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REPORTS

DATE:

Aug. 1990

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STATUS REPORT
REMEDIATION WORK AND ROUND 4 LONG-TERM GROUND WATER QUALITY MONITORING DATA RESULTS FOR MAVERIK REFINERY TANK FARM KIRTLAND, NEW MEXICO FOR MAVERIK COUNTRY STORES, INC.

Dames & Moore

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FOR MAVERIK REFINERY AND TANK FARM
KIRTLAND, NEW MEXICO
FOR MAVERIK COUNTRY STORES, INC.

INTRODUCTION

This status report summarizes the remediation work completed to date at the Maverik Refinery and Tank Farm in Kirtland, New Mexico. A general site vicinity map and location map which show the areas where remediation work has been conducted and the long-term ground water quality monitoring well sites are included on Plates 1 and 2, respectively. Rounds 1, 2, 3 and 4 long-term ground water quality monitoring data results are included herein.

Comprehensive ground water quality analytical data from the early baseline sampling program (Rounds 1, 2 and 3) for the monitor wells included in the long-term ground water quality monitoring program (monitor wells MW-9, MW-10 and MW-13) are also included herein. More detailed ground water quality data and contaminant evaluations are presented in previous Dames & Moore reports completed in 1988 and 1989 as referenced.

PURPOSE AND SCOPE

The work completed in May 1990 through July 1990 and presented in this report was conducted in accordance with the "Modified Ground Water Remediation Plan for the Maverik Refinery Study Area, Kirtland New Mexico" (June 1990) and amendments as per the July 18, 1990 letter to the OCD (Appendix C). As a result of subsequent discussions with both the OCD and the federal EPA in both Washington, D.C. and in Dallas, Texas, the July 18, 1990 Remediation Plan may be modified again to include a component 7, if in-situ ground water remediation is not subject to the new EPA-Toxicity Characteristic Rule effective September 25, 1990. One additional new monitor well will be completed, for a total of 7 rather than only 6 wells (Plate 2).

The work conducted to date, including this status report, completes components 1, 3, 4 and 5 of components 1 through 6 of the Ground Water Stabilization Plan. Components 2 and 6 are scheduled to be completed in 1990. Specifically, the work conducted since the March 1990 status report included the following:

- Round 4 long-term ground water quality sampling, laboratory analysis and data evaluation completion.
- North-south interceptor trench abandonment. On-site and imported fill material were used.
- On-site monitor and test wells (MW-11, MW-12, the test well and the north and east observation wells) abandonment via grouting to prevent well destruction and potential subsurface contamination during slurry wall construction.
- Slurry wall completion.
- Completion and submittal of this written report to the OCD in partial fulfillment of the monitoring requirements as defined in the Ground Water Remediation Plan.

REMEDIATION WORK

ON-SITE MONITOR WELL GROUTING

In order to prevent potential subsurface contamination of on-site monitor and test wells by the heavy equipment and slurry used in the slurry wall construction, five wells (MW-11, MW-12, the test well, northern and eastern observation wells) were pressure grouted prior to slurry wall construction using a neat cement-bentonite grout. Steel surface casings were removed and PVC well casings were cut off at ground surface.

INTERCEPTOR TRENCH ABANDONMENT

The north-south interceptor trench which was constructed in 1988 to collect free product from the surface of the water table, was backfilled just prior to slurry wall construction. The slurry wall which extended just west of the north-south interceptor trench, could not be constructed until the trench was properly back-filled and compacted. No free product was observed in the trench at the time it was backfilled.

SLURRY WALL COMPLETION

The slurry wall construction details are presented in Appendix B. The bentonite slurry wall was designed to isolate and control potential off-site contaminant migration from the contaminated areas on-site. The wall encompasses the southwestern corner of the tank farm where the historic leaded gasoline spill occurred, and it extends to depths ranging from about 12 to 25 feet, penetrating through the upper silty clayey sand zone, keying into the underlying clay.

ON-SITE SOIL VENTING

As part of the "Remediation/Stabilization Plan," and during contaminated soil excavation (to be conducted in August and September 1990), the unsaturated soils located within the slurry wall will be vented using a backhoe.

SOIL/SLUDGE EXCAVATION AND REMOVAL

Contaminated sludge and soil located on-site at the 4 designated locations at the tank farm are scheduled to be excavated and disposed of to the Thriftway Refinery Disposal and to CSI (see Appendix C, Figure 1). Approximately 1 to 3 feet of material will be excavated from each of the 4 sites. Sludge and the immediate underlying soils from the eastern sludge pit will be disposed of at CSI. Headspace analysis will be performed in the field on the remaining materials and will be documented by Dames & Moore. Additional samples for laboratory analysis of benzene, toluene, ethylbenzene and xylene will also be conducted on representative samples of materials remaining at each of the four sites. Additional off-site subsurface soil samples will be obtained in the area south of the refinery, where organic vapors have previously been detected. A composite sample will be analyzed in the laboratory by TCLP. Field HNU or OVA measurements will be taken and documented by Dames & Moore prior to any off-site soil excavation.

NEW MONITOR WELL CONSTRUCTION

Seven new shallow (10 to 25 feet deep) monitor wells will be completed in September 1990, on-site at locations that are upgradient, downgradient and inside of the slurry wall (Plate 2). Six wells were originally proposed (Appendix C), however, the OCD (Bill Olson) requested an additional monitor well be completed to the north just west of the slurry wall. These wells will be used to monitor ground water conditions both inside and outside the slurry wall. The three monitor wells to the north, east and west of the slurry wall will monitor subsurface conditions around the northern perimeter of the slurry wall. The two wells located about 75 feet from the southeast and southwest corners of the slurry wall and existing well MW-10 will serve as early warning monitor points for monitoring potential contaminant movement around the slurry wall and downgradient to the south. The two monitor wells located inside of the slurry wall will serve as replacement monitor wells for those grouted and will monitor ground water quality changes within the slurry wall. All of these wells will be sampled on a semi-annual basis along with the 4 off-site and 1 on-site monitor well(s) currently monitored as part of the long-term monitoring plan.

LONG-TERM GROUND WATER QUALITY MONITORING, ROUND 4

The long-term ground water quality monitoring program agreed to by the EID was implemented in April 1989 with the completion of Round 1 sampling and analyses. The plan requires tri-annual, bi-annual and annual monitoring of one on-site and four off-site monitor wells over a three-year period, respectively. Monitoring includes water level measurements and laboratory analysis for volatile organics (aromatic and halogenated), total dissolved solids, sulfate and chloride (Table 1). The field and laboratory water quality data for these selected monitor wells for Rounds 1, 2 and 3 long-term remediation monitoring and, as previously mentioned, comprehensive data from prior sampling Rounds 1, 2 and 3 for wells MW-9, MW-10 and MW-13 are presented in Appendix A. As presented and discussed herein, although there are wide variations in the concentrations of the inorganic constituents, the number and concentration of organic constituents detected are small and remain at or continue to decrease to near detection limits.

INORGANIC CONSTITUENTS

The laboratory results for Rounds 1, 2, 3 and 4 long-term ground water quality monitoring for the inorganic constituents are summarized in Table 2. These include data for total dissolved solids (TDS), sulfate (SO_4) and chloride (Cl). To account for seasonal fluctuations, the data from Round 4 should be compared to the April 1989 Round 1 long-term water quality monitoring data.

The TDS, SO_4 and Cl concentrations in MW-10 (on-site in the southern part of the refinery tank farm) and MW-9 (off-site and southwest of the tank farm) have decreased since April 1989. The May 1990 concentrations for TDS, SO_4 and Cl at MW-10 were 1,300, 577 and 72 mg/l, respectively, as compared to the April 1989 concentrations of these constituents of 2,310, 1,190 and 146 mg/l, respectively. Similarly, the May 1990 concentrations for TDS, SO_4 and Cl at MW-9 were 1,190, 574 and 35 mg/l, as compared to the April 1989 concentrations of 1,420, 727 and 39 mg/l, respectively.

The water quality off-site at MW-13 shows little change compared to the April 1989 water quality data. The May 1990 TDS, SO_4 and Cl concentrations measured 2,890, 1,480 and 112 mg/l as compared to April 1989 concentrations of 2,480, 1,350 and 94 mg/l, respectively. The water quality off-site at MW-15 has degraded somewhat compared to April 1989 concentrations. This monitor well is located in a known ground water discharge zone where evaporite deposits (reflecting mineralization of the ground water) can be observed on the ground surface. Wide fluctuations in the concentrations of inorganic constituents in the ground water in this area are therefore not unexpected.

The water quality in MW-14 showed some improvement, with May 1990 concentrations of TDS, SO_4 and Cl measuring 3,980, 2,120 and 202 mg/l, respectively, compared to April 1989 concentrations of 6,140, 3,320 and 406 mg/l, respectively.

The general reduction in the concentration of the inorganic constituents in the ground water at MW-9, MW-10 and typically at MW-14 is believed to be due primarily to the piping of the Westside Irrigation Ditch. Previously, the surface waters in the ditch seeped into the subsurface, through the upper unsaturated zone and into the water table. It is very likely that these ditch waters tended to flush constituents out of the unsaturated zone and into the ground water.

The water quality in the five monitor wells (MW-9, 10, 13, 14 and 15) has generally improved since November 1987 and since April/May 1989 Round 1, when MW-14 and MW-15 were first sampled. The most significant decrease in TDS concentration has been observed in MW-14, where the recent TDS concentration measured 2,620 mg/l as compared to 6,140 mg/l measured initially in the Round 1 long-term monitoring.

ORGANIC CONSTITUENTS

The laboratory results for the constituents detected for the (May 1990) Round 4 and Rounds 1, 2 and 3 long-term monitoring, and for the three previous rounds for the five organic constituents detected (halogenated and aromatic volatile organics) are presented in Table 3. The constituents that have been detected on-site are 1-2 dichloroethane (1-2, DCA), total xylenes, ethylbenzene, toluene and benzene. Only one of these parameters, 1-2 DCA, has been detected in all of these wells consistently but at very low concentrations.

The May 1990 water quality laboratory analytical results indicate that 1,2-DCA was only detected in two of the monitor wells, MW-10 and MW-9 at concentrations of 2.0 ug/l and 3.3 ug/l, respectively. These concentrations are well below 10 ug/l and 5 ug/l, the State of New Mexico and federal Environmental Protection Agency constituent concentrations for drinking water, respectively. No other organic constituents have been detected in any of these 5 monitor wells since the August 1989 Round 2 monitoring. No organic contaminants have been detected at MW-15, located off-site south of the tank farm and south of Highway 489.

CONCLUSIONS

These summary conclusions and recommendations are based on the remediation work conducted to date and all of Dames & Moore's previous work conducted at the Maverik Refinery and Tank Farm since 1987.

- The water quality data from Rounds 1, 2, 3 and 4 long-term ground water quality monitoring indicate that downgradient from the tank farm within about 100 to 250 feet, the number and concentrations of organic constituents detected have decreased to only one constituent at concentrations near detection limits. The May 1990 laboratory analytical data indicate that 1,2 DCA is the only volatile organic constituent detected, in one on-site and one off-site monitor well and at concentrations near detection limits.

- Over the past two years, on-site and off-site surface and subsurface tank farm-related contamination has been cleaned up and controlled to the extent that ground water monitoring data indicate that contaminant migration off-site is not a threat to public health or the environment. Specifically:

    - Free-product has been removed via the on-site interceptor trench;

    - Contaminant source areas have and are being cleaned up (i.e., the storage tanks and sludge areas);

    - West-side Irrigation Ditch waters were piped to eliminate potential contaminant seepage migration off-site into irrigation waters;

    - Where required, on-site wells were grouted to prevent vertical contaminant migration;

    - A slurry wall was constructed in June 1990 to ensure that subsurface contaminant migration off-site will be further controlled, and that both on-site surrounding and off-site downgradient ground water will not be impacted further by the gasoline-related contaminants now confined to the southwestern corner of the refinery tank farm;

    - Seven (7) new monitor wells, strategically placed to monitor the ground water surrounding and downgradient from the slurry wall, will be constructed and monitored semiannually as part of an "Early Warning" monitor system to ensure the early detection of potential contaminant migration away from the slurry wall; and,

- If it can be verified that in-situ ground water remediation via air sparging and/or venting (either passive or active) are not subject to the EPA-TC Rule effective September 25, 1990, a pilot program implementing one or both of these techniques will be implemented.

