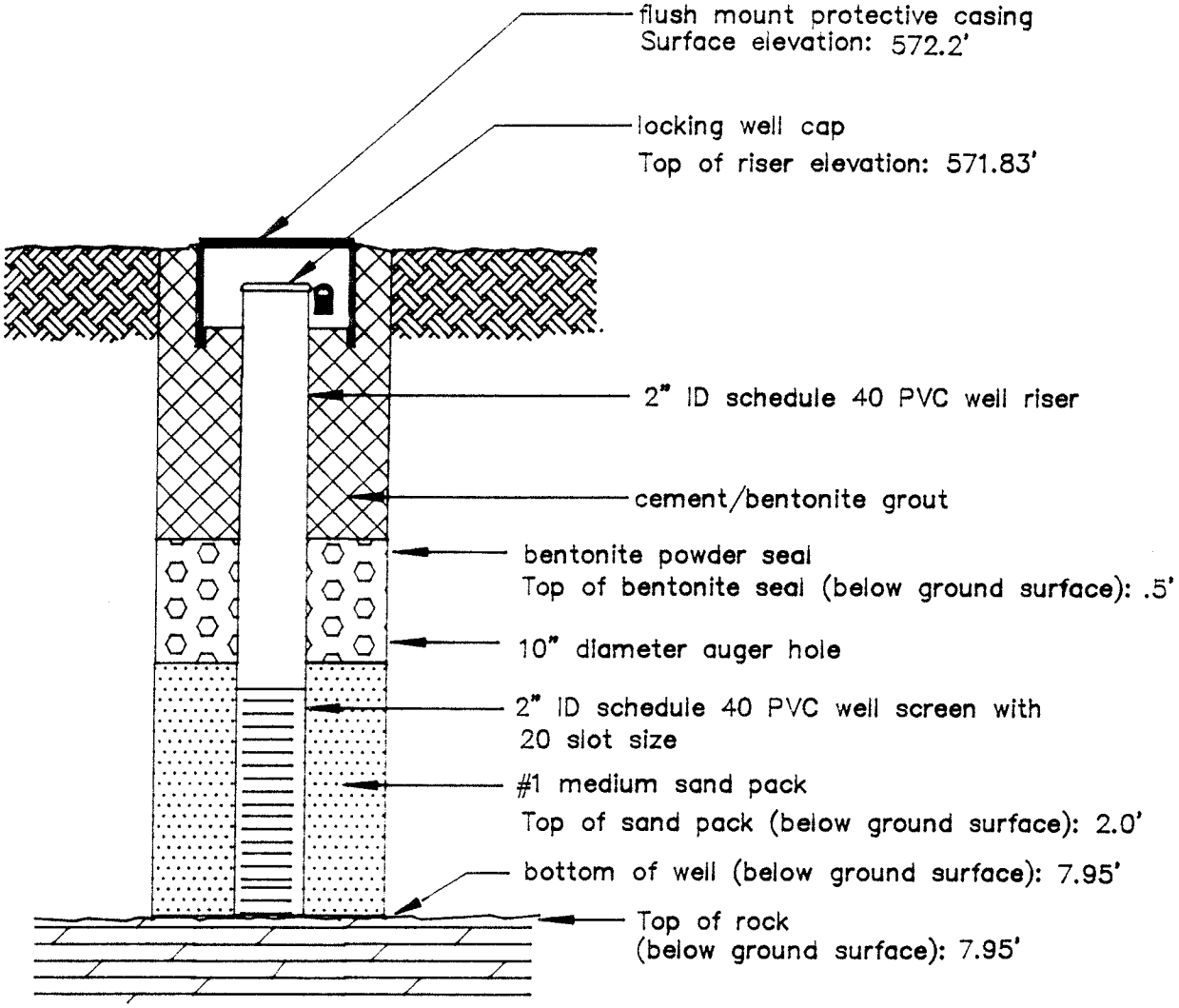

OCW-4

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