REFERENCES

Dames & Moore, February 1988. Phase I Hydrogeologic Evaluation, Maverik Refinery and Tank Farm, Kirtland, New Mexico.

Dames & Moore, June 1988. Addendum to Phase I Hydrogeologic Evaluation, Maverik Refinery and Tank Farm, Kirtland, New Mexico.

Dames & Moore, June 1988. Phase II Subsurface Soil and Solid Waste Contaminant Evaluation For Maverik Refinery and Tank Farm, Kirtland, New Mexico.

Dames & Moore, September 14, 1988. Ground Water Remediation Plan For Maverik Country Stores, Inc., Kirtland, New Mexico Refinery Tank Farm.

Dames & Moore, January 1989. Water Quality Data Summary Report For Completion of the Hydrogeologic Evaluation, Maverik Refinery and Tank Farm, Kirtland, New Mexico For Maverik Country Stores, Inc.

Dames & Moore, July 1989. Status Report, Remediation Work, Aquifer Pump Test and Round 1 Long-Term Ground Water Quality Monitoring Data Results For Maverik Refinery and Tank Farm, Kirtland, New Mexico, For Maverik Country Stores, Inc.

Dames & Moore, February 1990. Status Report, Remediation Work and Round 3 Long-Term Ground Water Quality Monitoring Data Results For Maverik Refinery and Tank Farm, Kirtland, New Mexico, For Maverik Country Stores, Inc.

Dames & Moore, March 1990. On-Site Ground, Surface Water and Sludge Laboratory Analytical Data and Modified Ground Water Remediation Plan For Maverik Tank Farm Kirtland, New Mexico For Maverik Country Stores, Inc.

Dames & Moore, August 8, 1989. Amended Ground Water Remediation Plan.

EPA, October 1986. Superfund Public Health Evaluation Manual, EPA 540/1-86/060.

TABLE 1

LONG-TERM MONITORING
LABORATORY WATER QUALITY PARAMETERS

General Inorganics

- Chloride
- Sulfate
- Total Dissolved Solids

Halogenated Volatile Organics
EPA Method 601

- Chloromethane
- Bromomethane (Methylbromide)
- Vinyl chloride
- Chloroethane
- Methylene chloride
- 1,1-Dichloroethene
- 1,1-Dichloroethane
- 1,2-Dichloroethene (cis/trans)
- Chloroform
- 1,1,2-Trichloro-2,2,1-trifluoroethane
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- Carbon tetrachloride
- Bromodichloromethane
- 1,2-Dichloropropane
- trans-1,3-Dichloropropene
- Trichloroethene
- Chlorodibromomethane
- cis-1,3-Dichloropropene
- 1,1,2-Trichloroethane
- EDB (1,2-Dibromoethane
- Bromoform
- 1,1,2,2-Tetrachloroethane
- Chlorobenzene

Aromatic Volatile Organics
EPA Method 602

- Benzene
- Toluene
- Chlorobenzene
- Ethylbenzene
- Total xylenes
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2-Dichlorobenzene

Note: For detail of methodology see ENSECO's (RMAL) attached report (Appendix A)

TABLE 2

LABORATORY RESULTS FOR MAJOR IONS, ROUND 4
LONG-TERM MONITORING, (AND PRIOR ANALYTICAL DATA RESULTS)
FOR MAVERIK COUNTRY STORES, REFINERY TANK FARM, KIRTLAND, NEW MEXICO

Sample Site Designation(1)	TDS(2) (mg/l)						Sulfate(2) (mg/l)						Chloride(2) mg/l					
NM MCL	1,000						600						250					
EPA MCL	500		(Long-Term)				250		Long-Term				250		Long-Term			
Rounds	1	2	1	2	3	4	1	2	1	2	3	4	1	2	1	2	3	4
Wells																		
On-Site																		
MW-10	1,240*	2,725*	2,310*	990	910	1,300*	568	1,640*	1,190*	470	404	577	46	191	146	45	34	72
Off-Site																		
MW-9	1,520*	2,160*	1,420*	1,200*	1,260*	1,190*	863*	1,510*	727*	624*	638*	574	43	81	39	37	38	35
MW-13	3,700*	1,850*	2,480*	2,660	3,580*	2,890*	1,980*	920*	1,350*	1,350*	1,890*	1,480*	257*	82	94	78	170	112
MW-14	-	-	6,140*	2,560*	2,620*	3,980*	-	-	3,320*	1,360*	1,370*	2,120*	-	-	406*	114	116	202
MW-15	-	-	2,360*	1,900*	2,940*	4,320*	-	-	1,220*	1,030*	1,720*	2,750*	-	-	178	139	204	347*

Footnotes:

(1) Data from Rounds 1 and 2 and from Rounds 1, 2, 3 and 4 long-term monitoring are presented for each sample site in subsequent columns, respectively.

(2) (Round 1 Sampled November 10-27, 1987)
(Round 2 Sampled February 22-24, 1988)
(Round 3 Sampled October 12-13, 1988 no laboratory analysis for inorganics)
(Round 1 Long-Term Monitoring, sampled April 27, 1989 and May 4, 1989)
(Round 2 Long-Term Monitoring, sampled August 10, 1989)
(Round 3 Long-Term Monitoring, sampled December 12, 1989)
(Round 4 Long-Term Monitoring, sampled May 2, 6, 1990)

* Exceeds New Mexico MCl For Drinking Water.

\- Indicates not analyzed

TABLE 3

LABORATORY RESULTS FOR DETECTED ORGANIC CONSTITUENTS, ROUND 4 LONG-TERM MONITORING (AND PRIOR ANALYTICAL DATA RESULTS) FOR MAVERIK COUNTRY STORES, REFINERY TANK FARM, KIRTLAND, NEW MEXICO

(Round 4 Long-Term Monitoring, Sampled May 2,6, 1990)
(Round 3 Long-Term Monitoring, Sampled December 12, 1989)
(Round 2 Long-Term Monitoring, Sampled August 10, 1989)
(Round 1 Long-Term Monitoring, Sampled April 27, 1989 and May 4, 1989)
(Round 1, Sampled November 10-27, 1987)
(Round 2, Sampled February 22-24, 1988)
(Round 3, Selective Sampling October 12-13, 1988)

Sample Site	1-2 DCA(2)							Total Xylene(2)							Ethylbenzene(2)						
Designation(1)	ug/l							(ug/l)							(ug/l)						
NM MCL	10							620							750						
EPA MCL	5			(Long-Term				10,000(3)			(Long-Term)				700(3)			(Long-Term			
Rounds	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3	4
Wells																					
On-Site																					
MW-10(2)	3.2	1.3	5.7	3.3	1.6	2.8	2.0	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Off-Site																					
MW-9(2)	8.3	8.6	5.6	4.5	3.4	2.6	3.30	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.00	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW-13(2)	<1	1.9	1.9	7.4	6.0	<1.0	<1.00	2.23	1.68	<0.50	<1.0	<1.0	<1.0	<1.00	0.54	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW-14(2)	-	-	-	<1.0	3.2	3.4	<1.00	-	-	-	3.2	<1.0	<1.0	<1.00	-	-	-	<0.50	<0.50	<0.50	<0.50
MW-15(2)	-	-	-	<1.0	<1.0	<1.0	<1.00	-	-	-	<1.0	<1.0	<1.0	<1.00	-	-	-	<0.50	<0.50	<0.50	<0.50

TABLE 3 (Continued)

Sample Site Designation(1)	Toluene(2) (ug/l)							Benzene(2) (ug/l)						
NM MCL	750							10						
EPA MCL	2,000(3)			(Long-Term)				5			(Long-Term)			
Rounds	1	2	3	1	2	3	4	1	2	3	1	2	3	4
Wells														
On-Site														
MW-10(2)	<0.50	<0.50	<0.50	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Off-Site														
MW-9(2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW-13(2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
MW-14(2)	-	-	-	1.1	<0.50	<0.50	<0.50	-	-	-	<0.50	<0.50	<0.50	<0.50
MW-15(2)	-	-	-	<0.50	<0.50	<0.50	<0.50	-	-	-	<0.50	<0.50	<0.50	<0.50

Footnotes:
(1) Data from each round are presented for each sample site in consecutive columns.
(2) Constituents for long-term monitoring, from designated wells as indicated.
(3) EPA proposed MCL's and MCLG's (May 22, 1989).
The values indicated as less than (<) are detection limits only, and not actual concentrations.
- Indicates not analyzed.
* Exceeds New Mexico MCL for drinking water.

TABLE 4

CHARACTERISTICS OF ORGANIC COMPOUNDS DETECTED LONG-TERM REMEDIATION MONITORING

	Molecular Weight	Density (gm/cm^3)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	K_{oc}(1) (ml/g)	K_{ow}(2)
Volatile Organic Parameters						
Benzene	78	0.88	1,750	95	83	132
Ethylbenzene	106	0.87	152	7	1,100	1,412
Toluene	92	0.87	535	28	300	537
Xylene, m	106	0.86	130	10	871	1,820
Xylene, p	106	0.86	192	10	676	1,412
Xylene, o	106	0.88	175	10	426	891
1,2-Dichloroethane	99	1.26	8,520	64	14	30

---

(1) Organic carbon partition coefficient, a measure of the tendency for organics to be adsorbed by soil and sediment.

(2) Octanol-water partition coefficient, a measure of the tendency of a chemical at equilibrium to distribute between an organic phase (octanol) and water.

Source: Superfund Public Health Evaluation Manual, EPA 540/1-86/060, October 1986; Land Treatment of Appendix VIII Constituents in Petroleum Industry Wastes, American Petroleum Institute Publication 4379, May 1984.

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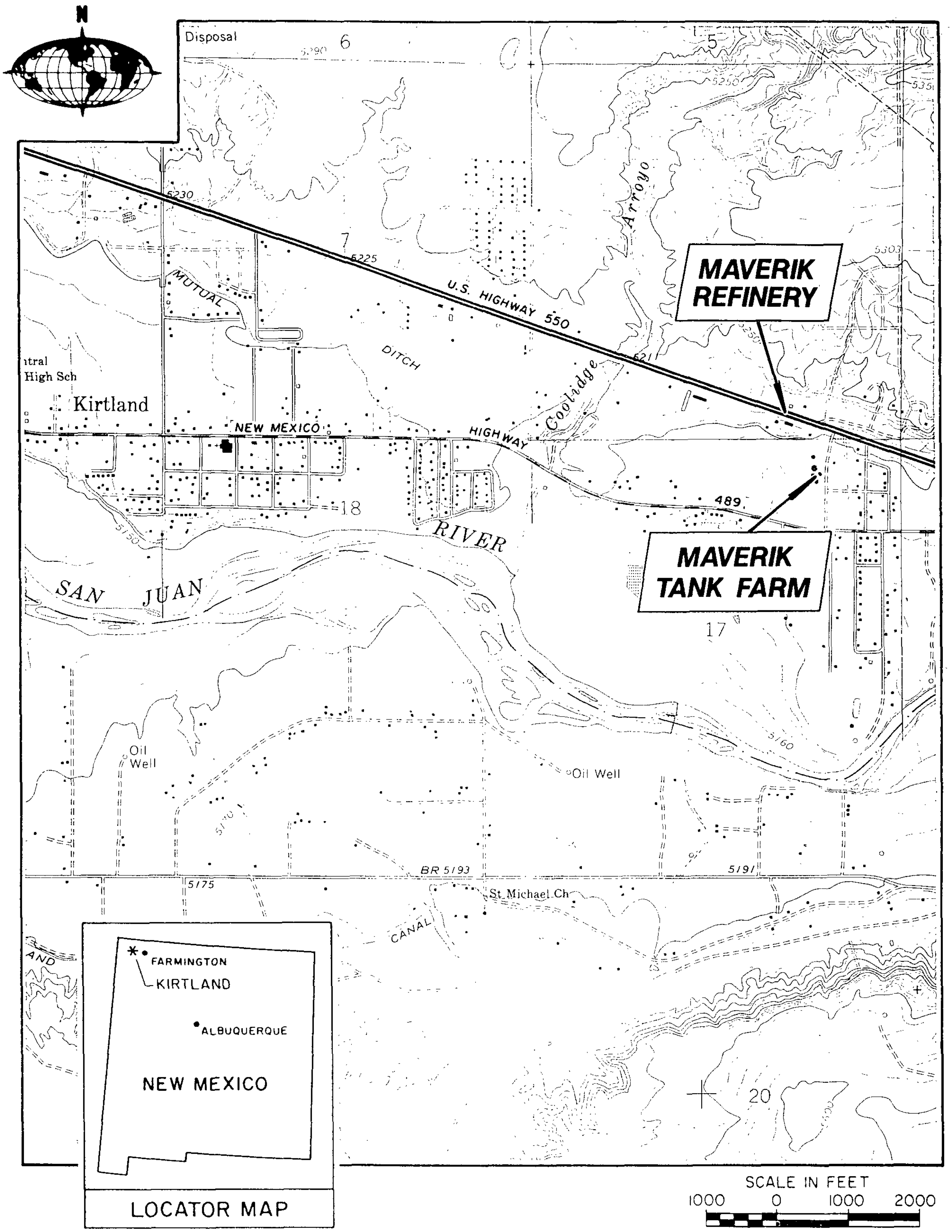
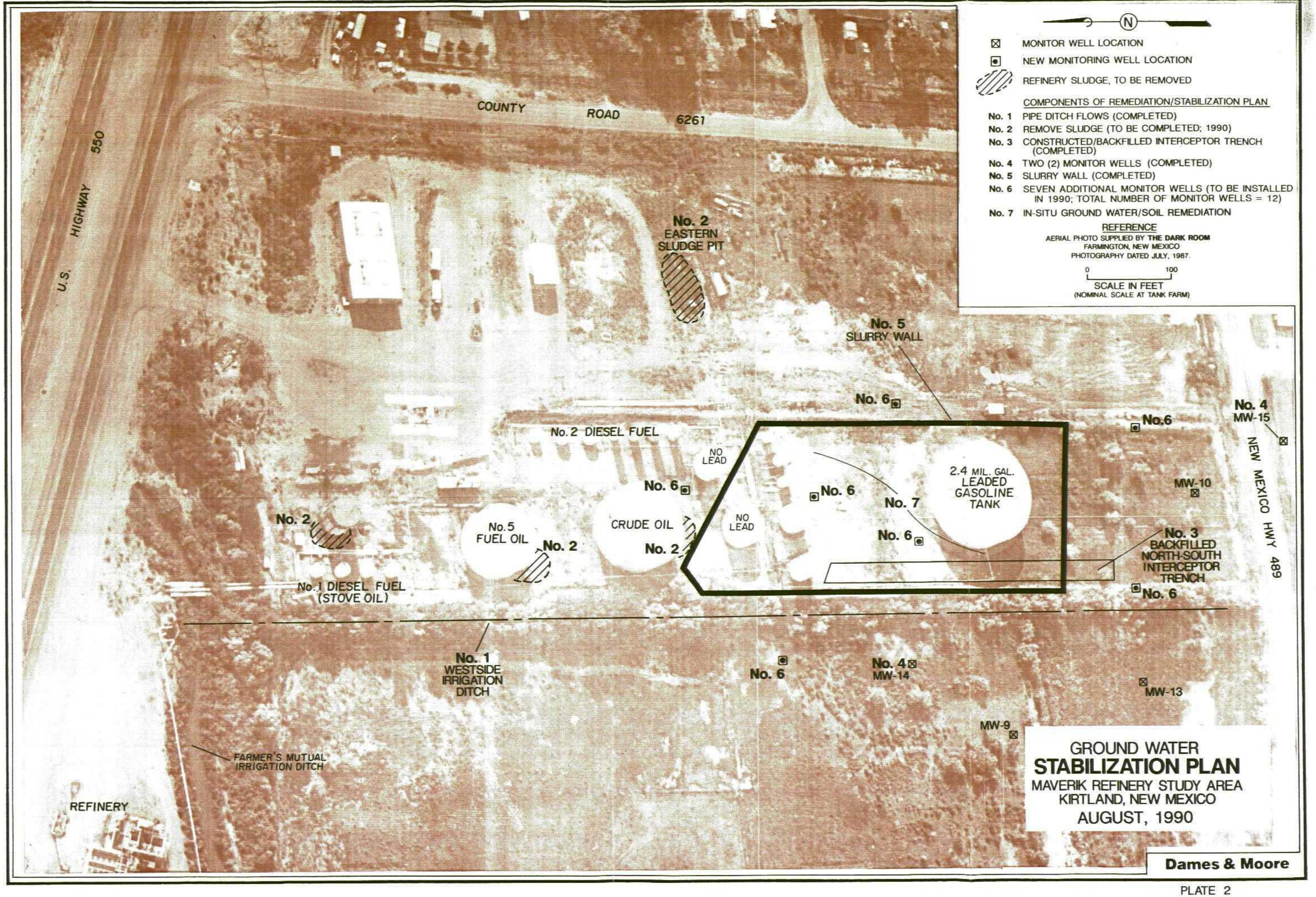


VICINITY MAP

REFERENCE-
U.S.G.S. QUADRANGLE ENTITLED
"KIRTLAND, NEW MEXICO" - 1966,
PHOTOREVISED 1979.

Dames & Moore

PLATE 1



⊠ MONITOR WELL LOCATION

⊡ NEW MONITORING WELL LOCATION

▨ REFINERY SLUDGE, TO BE REMOVED

COMPONENTS OF REMEDIATION/STABILIZATION PLAN

No. 1	PIPE DITCH FLOWS (COMPLETED)
No. 2	REMOVE SLUDGE (TO BE COMPLETED; 1990)
No. 3	CONSTRUCTED/BACKFILLED INTERCEPTOR TRENCH (COMPLETED)
No. 4	TWO (2) MONITOR WELLS (COMPLETED)
No. 5	SLURRY WALL (COMPLETED)
No. 6	SEVEN ADDITIONAL MONITOR WELLS (TO BE INSTALLED IN 1990; TOTAL NUMBER OF MONITOR WELLS = 12)
No. 7	IN-SITU GROUND WATER/SOIL REMEDIATION

REFERENCE

AERIAL PHOTO SUPPLIED BY **THE DARK ROOM**
FARMINGTON, NEW MEXICO
PHOTOGRAPHY DATED JULY, 1987.

0 100
SCALE IN FEET
(NOMINAL SCALE AT TANK FARM)

GROUND WATER
STABILIZATION PLAN
MAVERIK REFINERY STUDY AREA
KIRTLAND, NEW MEXICO
AUGUST, 1990

Dames & Moore

PLATE 2

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46612 (11-82)

APPENDIX A

FIELD AND LABORATORY GROUND WATER QUALITY DATA SAMPLING AND ANALYSIS AND QA/QC FOR ROUND 4 LONG-TERM REMEDIATION MONITORING AND PRIOR ROUNDS 1, 2 AND 3 AND ROUNDS 1, 2 AND 3 LONG-TERM MONITORING

APPENDIX A

FIELD AND LABORATORY GROUND WATER QUALITY DATA SAMPLING AND ANALYSIS AND QA/QC FOR ROUND 4 LONG-TERM REMEDIATION MONITORING AND PRIOR ROUNDS 1, 2 AND 3 AND ROUNDS 1, 2 AND 3 LONG-TERM MONITORING

WATER QUALITY SAMPLING

The monitor wells sampled for long-term remediation monitoring Round 4 (MW-9, MW-10, MW-13, MW-14 and MW-15) were purged with a teflon bailer, as in all previous sampling rounds. Ground water samples were then collected, preserved and analyzed in accordance with EPA guidance. All samples were analyzed by Rocky Mountain Analytical Laboratory (RMAL) a division of ENSECO, Incorporated, a well known multi-state certified and EPA Contract Laboratory-Program laboratory in Arvada, Colorado. RMAL has conducted the laboratory analysis on all of the prior samples taken at the project site. Bottom samples from the wells were collected by lowering a teflon bailer equipped with an end ball valve to the bottom of the wells. Samples were collected after 3 casing volumes of water had been removed. Water level data and the results of the field water quality analytical tests are presented in Table A-1.

The drop pipe that had been installed in monitor well MW-13 prior to Round 2 sampling (as described in our February 1988 report), was also used during this sampling round. The drop pipe was installed after a free oil phase had been detected in MW-13 during Round 1 sampling.

Sample bottles with appropriate preservatives (as detailed in RMAL's report), were shipped directly to the site by the laboratory. All water samples were iced immediately after collection and shipped to RMAL on the day of collection via overnight courier. Chain-of-custody documentation was maintained.

LABORATORY ANALYSIS

Analytical results from RMAL for the major inorganic and organic parameters for this round and previous sampling rounds for the five designated monitor wells are included in Table A-2. The data are presented in columns for comparative purposes. The detailed report from RMAL for Round 4 long-term monitoring is also included in this appendix.

The water quality analyses for long-term monitoring include a selected list of analytes based on those detected previously in wells in Rounds 1, 2 and 3 and as agreed to by the EID (September 14, 1988). RMAL conducted analyses for 24 halogenated volatile organics, 8 aromatic volatile organics and 3 inorganic constituents. The specific parameters are listed in Table 1 along with the analytical methods used. GC methods 601 and 602 were used to detect volatile organics.

APPENDIX A

REPORT OF ANALYSES

TABLE A-1

SUMMARY OF FIELD DATA FOR LONG-TERM GROUND WATER QUALITY REMEDIATION MONITORING ROUNDS 1, 2, 3 AND 4[1]

Well	Depth to Water (From Ground Surface, in ft.)				pH (pH units)			Conductivity umhos/cm		
	Round 1	Round 2	Round 3	Round 4	Round 1	Round 3	Round 4	Round 1	Round 3	Round 4
MW-9	2.77	1.7	0.90	1.9	7.04	7.58	7.43	2,000	1,600	-
MW-10	2.27	2.5	1.20	1.34	6.46	7.48	7.37	3,500	1,350	1,700
MW-13	1.9	1.9	0.35	0.50	8.06	7.60	-	2,500	5,100	-
MW-14	3.0	4.5	1.58	3.10	7.08	7.40	7.12	8,000	3,350	6,000
MW-15	1.0	2.3	0.77	1.06	6.45	7.27	6.95	3,500	2,500	5,800
MW-12	-	-	-	5.22	-	-	7.02	-	-	2,300

TABLE A-1 (Continued)

Well	Dissolved Oxygen			Remarks
	Round 1	Round 3	Round 4	
MW-9	-	-	-	Silty
MW-10	-	-	-	Silty
MW-13	-	-	-	Due to limited recharge, field parameters not measured
MW-14	-	-	3.65	Initially silty, cleared
MW-15	-	-	6.15	Initially rusty, Cleared but silty
MW-12	-	-	1.57	NC

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(1) Round 1 Data collected April 27, 1989 and May 4, 1989.
Round 2 Data collected August 10, 1989, measured from top of casing.
Round 3 Data collected December 11, 12, 1989.
Round 4 Data collected May 2, 5, 6, 1990.
(2) Round 4 Remarks.
\- Not tested
NC No Comment
Note: No field tests were conducted during Round 2 sampling.