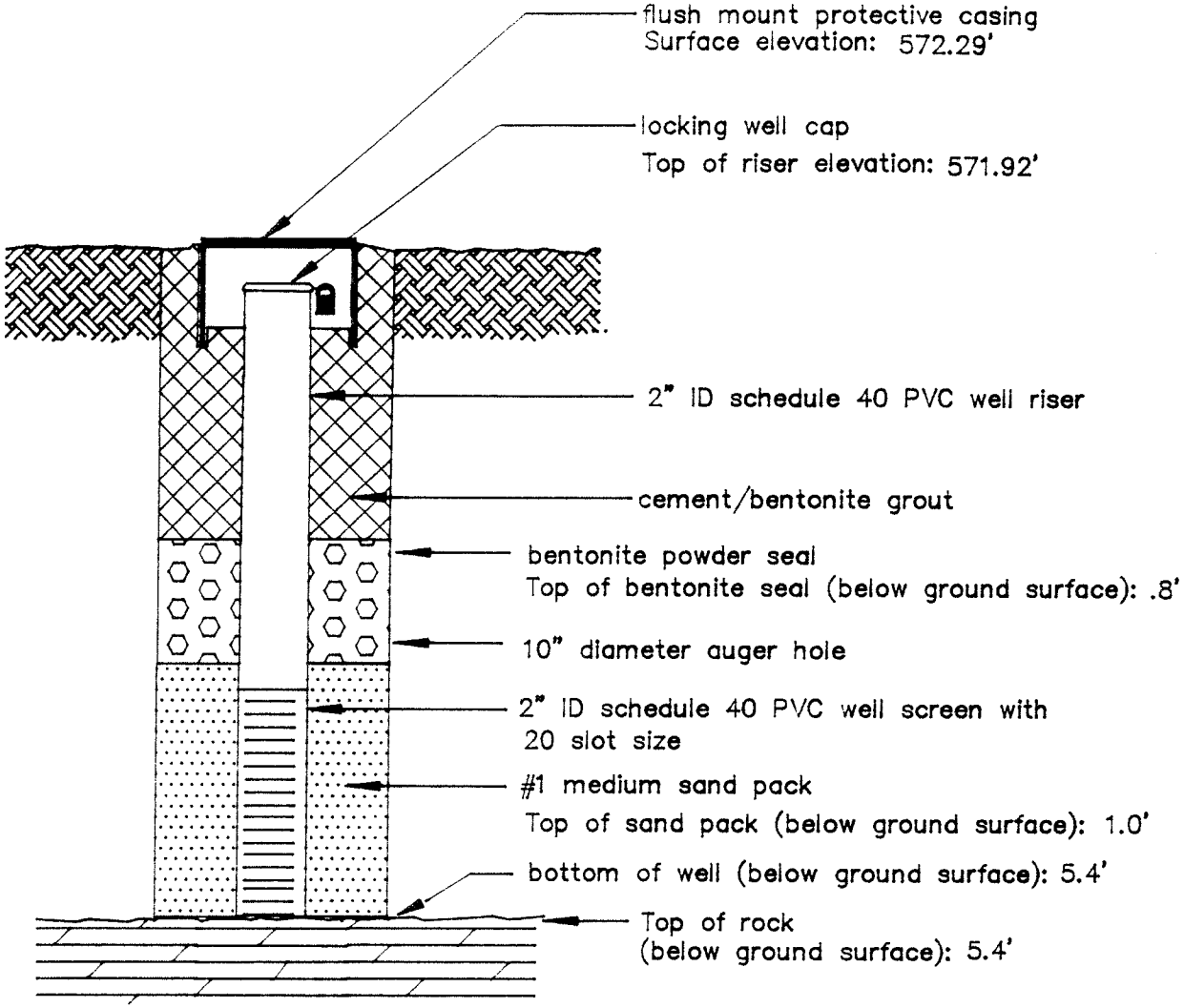
Olin Chemicals
Olin Caustic Area Wells