TABLE A-2

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-9	MW-9	MW-9	MW-9	MW-9	MW-9	MW-9
DATE SAMPLED	11-23-87	2-22-88	10-13-88	4-27-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	324.0	396.0	*	*	*	*	*
Magnesium (Mg)	29.0	41.0	*	*	*	*	*
Sodium (Na)	146.0	357.0	*	*	*	*	*
Potassium (K)	< 5.0	< 5.0	*	*	*	*	*
Iron (Fe)	< .05	< .05	*	*	*	*	*
Manganese (Mn)	*	.110	*	*	*	*	*
Ammonia (as N)	< .1	< .1	*	*	*	*	*
Chloride (Cl)	43.0	81.0	*	39.0	37.0	38.0	*
Sulfate (SO4)	863.	1510.	*	727.	624.	638.	*
Fluoride (F)	1.0	.8	*	*	*	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*	*	*	*
Total Alkalinity	372.0	250.0	*	*	*	*	*
Bicarbonate Alkalinity	*	250.0	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	304.8	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	13.3	*	15.5	14.8	*	*	*
Field pH	7.11	7.08	6.52	7.04	*	*	*
Lab pH (units)	7.59	7.71	*	*	*	*	*
Field Conductivity (umhos/cm	1400.0	2200.0	1600.0	2000.0	*	*	*
Lab Conductivity (umhos/cm)	1850.0	3000.0	*	*	*	*	*
Total Dissolved Solids(mg/l)	1520.0	2160.0	*	1420.0	1200.0	1260.0	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	< .50	< .50	< .50	< .50	< .50	< .50	*
Ethylbenzene	< .50	< .50	< .50	< .50	< .50	< .50	*
Toluene	< .50	< .50	< .50	< .50	< .50	< .50	*
m-Xylene	< .50	< .50	*	*	*	*	*
o,p-Xylene	< .50	< .50	*	*	*	*	*
Total Xylene	*	*	< .50	< 1.00	< 1.00	< 1.00	*
1,2 Dichloroethane	8.30	8.60	5.60	4.50	3.40	2.60	*
SEMIVOLATILE ORGANICS DETECTED (ug/L)							
Naphthalene	*	*	< 10.00	*	*	*	*
m & p-Cresol(s)	*	*	< 10.00	*	*	*	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	< .010	.004	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION		MW-9
DATE SAMPLED		5- 2-90
INORGANIC PARAMETERS (mg/L except as noted)		
Calcium (Ca)		*
Magnesium (Mg)		*
Sodium (Na)		*
Potassium (K)		*
Iron (Fe)		*
Manganese (Mn)		*
Ammonia (as N)		*
Chloride (Cl)		35.0
Sulfate (SO4)		574.
Fluoride (F)		*
Nitrate and Nitrite (as N)		*
Total Alkalinity		*
Bicarbonate Alkalinity		*
Carbonate Alkalinity		*
Bicarbonate (HCO3)		*
Carbonate (CO3)		*
FIELD AND LABORATORY MEASUREMENTS		
Temperature (Degrees C)		*
Field pH		*
Lab pH (units)		*
Field Conductivity (umhos/cm		*
Lab Conductivity (umhos/cm)		*
Total Dissolved Solids(mg/l)		1190.0
VOLATILE ORGANICS DETECTED (ug/L)		
Benzene	<	.50
Ethylbenzene	<	.50
Toluene	<	.50
m-Xylene		*
o,p-Xylene		*
Total Xylene	<	1.00
1,2 Dichloroethane		3.30
SEMIVOLATILE ORGANICS DETECTED (ug/L)		
Naphthalene		*
m & p-Cresol(s)		*
TOTAL ORGANIC LEAD (mg/L)		
Total Organic Lead		*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-10	MW-10	MW-10	MW-10	MW-10	MW-10	MW-10
DATE SAMPLED	11-23-87	2-23-88	10-12-88	4-27-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	126.0	196.0	*	*	*	*	*
Magnesium (Mg)	22.0	41.0	*	*	*	*	*
Sodium (Na)	250.0	578.0	*	*	*	*	*
Potassium (K)	< 5.0	< 5.0	*	*	*	*	*
Iron (Fe)	< .05	< .05	*	*	*	*	*
Manganese (Mn)	*	5.200	*	*	*	*	*
Ammonia (as N)	< .1	< .1	*	*	*	*	*
Chloride (Cl)	46.0	191.0	*	146.0	45.0	34.0	*
Sulfate (SO4)	568.	1640.	*	1190.	470.	404.	*
Fluoride (F)	.8	.7	*	*	*	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*	*	*	*
Total Alkalinity	153.0	271.0	*	*	*	*	*
Bicarbonate Alkalinity	*	271.0	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	330.4	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	12.5	*	15.6	13.0	*	*	*
Field pH	7.66	8.22	6.25	6.46	*	*	*
Lab pH (units)	7.74	7.70	*	*	*	*	*
Field Conductivity (umhos/cm	1280.0	3600.0	1375.0	3500.0	*	*	*
Lab Conductivity (umhos/cm)	1640.0	3720.0	*	*	*	*	*
Total Dissolved Solids(mg/l)	1240.0	2725.0	*	2310.0	990.0	910.0	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	< .50	< .50	< .50	< .50	< .50	< .50	*
Ethylbenzene	< .50	< .50	< .50	< .50	< .50	< .50	*
Toluene	< .50	< .50	< .50	.52	< .50	< .50	*
m-Xylene	< .50	< .50	*	*	*	*	*
o,p-Xylene	< .50	< .50	*	*	*	*	*
Total Xylene	*	*	< .50	< 1.00	< 1.00	< 1.00	*
1,2 Dichloroethane	3.20	1.30	5.70	3.30	1.60	2.80	*
SEMIVOLATILE ORGANICS DETECTED (ug/L)							
Naphthalene	*	*	< 10.00	*	*	*	*
m & p-Cresol(s)	*	*	< 10.00	*	*	*	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	< .020	.009	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION		MW-10	
DATE SAMPLED		5- 2-90	
INORGANIC PARAMETERS (mg/L except as noted)			
Calcium (Ca)			*
Magnesium (Mg)			*
Sodium (Na)			*
Potassium (K)			*
Iron (Fe)			*
Manganese (Mn)			*
Ammonia (as N)			*
Chloride (Cl)			72.1
Sulfate (SO4)			577.
Fluoride (F)			*
Nitrate and Nitrite (as N)			*
Total Alkalinity			*
Bicarbonate Alkalinity			*
Carbonate Alkalinity			*
Bicarbonate (HCO3)			*
Carbonate (CO3)			*
FIELD AND LABORATORY MEASUREMENTS			
Temperature (Degrees C)			*
Field pH			*
Lab pH (units)			*
Field Conductivity (umhos/cm			*
Lab Conductivity (umhos/cm)			*
Total Dissolved Solids(mg/l)			1300.0
VOLATILE ORGANICS DETECTED (ug/L)			
Benzene	<		.50
Ethylbenzene	<		.50
Toluene	<		.50
m-Xylene			*
o,p-Xylene			*
Total Xylene	<		1.00
1,2 Dichloroethane			2.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)			
Naphthalene			*
m & p-Cresol(s)			*
TOTAL ORGANIC LEAD (mg/L)			
Total Organic Lead			*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-11	MW-11	MW-11	MW-11	MW-11	MW-11	MW-11
DATE SAMPLED	11-11-87	2-23-88	10-12-88	4-27-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	138.0	186.0	*	*	*	*	*
Magnesium (Mg)	21.0	28.0	*	*	*	*	*
Sodium (Na)	234.0	263.0	*	*	*	*	*
Potassium (K)	< 5.0	< 5.0	*	*	*	*	*
Iron (Fe)	< .05	< .05	*	*	*	*	*
Manganese (Mn)	*	1.000	*	*	*	*	*
Ammonia (as N)	< .1	< .1	*	*	*	*	*
Chloride (Cl)	45.0	184.0	*	*	*	*	*
Sulfate (SO4)	592.	615.	*	*	*	*	598.
Fluoride (F)	.5	.5	*	*	*	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*	*	*	*
Total Alkalinity	267.0	242.0	*	*	*	*	*
Bicarbonate Alkalinity	267.0	242.0	*	*	*	*	*
Carbonate Alkalinity	< 5.0	*	*	*	*	*	*
Bicarbonate (HCO3)	325.5	295.1	*	*	*	*	*
Carbonate (CO3)	< 3.0	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	14.5	*	19.4	*	*	*	12.8
Field pH	7.85	7.80	6.94	*	*	*	7.29
Lab pH (units)	7.80	7.62	*	*	*	*	*
Field Conductivity (umhos/cm	1050.0	2050.0	2600.0	*	*	*	1200.0
Lab Conductivity (umhos/cm)	1720.0	2120.0	*	*	*	*	*
Total Dissolved Solids(mg/l)	1250.0	1470.0	*	*	*	*	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	.81	25.00	< .50	*	*	*	< .50
Ethylbenzene	< .50	< .50	< .50	*	*	*	< .50
Toluene	< .50	< .50	< .50	*	*	*	< .50
m-Xylene	< .50	< .50	*	*	*	*	*
o,p-Xylene	< .50	< .50	*	*	*	*	*
Total Xylene	*	*	< .50	*	*	*	< 1.00
1,2 Dichloroethane	1.00	4.60	< 1.00	*	*	*	< 1.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)							
Naphthalene	*	*	< 10.00	*	*	*	*
m & p-Cresol(s)	*	*	< 10.00	*	*	*	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	.007	< .004	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-11
DATE SAMPLED	5- 2-90
INORGANIC PARAMETERS (mg/L except as noted)	
Calcium (Ca)	*
Magnesium (Mg)	*
Sodium (Na)	*
Potassium (K)	*
Iron (Fe)	*
Manganese (Mn)	*
Ammonia (as N)	*
Chloride (Cl)	*
Sulfate (SO4)	*
Fluoride (F)	*
Nitrate and Nitrite (as N)	*
Total Alkalinity	*
Bicarbonate Alkalinity	*
Carbonate Alkalinity	*
Bicarbonate (HCO3)	*
Carbonate (CO3)	*
FIELD AND LABORATORY MEASUREMENTS	
Temperature (Degrees C)	*
Field pH	*
Lab pH (units)	*
Field Conductivity (umhos/cm	*
Lab Conductivity (umhos/cm)	*
Total Dissolved Solids(mg/l)	*
VOLATILE ORGANICS DETECTED (ug/L)	
Benzene	*
Ethylbenzene	*
Toluene	*
m-Xylene	*
o,p-Xylene	*
Total Xylene	*
1,2 Dichloroethane	*
SEMIVOLATILE ORGANICS DETECTED (ug/L)	
Naphthalene	*
m & p-Cresol(s)	*
TOTAL ORGANIC LEAD (mg/L)	
Total Organic Lead	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

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*: Parameter was not analyzed.

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*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-12	MW-12	MW-12	MW-12	MW-12	MW-12	MW-12
DATE SAMPLED	11-27-87	2-23-88	10-12-88	4-27-89	8-10-89	12-12-89	1-17-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	148.0	133.0	*	*	*	*	*
Magnesium (Mg)	42.0	39.0	*	*	*	*	*
Sodium (Na)	222.0	239.0	*	*	*	*	*
Potassium (K)	< 5.0	< 5.0	*	*	*	*	*
Iron (Fe)	.13	.09	*	*	*	*	*
Manganese (Mn)	*	3.600	*	*	*	*	*
Ammonia (as N)	< .1	< .1	*	*	*	*	*
Chloride (Cl)	321.0	360.0	*	*	*	*	*
Sulfate (SO4)	16.	9.	*	*	*	*	30.
Fluoride (F)	.3	.3	*	*	*	*	*
Nitrate and Nitrite (as N)	< .1	< .1	*	*	*	*	*
Total Alkalinity	508.0	541.0	*	*	*	*	*
Bicarbonate Alkalinity	*	541.0	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	659.6	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	17.0	*	23.0	*	*	*	13.0
Field pH	6.74	7.25	6.93	*	*	*	6.97
Lab pH (units)	6.99	7.05	*	*	*	*	*
Field Conductivity (umhos/cm	1510.0	2010.0	2100.0	*	*	*	1600.0
Lab Conductivity (umhos/cm)	1930.0	2070.0	*	*	*	*	*
Total Dissolved Solids(mg/l)	1200.0	1310.0	*	*	*	*	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	19000.00	24000.00	6200.00	*	*	*	2400.00
Ethylbenzene	1300.00	1500.00	180.00	*	*	*	120.00
Toluene	2000.00	20000.00	1000.00	*	*	*	1100.00
m-Xylene	*	*	*	*	*	*	*
o,p-Xylene	*	*	*	*	*	*	*
Total Xylene	3000.00	10000.00	470.00	*	*	*	*
1,2 Dichloroethane	450.00	2400.00	< 200.00	*	*	*	800.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)							
Naphthalene	*	*	33.00	*	*	*	*
m & p-Cresol(s)	*	*	11.00	*	*	*	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	< .020	.060	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-12
DATE SAMPLED	5- 2-90
INORGANIC PARAMETERS (mg/L except as noted)	
Calcium (Ca)	*
Magnesium (Mg)	*
Sodium (Na)	*
Potassium (K)	*
Iron (Fe)	*
Manganese (Mn)	*
Ammonia (as N)	*
Chloride (Cl)	*
Sulfate (SO4)	26.
Fluoride (F)	*
Nitrate and Nitrite (as N)	*
Total Alkalinity	*
Bicarbonate Alkalinity	*
Carbonate Alkalinity	*
Bicarbonate (HCO3)	*
Carbonate (CO3)	*
FIELD AND LABORATORY MEASUREMENTS	
Temperature (Degrees C)	*
Field pH	*
Lab pH (units)	*
Field Conductivity (umhos/cm	*
Lab Conductivity (umhos/cm)	*
Total Dissolved Solids(mg/l)	*
VOLATILE ORGANICS DETECTED (ug/L)	
Benzene	10000.00
Ethylbenzene	< 250.00
Toluene	2300.00
m-Xylene	*
o,p-Xylene	*
Total Xylene	850.00
1,2 Dichloroethane	800.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)	
Naphthalene	*
m & p-Cresol(s)	*
TOTAL ORGANIC LEAD (mg/L)	
Total Organic Lead	*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-13	MW-13	MW-13	MW-13	MW-13	MW-13	MW-13
DATE SAMPLED	11-27-87	2-24-88	10-12-88	5- 4-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	364.0	219.0	*	*	*	*	*
Magnesium (Mg)	105.0	47.0	*	*	*	*	*
Sodium (Na)	666.0	370.0	*	*	*	*	*
Potassium (K)	24.0	< 5.0	*	*	*	*	*
Iron (Fe)	.39	.12	*	*	*	*	*
Manganese (Mn)	*	1.900	*	*	*	*	*
Ammonia (as N)	.5	.5	*	*	*	*	*
Chloride (Cl)	257.0	82.0	*	94.0	78.0	170.0	*
Sulfate (SO4)	1980.	920.	*	1350.	1350.	1890.	*
Fluoride (F)	1.0	.8	*	*	*	*	*
Nitrate and Nitrite (as N)	.3	< .1	*	*	*	*	*
Total Alkalinity	419.0	581.0	*	*	*	*	*
Bicarbonate Alkalinity	*	581.0	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	708.4	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	8.1	*	18.3	16.0	*	*	*
Field pH	8.14	8.36	7.51	8.06	*	*	*
Lab pH (units)	7.89	8.11	*	*	*	*	*
Field Conductivity (umhos/cm	2300.0	2600.0	4350.0	2500.0	*	*	*
Lab Conductivity (umhos/cm)	4300.0	2650.0	*	*	*	*	*
Total Dissolved Solids(mg/l)	3700.0	1850.0	*	2480.0	2660.0	3580.0	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	< .50	< .50	< .50	< .50	< .50	< .50	*
Ethylbenzene	.54	< .50	< .50	< .50	< .50	< .50	*
Toluene	< .50	< .50	< .50	< .50	< .50	< .50	*
m-Xylene	1.40	1.10	*	*	*	*	*
o,p-Xylene	.83	.58	*	*	*	*	*
Total Xylene	*	*	< .50	< 1.00	< 1.00	< 1.00	*
1,2 Dichloroethane	< 1.00	1.90	1.90	7.40	6.00	< 1.00	*
SEMIVOLATILE ORGANICS DETECTED (ug/L)							
Naphthalene	*	*	< 10.00	*	*	*	*
m & p-Cresol(s)	*	*	< 10.00	*	*	*	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	< .010	< .004	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION		MW-13
DATE SAMPLED		5- 6-90
INORGANIC PARAMETERS (mg/L except as noted)		
Calcium (Ca)		*
Magnesium (Mg)		*
Sodium (Na)		*
Potassium (K)		*
Iron (Fe)		*
Manganese (Mn)		*
Ammonia (as N)		*
Chloride (Cl)		112.0
Sulfate (SO4)		1480.
Fluoride (F)		*
Nitrate and Nitrite (as N)		*
Total Alkalinity		*
Bicarbonate Alkalinity		*
Carbonate Alkalinity		*
Bicarbonate (HCO3)		*
Carbonate (CO3)		*
FIELD AND LABORATORY MEASUREMENTS		
Temperature (Degrees C)		*
Field pH		*
Lab pH (units)		*
Field Conductivity (umhos/cm		*
Lab Conductivity (umhos/cm)		*
Total Dissolved Solids(mg/l)		2890.0
VOLATILE ORGANICS DETECTED (ug/L)		
Benzene	<	.50
Ethylbenzene	<	.50
Toluene	<	.50
m-Xylene		*
o,p-Xylene		*
Total Xylene	<	1.00
1,2 Dichloroethane	<	1.00
SEMIVOLATILE ORGANICS DETECTED (ug/L)		
Naphthalene		*
m & p-Cresol(s)		*
TOTAL ORGANIC LEAD (mg/L)		
Total Organic Lead		*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-14	MW-14	MW-14	MW-14	MW-14	MW-14	MW-14
DATE SAMPLED	11-27-87	2-24-88	10-12-88	4-27-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	*	*	*	*	*	*	*
Magnesium (Mg)	*	*	*	*	*	*	*
Sodium (Na)	*	*	*	*	*	*	*
Potassium (K)	*	*	*	*	*	*	*
Iron (Fe)	*	*	*	*	*	*	*
Manganese (Mn)	*	*	*	*	*	*	*
Ammonia (as N)	*	*	*	*	*	*	*
Chloride (Cl)	*	*	*	406.0	114.0	116.0	*
Sulfate (SO4)	*	*	*	3320.	1360.	1370.	*
Fluoride (F)	*	*	*	*	*	*	*
Nitrate and Nitrite (as N)	*	*	*	*	*	*	*
Total Alkalinity	*	*	*	*	*	*	*
Bicarbonate Alkalinity	*	*	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	*	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	*	*	*	16.2	*	*	*
Field pH	*	*	*	7.08	*	*	*
Lab pH (units)	*	*	*	*	*	*	*
Field Conductivity (umhos/cm	*	*	*	8000.0	*	*	*
Lab Conductivity (umhos/cm)	*	*	*	*	*	*	*
Total Dissolved Solids(mg/l)	*	*	*	6140.0	2560.0	2620.0	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	*	*	*	< .50	.50	.50	*
Ethylbenzene	*	*	*	< .50	.50	.50	*
Toluene	*	*	*	1.10	< .50	< .50	*
m-Xylene	*	*	*	*	*	*	*
o,p-Xylene	*	*	*	*	*	*	*
Total Xylene	*	*	*	3.20	1.00	1.00	*
1,2 Dichloroethane	*	*	*	< 1.00	3.20	3.40	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	*	*	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION		MW-14
DATE SAMPLED		5- 6-90
INORGANIC PARAMETERS (mg/L except as noted)		
Calcium (Ca)		*
Magnesium (Mg)		*
Sodium (Na)		*
Potassium (K)		*
Iron (Fe)		*
Manganese (Mn)		*
Ammonia (as N)		*
Chloride (Cl)		202.0
Sulfate (SO4)		2120.
Fluoride (F)		*
Nitrate and Nitrite (as N)		*
Total Alkalinity		*
Bicarbonate Alkalinity		*
Carbonate Alkalinity		*
Bicarbonate (HCO3)		*
Carbonate (CO3)		*
FIELD AND LABORATORY MEASUREMENTS		
Temperature (Degrees C)		*
Field pH		*
Lab pH (units)		*
Field Conductivity (umhos/cm		*
Lab Conductivity (umhos/cm)		*
Total Dissolved Solids(mg/l)		3980.0
VOLATILE ORGANICS DETECTED (ug/L)		
Benzene	<	.50
Ethylbenzene	<	.50
Toluene	<	.50
m-Xylene		*
o,p-Xylene		*
Total Xylene	<	1.00
1,2 Dichloroethane	<	1.00
TOTAL ORGANIC LEAD (mg/L)		
Total Organic Lead		*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-15	MW-15	MW-15	MW-15	MW-15	MW-15	MW-15
DATE SAMPLED	11-27-87	2-24-88	10-12-88	4-27-89	8-10-89	12-12-89	1-16-90
INORGANIC PARAMETERS (mg/L except as noted)							
Calcium (Ca)	*	*	*	*	*	*	*
Magnesium (Mg)	*	*	*	*	*	*	*
Sodium (Na)	*	*	*	*	*	*	*
Potassium (K)	*	*	*	*	*	*	*
Iron (Fe)	*	*	*	*	*	*	*
Manganese (Mn)	*	*	*	*	*	*	*
Ammonia (as N)	*	*	*	*	*	*	*
Chloride (Cl)	*	*	*	178.0	139.0	204.0	*
Sulfate (SO4)	*	*	*	1220.	1030.	1720.	*
Fluoride (F)	*	*	*	*	*	*	*
Nitrate and Nitrite (as N)	*	*	*	*	*	*	*
Total Alkalinity	*	*	*	*	*	*	*
Bicarbonate Alkalinity	*	*	*	*	*	*	*
Carbonate Alkalinity	*	*	*	*	*	*	*
Bicarbonate (HCO3)	*	*	*	*	*	*	*
Carbonate (CO3)	*	*	*	*	*	*	*
FIELD AND LABORATORY MEASUREMENTS							
Temperature (Degrees C)	*	*	*	14.2	*	*	*
Field pH	*	*	*	6.45	*	*	*
Lab pH (units)	*	*	*	*	*	*	*
Field Conductivity (umhos/cm	*	*	*	3500.0	*	*	*
Lab Conductivity (umhos/cm)	*	*	*	*	*	*	*
Total Dissolved Solids(mg/l)	*	*	*	2360.0	1900.0	2940.0	*
VOLATILE ORGANICS DETECTED (ug/L)							
Benzene	*	*	*	< .50	< .50	< .50	*
Ethylbenzene	*	*	*	< .50	< .50	< .50	*
Toluene	*	*	*	< .50	< .50	< .50	*
m-Xylene	*	*	*	*	*	*	*
o,p-Xylene	*	*	*	*	*	*	*
Total Xylene	*	*	*	< 1.00	< 1.00	< 1.00	*
1,2 Dichloroethane	*	*	*	< 1.00	< 1.00	< 1.00	*
TOTAL ORGANIC LEAD (mg/L)							
Total Organic Lead	*	*	*	*	*	*	*

<: Parameter value is less than given detection limits
*: Parameter was not analyzed.

MAVERIK-KIRTLAND WATER QUALITY

SAMPLE IDENTIFICATION	MW-15
DATE SAMPLED	5- 6-90
INORGANIC PARAMETERS (mg/L except as noted)	
Calcium (Ca)	*
Magnesium (Mg)	*
Sodium (Na)	*
Potassium (K)	*
Iron (Fe)	*
Manganese (Mn)	*
Ammonia (as N)	*
Chloride (Cl)	347.0
Sulfate (SO4)	2750.
Fluoride (F)	*
Nitrate and Nitrite (as N)	*
Total Alkalinity	*
Bicarbonate Alkalinity	*
Carbonate Alkalinity	*
Bicarbonate (HCO3)	*
Carbonate (CO3)	*
FIELD AND LABORATORY MEASUREMENTS	
Temperature (Degrees C)	*
Field pH	*
Lab pH (units)	*
Field Conductivity (umhos/cm	*
Lab Conductivity (umhos/cm)	*
Total Dissolved Solids(mg/l)	4320.0
VOLATILE ORGANICS DETECTED (ug/L)	
Benzene	< .50
Ethylbenzene	< .50
Toluene	< .50
m-Xylene	*
o,p-Xylene	*
Total Xylene	< 1.00
1,2 Dichloroethane	< 1.00
TOTAL ORGANIC LEAD (mg/L)	
Total Organic Lead	*

<: Parameter value is less than given detection limits

*: Parameter was not analyzed.