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists



OCW-5

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92C2030-9	DATE: 10-4-93	FIGURE NO:

Olin Chemicals
Olin Caustic Area Wells

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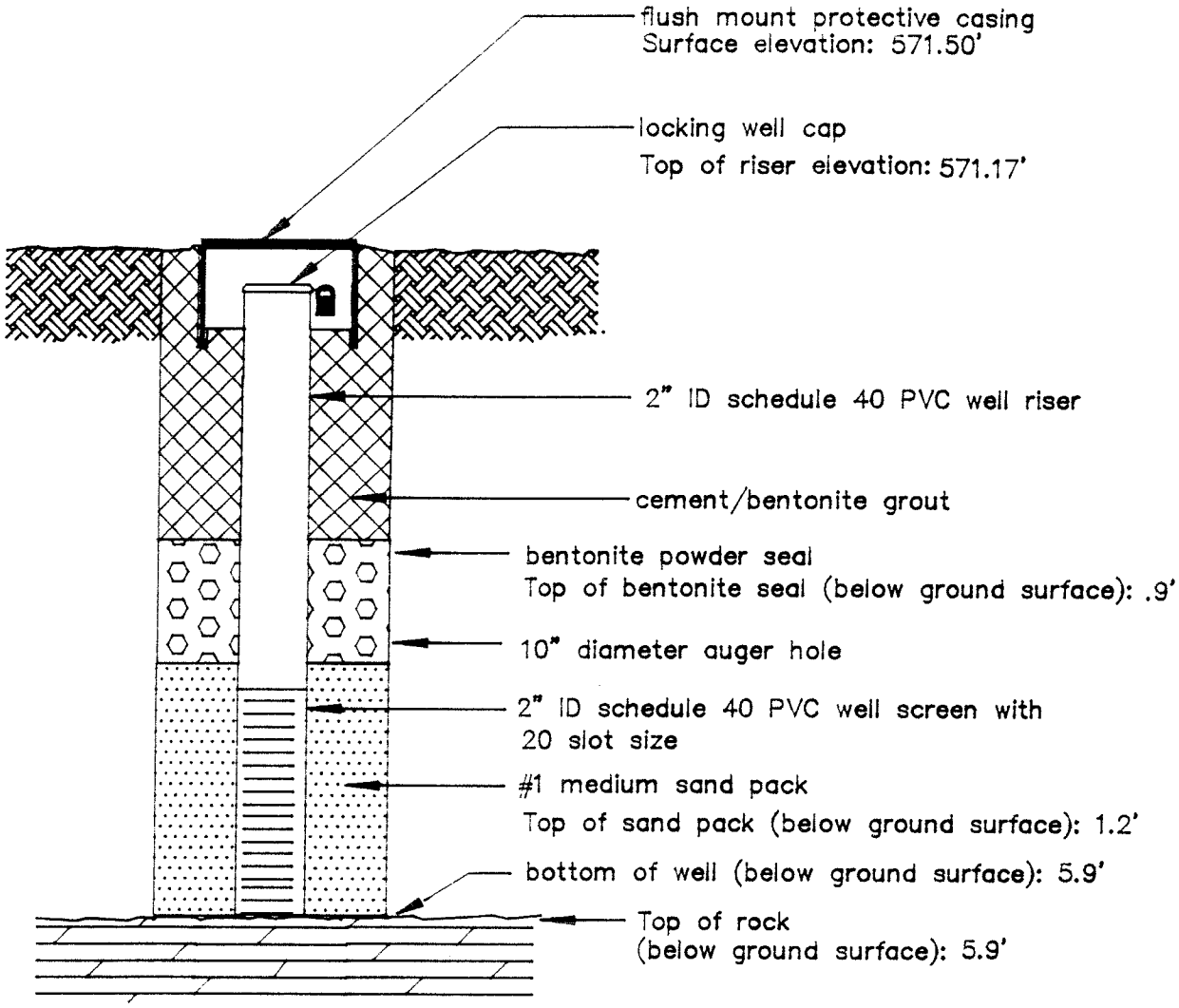

OCW–6

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92C2030–9	DATE: 10–4–93	FIGURE NO:

Olin Chemicals
Olin Caustic Area Wells

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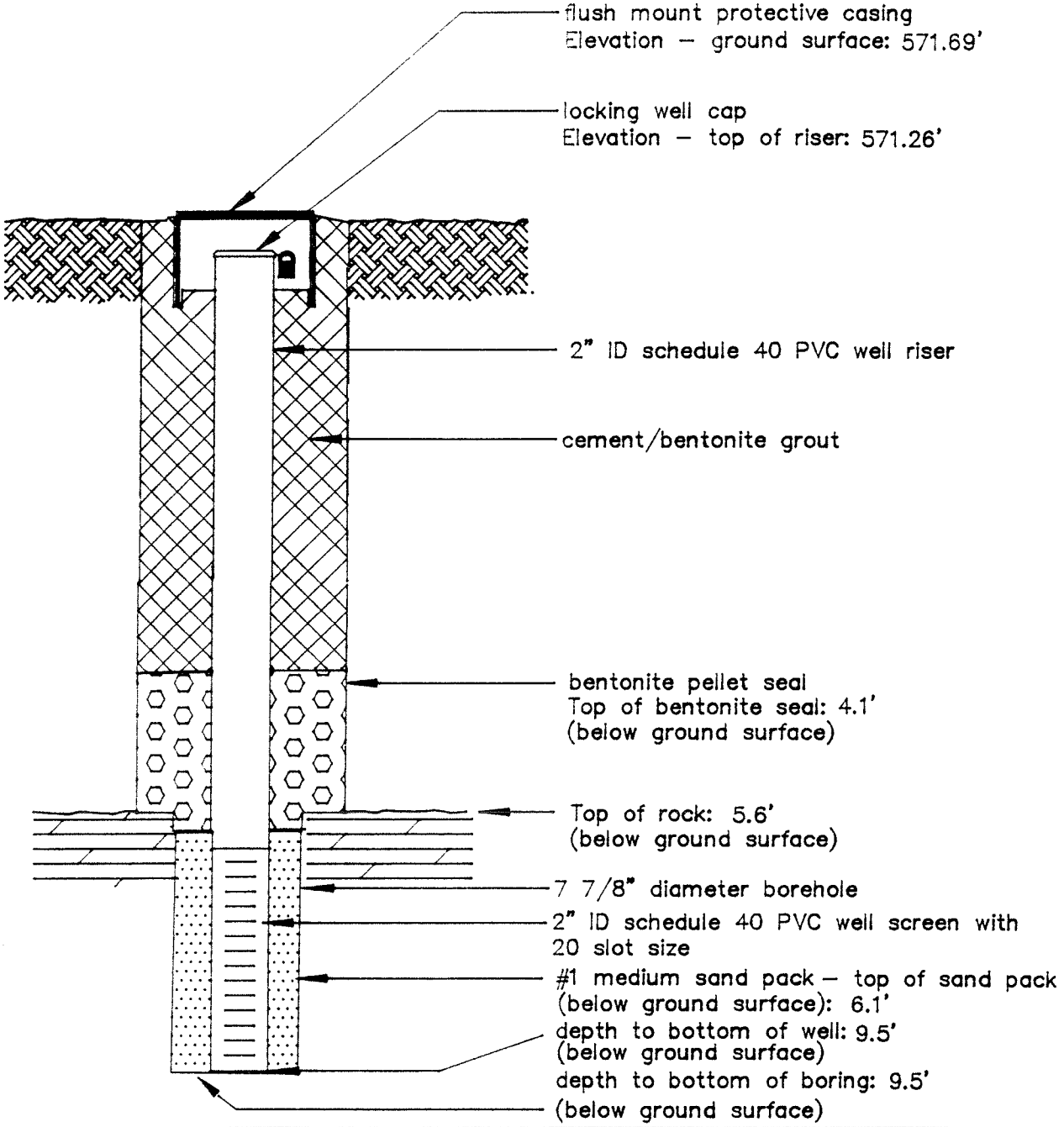
Consulting Engineers, Geologists and Environmental Scientists