Rocky Mountain
Analytical Laboratory

Enseco

May 25, 1990

Peter F. Olsen, Ph.D.
Dames and Moore
127 South 500 East
Suite 300
Salt Lake City, UT 84102-1959

Dear Pete:

Enclosed is the report for three aqueous samples we received at Enseco-Rocky Mountain Analytical Laboratory on May 8, 1990.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Randall Thompson
Program Administrator

RT/lw
Enclosures

RMAL #009431

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

ANALYTICAL RESULTS
FOR
DAMES AND MOORE
ENSECO-RMAL NO. 009431

MAY 25, 1990

Enseco

Reviewed by: Randall Thompson

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

SAMPLE DESCRIPTION INFORMATION
for
Dames and Moore

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
009431-0001-SA	MW-13	AQUEOUS	06 MAY 90	08:45	08 MAY 90
009431-0002-SA	MW-15	AQUEOUS	06 MAY 90	09:15	08 MAY 90
009431-0003-SA	MW-14	AQUEOUS	06 MAY 90	10:00	08 MAY 90

ANALYTICAL TEST REQUESTS
for
Dames and Moore

Lab ID: 009431	Group Code	Analysis Description	Custom Test?
0001 - 0003	A	Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)	N
		Halogenated Volatile Organics	Y
		Sulfate, Ion Chromatography	N
		Total Dissolved Solids (TDS)	N
		Chloride, Ion Chromatography	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, April, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 009431-0001-SA
Enseco ID: 1075024
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: NA
Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan

Approved By: Greg Gustina

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 009431-0001-SA
Enseco ID: 1075024
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: NA
Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan
Approved By: Greg Gustina

General Inorganics

Client Name: Dames and Moore
Client ID: MW-13
Lab ID: 009431-0001-SA
Enseco ID: 1075024
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Chloride	112	mg/L	3.0	300.0	NA	15 MAY 90
Sulfate	1480	mg/L	25.0	300.0	NA	15 MAY 90
Total Dissolved Solids	2890	mg/L	50.0	160.1	NA	11 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Mary Grehl

Approved By: Toni Stovall

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 009431-0002-SA
Enseco ID: 1075025
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: NA
Analyzed: 15 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan
Approved By: Greg Gustina

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 009431-0002-SA
Enseco ID: 1075025
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: NA
Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan

Approved By: Greg Gustina

General Inorganics

Client Name: Dames and Moore
Client ID: MW-15
Lab ID: 009431-0002-SA
Enseco ID: 1075025
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: See Below
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Chloride	347	mg/L	30.0	300.0	NA	15 MAY 90
Sulfate	2750	mg/L	50.0	300.0	NA	15 MAY 90
Total Dissolved Solids	4320	mg/L	50.0	160.1	NA	11 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Mary Grehl

Approved By: Toni Stovall

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW-14
Lab ID: 009431-0003-SA Enseco ID: 1075026
Matrix: AQUEOUS Sampled: 06 MAY 90 Received: 08 MAY 90
Authorized: 08 MAY 90 Prepared: NA Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan Approved By: Greg Gustina

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name: Dames and Moore
Client ID: MW-14
Lab ID: 009431-0003-SA
Enseco ID: 1075026
Matrix: AQUEOUS
Sampled: 06 MAY 90
Received: 08 MAY 90
Authorized: 08 MAY 90
Prepared: NA
Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: William Sullivan

Approved By: Greg Gustina

General Inorganics

Client Name: Dames and Moore
Client ID: MW-14
Lab ID: 009431-0003-SA Enseco ID: 1075026
Matrix: AQUEOUS Sampled: 06 MAY 90 Received: 08 MAY 90
Authorized: 08 MAY 90 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Chloride	202	mg/L	30.0	300.0	NA	15 MAY 90
Sulfate	2120	mg/L	50.0	300.0	NA	15 MAY 90
Total Dissolved Solids	3980	mg/L	50.0	160.1	NA	11 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Mary Grehl Approved By: Toni Stovall

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\%\ \text{Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{|\ \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2}\ |}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009431-0001-SA	AQUEOUS	602-A	14 MAY 90-P	14 MAY 90-P
009431-0001-SA	AQUEOUS	601-A	14 MAY 90-F	14 MAY 90-F
009431-0002-SA	AQUEOUS	602-A	14 MAY 90-P	14 MAY 90-P
009431-0002-SA	AQUEOUS	601-A	15 MAY 90-F	15 MAY 90-F
009431-0003-SA	AQUEOUS	602-A	14 MAY 90-P	14 MAY 90-P
009431-0003-SA	AQUEOUS	601-A	14 MAY 90-F	14 MAY 90-F

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC

	Concentration				Accuracy		Precision	
Analyte	Spiked		Measured		Average(%)		(RPD)	
		DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Category: 602-A Matrix: AQUEOUS QC Lot: 14 MAY 90-P Concentration Units: ug/L								
Benzene	5.0	4.55	4.58	4.56	91	80-120	0.7	15
Toluene	5.0	4.47	4.48	4.48	90	80-120	0.2	15
Ethylbenzene	5.0	4.54	4.51	4.52	91	80-120	0.7	15
Xylenes (total)	5.0	4.53	4.56	4.54	91	80-120	0.7	15
1,3-Dichlorobenzene	5.0	4.85	4.85	4.85	97	80-120	0.0	15
Category: 601-A Matrix: AQUEOUS QC Lot: 14 MAY 90-F Concentration Units: ug/L								
1,1-Dichloroethane	5.0	4.57	4.81	4.69	94	80-130	5.1	20
Chloroform	5.0	5.98	6.40	6.19	124	80-120	6.8	20
Bromodichloromethane	10	10.0	10.6	10.3	103	80-120	5.8	20
Trichloroethene	5.0	5.01	5.31	5.16	103	70-120	5.8	20
Chlorobenzene	5.0	4.55	4.92	4.74	95	80-120	7.8	20
Category: 601-A Matrix: AQUEOUS QC Lot: 15 MAY 90-F Concentration Units: ug/L								
1,1-Dichloroethane	5.0	4.48	4.48	4.48	90	80-130	0.0	20
Chloroform	5.0	6.01	5.98	6.00	120	80-120	0.5	20
Bromodichloromethane	10	10.1	10.1	10.1	101	80-120	0.0	20
Trichloroethene	5.0	5.05	5.04	5.04	101	70-120	0.2	20
Chlorobenzene	5.0	4.66	4.67	4.66	93	80-120	0.2	20

Calculations are performed before rounding to avoid round-off errors in calculated results.

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
Category: 602-A Matrix: AQUEOUS QC Lot: 14 MAY 90-P QC Run: 14 MAY 90-P Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	30.3	101	20-160
Category: 601-A Matrix: AQUEOUS QC Lot: 14 MAY 90-F QC Run: 14 MAY 90-F Concentration Units: ug/L				
Bromochloromethane	5.00	6.46	129	20-160
Category: 601-A Matrix: AQUEOUS QC Lot: 15 MAY 90-F QC Run: 15 MAY 90-F Concentration Units: ug/L				
Bromochloromethane	5.00	6.29	126	20-160

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 602-BTEX-AP Matrix: AQUEOUS QC Lot: 14 MAY 90-P QC Run: 14 MAY 90-P			
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0
Test: 601-A Matrix: AQUEOUS QC Lot: 14 MAY 90-F QC Run: 14 MAY 90-F			
1,2-Dichloroethane	ND	ug/L	1.0
Test: 601-A Matrix: AQUEOUS QC Lot: 15 MAY 90-F QC Run: 15 MAY 90-F			
1,2-Dichloroethane	ND	ug/L	1.0

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009431-0001-SA	AQUEOUS	S04-IC-A	15 MAY 90-M	-
009431-0001-SA	AQUEOUS	TDS-A	11 MAY 90-A	11 MAY 90-A
009431-0001-SA	AQUEOUS	CL-IC-A	15 MAY 90-M	-
009431-0002-SA	AQUEOUS	S04-IC-A	15 MAY 90-M	-
009431-0002-SA	AQUEOUS	TDS-A	11 MAY 90-B	11 MAY 90-B
009431-0002-SA	AQUEOUS	CL-IC-A	15 MAY 90-M	-
009431-0003-SA	AQUEOUS	S04-IC-A	15 MAY 90-M	-
009431-0003-SA	AQUEOUS	TDS-A	11 MAY 90-B	11 MAY 90-B
009431-0003-SA	AQUEOUS	CL-IC-A	15 MAY 90-M	-

DUPLICATE CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

	Concentration				Accuracy Average(%)		Precision (RPD)	
Analyte	Spiked	Measured DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Category: SO4-IC-A Matrix: AQUEOUS QC Lot: 15 MAY 90-M Concentration Units: mg/L								
Sulfate	200	201	201	201	101	93-107	0.0	20
Category: TDS-A Matrix: AQUEOUS QC Lot: 11 MAY 90-A Concentration Units: mg/L								
Total Dissolved Solids	935	883	894	888	95	90-110	1.2	10
Category: CL-IC-A Matrix: AQUEOUS QC Lot: 15 MAY 90-M Concentration Units: mg/L								
Chloride	100	101	100	100	101	92-108	1.0	20
Category: TDS-A Matrix: AQUEOUS QC Lot: 11 MAY 90-B Concentration Units: mg/L								
Total Dissolved Solids	935	883	918	900	96	90-110	3.9	10

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Wet Chemistry Analysis and Preparation

Analyte	Result	Units	Reporting Limit
Test: TDS-BAL-A Matrix: AQUEOUS QC Lot: 11 MAY 90-A QC Run: 11 MAY 90-A			
Total Dissolved Solids	ND	mg/L	10.0
Test: TDS-BAL-A Matrix: AQUEOUS QC Lot: 11 MAY 90-B QC Run: 11 MAY 90-B			
Total Dissolved Solids	ND	mg/L	10.0

Enseco - Rocky Mountain Analytical

4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Facsimile: 303/431-7171

CHAIN OF CUSTODY

No.