OCW-6BR

DRAWN BY: FRG	CHECKED BY: KRM	PROJECT NUMBER: 92c2030-9	DATE: 10-5-93	FIGURE NO:

Appendix B

LOG of BORING No. OCW-1

Sheet 1 of 1

DATE 7/15/93 SURFACE ELEVATION 571.1 LOCATION

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Shot rock and pieces of sandstone rubble; no split-spoon sample collected from 0 to 2 feet.			
					569.1		
2		22	SS	Dense to very dense, rock fragments and medium to large gravel in a light brown to dark brown clay and silt matrix.	568.8		
					568.5		
				Dense to very dense, light tan to brown medium to coarse sand and fine gravel. Dry.			
4		14	SS	Firm to stiff, dark brown silty clay with little gravel. Moist to very moist.	567.1	12	11.03
				Firm to stiff, tan-brown clay and silt, some gravel. Dry.			
					565.9		
				Bedrock	565.7		
6							
8							
10							
12							
14							
16							

Completion Depth: 5.4 Ft. Water Depth: 4.5 ft., After ____ hrs.

Project No.: 92C2030-9 ____ ft., After ____ hrs.

Project Name: Olin Caustic Area Wells ____ ft., After ____ hrs.

Drilling Method: 6 1/4" ID HSA ____ ft., After ____ hrs.

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LOG of BORING No. OCW-2

Sheet 1 of 1

DATE 7/13/93 SURFACE ELEVATION 572.7 LOCATION

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Asphalt pavement to .3'.	572.4		
				Shot rock with brown silt. Dry; no split-spoon sample collected 0 to 2 feet.			
2		32	SS				
					569.6		
				Firm/dense, black silt and wood fragments, some small red brick pieces. Moist. Burnt odor.	569.3	8	9.6
					569.0	7	8.95
4		100/.3'	SS	Dense to very dense, gravel with brown silt and red brick pieces. Moist to dry. Burnt odor.	568.4		
				Fresh rock chips in split-spoon; refusal on bedrock.			
6							
8							
10				Note: 1) Boring dry at completion.			
12							
14							
16							

Completion Depth: 4.3 Ft.
Project No.: 92C2030-9
Project Name: Olin Caustic Area Wells
Drilling Method: 6 1/4" ID HSA

Water Depth: ____ft., After ____hrs.
____ft., After ____hrs.
____ft., After ____hrs.
____ft., After ____hrs.

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LOG of BORING No. OCW-3

Sheet 1 of 1

DATE 7/13/93 SURFACE ELEVATION 572.8 LOCATION

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Asphalt pavement to .3'	572.5		
				Shot rock with brown silt. Dry; no split-spoon sample collected 0 to 2 feet.			
2		40	SS				
					569.6	8 to 9	9.75
				Stiff/very dense, black-brown silt with red brick pieces, little black flyash, trace yellow silt. Slightly moist.	569.3		
					569.0	11	11.52
4				Very dense, brown silt and rock fragments with little clay. Slightly moist.	568.8		
				Bedrock			
6							
8							
10				Note: 1) Refusal of split-spoon sampler at depth 3.9 feet, hollow-stem auger refusal at depth 4.0 feet. 2) Boring dry at completion.			
12							
14							
16							

Completion Depth: 4.0 Ft.
Project No.: 92C2030-9
Project Name: Olin Caustic Area Wells
Drilling Method: 6 1/4" ID HSA

Water Depth: ____ft., After ____hrs.
____ft., After ____hrs.
____ft., After ____hrs.
____ft., After ____hrs.

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LOG of BORING No. OCW-4

Sheet 1 of 1

DATE 7/16/93 SURFACE ELEVATION 572.2 LOCATION

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Asphalt pavement to .4'	571.8		
				Shot rock and brown silt; no split-spoon sample collected 0 to 2 feet.			
2		14	SS				
				As above, medium dense to very dense, shot rock and silt fill, some red brick fragments		7.5	8.45
4		59	SS	-becoming more silty -becoming moist -becoming wet		11	11.68
6		18	SS	-red brick fragments becoming more numerous	565.6	12	12.63
				Medium dense to dense, black fine grained silty material (possibly flyash) with little clay and tan mottling of medium to coarse sand. Very moist.	565.1	12	12.79
8		100/.4'	SS	Medium dense, coarse to fine gravel and sand-sized fragments of weathered, red brick. Wet -becoming very dense with fresh rock fragments	563.9		
				Bedrock	563.7		
10							
12				Note: 1) Refusal of split-spoon sampler at 8.4 feet, advance hollow-stem augers to 8.5 feet.			
14							
16							

Completion Depth: 8.5 Ft.
Project No.: 92C2030-9
Project Name: Olin Caustic Area Wells
Drilling Method: 6 1/4" ID HSA

Water Depth: 7.75 ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

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LOG of BORING No. OCW-5

Sheet 1 of 1

DATE 7/14/93 SURFACE ELEVATION 572.3 LOCATION

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Asphalt pavement to .3'	572.0		
		31	SS	Shot rock with brown-black silt; no split-spoon sample collected 0 to 1 foot.		7.5	9.05
2				-increasing clay content	570.0		
				Medium dense to dense, light brown to tan, fine, uniform sand, slightly moist.	569.4	7.5	8.93
		17	SS	Dense, brown-black silt and fine sand, some gravel. Dry.	569.2	7.5	8.75
4				Medium dense to dense, light brown to tan, fine uniform sand. Moist.	568.5	10.5	10.12
				-becoming very wet			
		100/.4	SS	Dense, brown to tan fine sand with red brick fragments and gravel. Wet.	567.3	12.5	11.88
6				Very dense, rock chips and fragments in matrix of wet silt and fine sand (Weathered bedrock)	566.8		
				Fresh rock chips (Bedrock).	566.6		
8							
10				Note: 1) Refusal of split-spoon sampler at depth 5.4 feet, advance hollow-stem augers to refusal at 5.7 feet.			
12							
14							
16							

Completion Depth: 5.7 Ft. Water Depth: 3.7 ft., After ____ hrs.

Project No.: 92C2030-9 ____ ft., After ____ hrs.

Project Name: Olin Caustic Area Wells ____ ft., After ____ hrs.

Drilling Method: 6 1/4" ID HSA ____ ft., After ____ hrs.

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LOG of BORING No. OCW-6

Sheet 1 of 1

DATE 7/14/93 SURFACE ELEVATION 571.5 LOCATION _____

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	pH PAPER	pH METER
0				Asphalt pavement to .3'	571.2		
		48	SS	Shot rock and rock fragments with brown to black silt; no split-spoon sample collected 0 to 1 foot. As above, dense to very dense shot rock and silt fill -becoming moist to wet			
2						10.5	10.32
		24	SS	Loose to dense, light brown silt and rock fragments (weathered bedrock). Dry to slightly moist.	568.5		
4						12	12.35
		100/.4'	SS	-rock fragments in brown clay matrix. Wet.	565.7	13.5	14.05
6				Bedrock	565.5		
8							
10				Note: 1) Hollow-stem auger refusal on obstruction at depth 1.8 feet, offset 2 feet northwest and auger to depth 3.0 feet to continue the boring. 2) Refusal of split-spoon sampler at depth 5.9 feet, refusal of hollow-stem augers at depth 6.0 feet.			
12							
14							
16							

Completion Depth: 6.0 Ft.
Project No.: 92C2030-9
Project Name: Olin Caustic Area Wells
Drilling Method: 6 1/4" ID HSA

Water Depth: 5.45 ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

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