Attn: Randy Thompson

Enseco Client Dames & Moore
Project Maverik - Refinery
Sampling Co. Dames & Moore
Sampling Site Maverik - FM, New Mexico
Team Leader Levi Todd

SAMPLE SAFE™ CONDITIONS

1. Packed by: ______ Seal # ______
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: ok
4. Sealed for Shipping by: Levi Todd
5. Initial Contents Temp.: 4 °C Seal # ______
6. Sampling Status: [✓ Done] Continuing Until ______
7. Seal Intact Upon Receipt by Laboratory: Yes No
8. Contents Temperature Upon Receipt by Lab: ______ °C
9. Condition of Contents: ______

#

RMA
431

	Date	Time	Sample ID/Description RMA #9431		Sample Type	No. Containers	Analysis Parameters	Remarks
1	5/6	8:45	MW 13	01	WTR	1	TDS, SO_4^{-2}, Cl^-	Minimal fluid. Analyze SO_4^{-2} TDS Cl in that order if insuff.
	5/6	8:45	"		"	~~4~~	BTEX, ~~[illegible]~~ 1,2 DCA	Analyze Voa vial #1, 2 w/out sediment if possible
2	5/6	9:15	MW 15	02	"	1	TDS, SO_4^{-2}, Cl^-	
	5/6	9:15	"		"	5	BTEX, 1,2 DCA	
3	5/6	10:00 am	MW 14	03	"	1	TDS, SO_4^{-2}, Cl^-	
	5/6	1000 a	"		"	5	BTEX; 1,2 DCA	
	5/5	4:00pm	ESP - SOIL		SOIL	1	BTEX	HOLD FOR ANALYSIS UNTIL NOTIFIED

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1				
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: Levi Todd
Method of Shipment: Fed X Airbill # 6065557665
Received for Lab: RMA Signed: Ch Pa Date/Time 05-08-90 0800
Enseco Project No. 9431

White and Pink Copies to Lab Yellow to Sampler

SS-001

Rocky Mountain
Analytical Laboratory

Enseco

May 25, 1990

Peter F. Olsen, Ph.D.
Dames and Moore
127 South 500 East
Suite 300
Salt Lake City, UT 84102

Dear Pete:

Enclosed is the report for two aqueous samples we received at Enseco-Rocky Mountain Analytical Laboratory on May 4, 1990.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Randall Thompson
Program Administrator

RT/dmh
Enclosures

RMAL #009386

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

ANALYTICAL RESULTS
FOR
DAMES AND MOORE
ENSECO-RMAL NO. 009386

MAY 25, 1990

Enseco

Reviewed by: ____________________
Randall Thompson

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

SAMPLE DESCRIPTION INFORMATION
for
Dames and Moore

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
009386-0001-SA	MW #10-1,2,3	AQUEOUS	02 MAY 90	14:30	04 MAY 90
009386-0002-SA	MW #9A,B,C	AQUEOUS	02 MAY 90	16:30	04 MAY 90

ANALYTICAL TEST REQUESTS
for
Dames and Moore

Lab ID: 009386	Group Code	Analysis Description	Custom Test?
0001 - 0002	A	Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)	N
		Halogenated Volatile Organics	Y
		Sulfate, Ion Chromatography	N
		Chloride, Ion Chromatography	N
		Total Dissolved Solids (TDS)	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, April, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW #10-1,2,3
Lab ID: 009386-0001-SA Enseco ID: 1074723
Matrix: AQUEOUS Sampled: 02 MAY 90 Received: 04 MAY 90
Authorized: 04 MAY 90 Prepared: NA Analyzed: 08 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	2.0	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: Nathaniel Biah Approved By: Barbara Sullivan

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name: Dames and Moore
Client ID: MW #10-1,2,3
Lab ID: 009386-0001-SA
Enseco ID: 1074723
Matrix: AQUEOUS
Sampled: 02 MAY 90
Received: 04 MAY 90
Authorized: 04 MAY 90
Prepared: NA
Analyzed: 10 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: Nathaniel Biah

Approved By: Barbara Sullivan

General Inorganics

Client Name:	Dames and Moore				
Client ID:	MW #10-1,2,3				
Lab ID:	009386-0001-SA	Enseco ID:	1074723		
Matrix:	AQUEOUS	Sampled:	02 MAY 90	Received:	04 MAY 90
Authorized:	04 MAY 90	Prepared:	See Below	Analyzed:	See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Chloride	72.1	mg/L	3.0	300.0	NA	07 MAY 90
Sulfate	577	mg/L	25.0	300.0	NA	07 MAY 90
Total Dissolved Solids	1300	mg/L	14.0	160.1	NA	08 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Kimberly Conroy   Approved By: Toni Stovall

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW #9A,B,C
Lab ID: 009386-0002-SA
Enseco ID: 1074724
Matrix: AQUEOUS
Sampled: 02 MAY 90
Received: 04 MAY 90
Authorized: 04 MAY 90
Prepared: NA
Analyzed: 08 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	3.3	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: Nathaniel Biah

Approved By: Barbara Sullivan

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name:	Dames and Moore				
Client ID:	MW #9A,B,C				
Lab ID:	009386-0002-SA	Enseco ID:	1074724		
Matrix:	AQUEOUS	Sampled:	02 MAY 90	Received:	04 MAY 90
Authorized:	04 MAY 90	Prepared:	NA	Analyzed:	10 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0

ND = Not detected
NA = Not applicable

Reported By: Nathaniel Biah

Approved By: Barbara Sullivan

General Inorganics

Client Name: Dames and Moore
Client ID: MW #9A,B,C
Lab ID: 009386-0002-SA
Matrix: AQUEOUS
Authorized: 04 MAY 90
Enseco ID: 1074724
Sampled: 02 MAY 90
Prepared: See Below
Received: 04 MAY 90
Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Chloride	35.0	mg/L	3.0	300.0	NA	07 MAY 90
Sulfate	574	mg/L	10.0	300.0	NA	07 MAY 90
Total Dissolved Solids	1190	mg/L	14.0	160.1	NA	08 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Kimberly Conroy

Approved By: Toni Stovall

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\%\ \text{Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{|\ \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2}\ |}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009386-0001-SA	AQUEOUS	602-A	10 MAY 90-P	10 MAY 90-P
009386-0001-SA	AQUEOUS	601-A	08 MAY 90-F	08 MAY 90-F
009386-0002-SA	AQUEOUS	602-A	10 MAY 90-P	10 MAY 90-P
009386-0002-SA	AQUEOUS	601-A	08 MAY 90-F	08 MAY 90-F

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC

Category: 602-A
Matrix: AQUEOUS
QC Lot: 10 MAY 90-P
Concentration Units: ug/L

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
Benzene	5.0	4.93	4.94	4.94	99	80-120	0.2	15
Toluene	5.0	4.80	4.79	4.80	96	80-120	0.2	15
Ethylbenzene	5.0	4.82	4.80	4.81	96	80-120	0.4	15
Xylenes (total)	5.0	4.79	4.80	4.80	96	80-120	0.2	15
1,3-Dichlorobenzene	5.0	5.04	5.05	5.04	101	80-120	0.2	15

Category: 601-A
Matrix: AQUEOUS
QC Lot: 08 MAY 90-F
Concentration Units: ug/L

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
1,1-Dichloroethane	5.0	4.12	4.27	4.20	84	80-130	3.6	20
Chloroform	5.0	4.53	4.63	4.58	92	80-120	2.2	20
Bromodichloromethane	10	8.87	9.33	9.10	91	80-120	5.1	20
Trichloroethene	5.0	4.86	4.74	4.80	96	70-120	2.5	20
Chlorobenzene	5.0	4.16	4.40	4.28	86	80-120	5.6	20

Calculations are performed before rounding to avoid round-off errors in calculated results.

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 602-A Matrix: AQUEOUS QC Lot: 10 MAY 90-P QC Run: 10 MAY 90-P Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	30.3	101	20-160
Category: 601-A Matrix: AQUEOUS QC Lot: 08 MAY 90-F QC Run: 08 MAY 90-F Concentration Units: ug/L				
Bromochloromethane	5.00	4.39	88	20-160

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 602-BTEX-AP Matrix: AQUEOUS QC Lot: 10 MAY 90-P QC Run: 10 MAY 90-P			
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0
Test: 601-A Matrix: AQUEOUS QC Lot: 08 MAY 90-F QC Run: 08 MAY 90-F			
1,2-Dichloroethane	ND	ug/L	1.0

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009386-0001-SA	AQUEOUS	S04-IC-A	07 MAY 90-M	-
009386-0001-SA	AQUEOUS	CL-IC-A	07 MAY 90-M	-
009386-0001-SA	AQUEOUS	TDS-A	08 MAY 90-A	08 MAY 90-A
009386-0002-SA	AQUEOUS	S04-IC-A	07 MAY 90-M	-
009386-0002-SA	AQUEOUS	CL-IC-A	07 MAY 90-M	-
009386-0002-SA	AQUEOUS	TDS-A	08 MAY 90-A	08 MAY 90-A

DUPLICATE CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Average(%) Limits	Precision (RPD) DCS	Precision (RPD) Limit
Category: S04-IC-A Matrix: AQUEOUS QC Lot: 07 MAY 90-M Concentration Units: mg/L								
Sulfate	200	195	195	195	98	93-107	0.0	20
Category: CL-IC-A Matrix: AQUEOUS QC Lot: 07 MAY 90-M Concentration Units: mg/L								
Chloride	100	98.8	98.4	98.6	99	92-108	0.4	20
Category: TDS-A Matrix: AQUEOUS QC Lot: 08 MAY 90-A Concentration Units: mg/L								
Total Dissolved Solids	1270	1200	1190	1200	94	90-110	0.8	10

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Wet Chemistry Analysis and Preparation

Test: TDS-BAL-A
Matrix: AQUEOUS
QC Lot: 08 MAY 90-A QC Run: 08 MAY 90-A

Analyte	Result	Units	Reporting Limit
Total Dissolved Solids	14.0	mg/L	10.0

Enseco - Rocky Mountain Analytical

4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Facsimile: 303/431-7171

CHAIN OF CUSTODY

No. 2

Attn: Rocky Thompson / Jennie Hanhart

Enseco Client: Dames & Moore

Project: MAVERIK

Sampling Co.: Dames & Moore

Sampling Site: Maverik Refinery - Fm, NM

Team Leader: LEVI TODD

SAMPLE SAFE™ CONDITIONS

1. Packed by: LEVI TODD Seal #
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: ok
4. Sealed for Shipping by: Levi Todd
5. Initial Contents Temp.: 4 °C Seal #
6. Sampling Status: Done [✓ Continuing Until] 5/6?
7. Seal Intact Upon Receipt by Laboratory: Yes No
8. Contents Temperature Upon Receipt by Lab: °C
9. Condition of Contents:

MA# 386	Date	Time	Sample ID/Description	Sample Type	No. Containers	Analysis Parameters	Remarks
01	5/2/90	2:30pm	MW #10-1, MW10-2, MW10-3	WTR	3	BTEX	Analyze #1 if possible
01	5/2/90	"	MW 10-1, MW 10-2	WTR	2	1,2 DCA	
01	5/2/9	2:30	MW 10	WTR	1	SO_4^{-2}, TDS, Cl^-	
02	5/2/9	4:30 -5:00	MW 9 A, MW9 B, MW9 C	"	3	BTEX	Analyze #A if possible
02	"	"	MW 9 A, MW9 B	"	2	1,2 DCA	
02	5/2/9		MW9	"	1	SO_4^{-2}, TDS, Cl^-	

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1	Levi Todd	FED EX		
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: Levi Todd

Method of Shipment: FED EX Airbill # 6067169754

Received for Lab: RMA Signed: Date/Time 5/4/90

Enseco Project No. 080

White and Pink Copies to Lab Yellow to Sampler

SS-

Rocky Mountain
Analytical Laboratory

Enseco

May 18, 1990

Peter F. Olsen, Ph.D.
Dames and Moore
Suite 300
127 South 500 East
Salt Lake City, UT 84102-1959

Dear Pete:

Enclosed is the report for one aqueous sample we received at Enseco-Rocky Mountain Analytical Laboratory on May 7, 1990.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Randall Thompson
Program Administrator

RT/dmh
Enclosures

RMAL #009412

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

ANALYTICAL RESULTS
FOR
DAMES AND MOORE
ENSECO-RMAL NO. 009412

MAY 18, 1990

Enseco

Reviewed by: Randall Thompson

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration curve, samples were diluted. For this project sample 009412-0001 was diluted during the Method 8010 and 8020 analyses due to concentrations of target compounds. The reporting limits have been adjusted relative to these dilutions.

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

SAMPLE DESCRIPTION INFORMATION
for
Dames and Moore

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
009412-0001-SA	MW12-A,B,C,D,E	AQUEOUS	05 MAY 90	11:30	07 MAY 90

ANALYTICAL TEST REQUESTS
for
Dames and Moore

Lab ID: 009412	Group Code	Analysis Description	Custom Test?
0001	A	Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)	N
		Halogenated Volatile Organics	Y
		Sulfate, Ion Chromatography	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, April, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)

Method 8020

Client Name:	Dames and Moore				
Client ID:	MW12-A,B,C,D,E				
Lab ID:	009412-0001-SA	Enseco ID:	1074940		
Matrix:	AQUEOUS	Sampled:	05 MAY 90	Received:	07 MAY 90
Authorized:	07 MAY 90	Prepared:	NA	Analyzed:	13 MAY 90

Parameter	Result	Units	Reporting Limit
Benzene	10000	ug/L	250
Toluene	2300	ug/L	250
Ethylbenzene	ND	ug/L	250
Xylenes (total)	850	ug/L	500

ND = Not detected
NA = Not applicable

Reported By: Leewaphath Xaiyasang Approved By: Greg Gustina

Halogenated Volatile Organics

Method 8010

Client Name: Dames and Moore
Client ID: MW12-A,B,C,D,E
Lab ID: 009412-0001-SA
Enseco ID: 1074940
Matrix: AQUEOUS
Sampled: 05 MAY 90
Received: 07 MAY 90
Authorized: 07 MAY 90
Prepared: NA
Analyzed: 14 MAY 90

Parameter	Result	Units	Reporting Limit
1,2-Dichloroethane	800	ug/L	50

ND = Not detected
NA = Not applicable

Reported By: William Sullivan

Approved By: Greg Gustina

General Inorganics

Client Name:	Dames and Moore				
Client ID:	MW12-A,B,C,D,E				
Lab ID:	009412-0001-SA	Enseco ID:	1074940		
Matrix:	AQUEOUS	Sampled:	05 MAY 90	Received:	07 MAY 90
Authorized:	07 MAY 90	Prepared:	See Below	Analyzed:	See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Sulfate	25.6	mg/L	5.0	300.0	NA	08 MAY 90

ND = Not detected
NA = Not applicable

Reported By: Steve Pope

Approved By: Kimberly Conroy

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\text{\% Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{|\text{Measured Concentration DCS1} - \text{Measured Concentration DCS2}|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009412-0001-SA	AQUEOUS	602-A	13 MAY 90-YA	13 MAY 90-YA
009412-0001-SA	AQUEOUS	601-A	14 MAY 90-F	14 MAY 90-F

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration				Accuracy Average(%)		Precision (RPD)	
	Spiked	Measured DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Category: 602-A								
Matrix: AQUEOUS								
QC Lot: 13 MAY 90-YA								
Concentration Units: ug/L								
Benzene	5.0	5.25	5.33	5.29	106	80-120	1.5	15
Toluene	5.0	4.62	4.68	4.65	93	80-120	1.3	15
Ethylbenzene	5.0	4.68	4.35	4.52	90	80-120	7.3	15
Xylenes (total)	5.0	4.21	4.28	4.24	85	80-120	1.6	15
1,3-Dichlorobenzene	5.0	3.98	4.04	4.01	80	80-120	1.5	15
Category: 601-A								
Matrix: AQUEOUS								
QC Lot: 14 MAY 90-F								
Concentration Units: ug/L								
1,1-Dichloroethane	5.0	4.57	4.81	4.69	94	80-130	5.1	20
Chloroform	5.0	5.98	6.40	6.19	124	80-120	6.8	20
Bromodichloromethane	10	10.0	10.6	10.3	103	80-120	5.8	20
Trichloroethene	5.0	5.01	5.31	5.16	103	70-120	5.8	20
Chlorobenzene	5.0	4.55	4.92	4.74	95	80-120	7.8	20

Calculations are performed before rounding to avoid round-off errors in calculated results.

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 602-A Matrix: AQUEOUS QC Lot: 13 MAY 90-YA QC Run: 13 MAY 90-YA Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	32.4	108	20-160
Category: 601-A Matrix: AQUEOUS QC Lot: 14 MAY 90-F QC Run: 14 MAY 90-F Concentration Units: ug/L				
Bromochloromethane	5.00	6.46	129	20-160

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 602-BTEX-AP Matrix: AQUEOUS QC Lot: 13 MAY 90-YA QC Run: 13 MAY 90-YA			
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	1.0
Test: 601-A Matrix: AQUEOUS QC Lot: 14 MAY 90-F QC Run: 14 MAY 90-F			
1,2-Dichloroethane	ND	ug/L	1.0

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
009412-0001-SA	AQUEOUS	SO4-IC-A	08 MAY 90-N	-

DUPLICATE CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Category: S04-IC-A
Matrix: AQUEOUS
QC Lot: 08 MAY 90-N
Concentration Units: mg/L

	Concentration				Accuracy		Precision	
		Measured			Average(%)		(RPD)	
Analyte	Spiked	DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Sulfate	200	188	191	190	95	93-107	1.6	20

Calculations are performed before rounding to avoid round-off errors in calculated results.

APPENDIX B

AS-BUILTS, SLURRY WALL

SLURRY WALL INSTALLATION REPORT
MAVERIK COUNTRY STORES, INC.
CARIBOU REFINERY
FARMINGTON, NEW MEXICO

Prepared for:

Dames and Moore
127 South 500 East
Suite 300
Salt Lake City, Utah 84102-1959

Prepared by:

Envirocon, Inc.
101 International Way
Missoula, Montana 59807

July 1990

ENVIROCON, INC.

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1.0 INTRODUCTION

A slurry trench cutoff wall was constructed for Maverik Country Stores, Inc. (Maverik) at the former Caribou refinery near Farmington, New Mexico. The slurry wall design and the bid and specification package for the project was prepared by Dames & Moore, Inc. of Salt Lake City. Field oversight on behalf of Maverik was also provided by Dames & Moore.

This report summarizes the project and the work performed to install the slurry wall in accordance with the construction documents. This report includes operational summaries of the work, quality control test data summaries, and as-built information, and is summarized within the following sections.

2.0 PROJECT DESCRIPTION

The purpose of the project was to install a slurry trench cutoff wall around the perimeter of an area within the Caribou refinery. This area represents a potential source of contaminants that may be subject to migration within the ground water. The use of the slurry wall will provide containment of the ground water, minimize future potential migration, and facilitate future remedial actions. This section briefly outlines the site characteristics, chemical contaminants, and the concept behind the approach.

2.1 Site Characteristics

The former Caribou refinery is located just west of Farmington, New Mexico as shown on Figure 1. The refinery is currently inactive and was used previously for refining crude oil into various gasoline formulations. The layout of the refinery facilities is also shown on Figure 1.

The area of the refinery where the slurry wall was installed is within the above-ground tank storage area. This area is located on a sidehill that slopes from north to south with an average slope of approximately 4 percent.

The near-surface soils at the site include sands at the surface which extend to depths ranging from approximately 8 to 23 feet. Beneath the sand is a layer of silty clay that varies in thickness beneath the site from approximately a trace to 12 feet. Underlying the silty clay layer is a layer of gravel of unknown thickness.

Ground water beneath the site flows from north to south. The ground water within the vicinity of the slurry wall is deepest at the north side and becomes shallower (approximately 4 feet) along the south end of the slurry wall alignment.

2.2 Chemical Contamination

The chemical contamination at the refinery is presumably a result of leaks from the tanks and piping within the refinery. The materials leaked have been intermixed with the subsoils and ground water. The predominant contaminants are petroleum hydrocarbons and the associated additives used for gasoline formulation. These contaminants include tetraethyl lead, benzene, xylene, toluene, and ethylbenzene, in addition to the base petroleum hydrocarbons.

The concentration of contaminants across the site varies widely as evidenced by the subsurface soils encountered during excavation for the slurry wall. The odors which emanated from the soils varied widely with some soils having no distinct evidence of any contamination.

2.3 Slurry Wall Construction

The contamination at the facility and the potential for contaminant migration within the ground water makes it appropriate to consider facility-wide source control measures that will contain and prevent future migration. The slurry wall, as designed, accomplishes containment by creating a relatively impermeable barrier to ground water flow either into or away from the area contained.

The slurry wall constructed was formed by excavating a vertical trench from the ground surface down into the underlying silty clay or gravel layer, as required by the Resident Project Representative for Dames and Moore. The trench stability during excavation was maintained by flooding with a water-bentonite slurry mixture. The excavated soils were then mixed with slurry and dry bentonite at a 3 percent by weight mixture. The mixing process was monitored to assure complete mixing, although mixing was hampered somewhat by the dry sand prevalent across the surface of the site. The soils, once properly moisture conditioned and mixed, were then placed back in the trench. The placement operations were performed progressively from a single point to allow backfill to horizontally displace previously deposited materials, rather than freefall through the slurry.

Once the slurry wall was backfilled, the upper 1 foot of material was removed to facilitate placement of a vapor barrier and structural backfill. The structural backfill was placed over the vapor barrier and then compacted using a vibratory plate compactor.

3.0 DESCRIPTION OF WORK

The work performed for the construction of the slurry wall involved a number of activities. The following sections outline the predominant field construction activities.

3.1 Site Preparation

The site required a number of operations to prepare for slurry wall installation. These operations primarily involved site grading operations to allow access by equipment and sufficient clearance for slurry wall installation. The site grading work performed is summarized on Figure 2.

3.2 Work Zones

The presence of hazardous materials at the site required that measures be taken, in accordance with the Corporate Health and Safety Plan, to separate work zones. The separation of work zones was performed to limit the potential exposure of workers to chemicals and prevent migration of chemicals present to adjacent areas as a result of the planned construction activities.

The facility was divided into three work zones, including the following:

- Exclusion Zone - The area contained within the perimeter of the slurry wall. For practical purposes, the exclusion zone boundary was a temporary fence which extended around the top of the dike used to control access. The temporary fence was determined to be sufficient since Envirocon or security personnel were present on a 24-hour-a-day basis;

- Contaminant Reduction Zone - An area adjacent to the exclusion zone which allowed access by personnel to a personal decontamination station equipped with a water bath, portable eye wash, and personal protective equipment supplies; and

- Support Zone - An area external to the exclusion zone where equipment was staged, office facilities and water supply were present, and an emergency shower was available.

These work zones are shown on Figure 3. The ongoing function of these zones and enforcement of the Corporate and Site-Specific Health and Safety Plan during site operations was maintained by the Site Safety Representative.

During the project, the zones, as arranged, worked well in providing protection to health and safety by preventing the spread of contamination and by facilitating worker relief because of the 100°F temperatures.

3.3 Slurry Mixing

Slurry mixing was accomplished by constructing a pond within the central portion of the site as shown on Figure 2. The pond was approximately 75 feet square with an effective depth of approximately 6 feet. The construction of the pond was performed by excavating soils within the area with the bulldozer and placement of the soils to form a perimeter berm. The excavation of the soils within the bottom of the pond was limited by the prevalence of contamination within the subsoils at a depth of approximately 2.5 to 3 feet. The resulting pond configuration was determined to be adequate for mixing a sufficient volume of slurry for the project. The pond was not lined because of the sealing action inherent with the bentonite slurry that was to be contained within the pond.

The bentonite mixed into slurry for use in the trench was delivered to the project site in pneumatic trucks. The bentonite slurry was then formed by mixing water with the bentonite. The mixing process utilized water from a hydrant located in the support zone. The water was routed through a high-shear mixing valve which mixed the water with the bentonite under pressure from the pneumatic trucks. The high-shear action of the mixing valve wetted the bentonite and facilitated more rapid and complete hydration of the bentonite than by using typical contact mixing methods.

Bentonite that was mixed into the slurry and placed within the pond was delivered on a one truck per day basis. This allowed mixing of measured amounts of slurry in a way to monitor hydration and slurry viscosity. This monitoring was appropriate to determine the potential magnitude of impacts on slurry characteristics created by the degree of hardness within the water. A summary of the bentonite usage in the ponds per truck is presented on Table 1.

An approximate total of 107,000 pounds of bentonite was mixed with water and placed within the mixing pond. For the purposes of hydration and to facilitate later adjustments in the slurry viscosity, the slurry was mixed at a relatively high solids content of approximately 12 percent. This resulted in approximately 110,000 gallons of hydrated slurry within the pond prior to introduction into the trench.

During the course of the project, the tests performed on the slurry included the following:

- Marsh funnel viscosity;
- Gradation;
- Filtrate loss;

TABLE 1

SUMMARY OF BENTONITE USAGE IN THE SLURRY MIXING POND

DATE DELIVERED	WEIGHT	TYPE OF TRUCK	INVOICE NO.
June 14, 1990	51,900 lb	Pneumatic	001152
June 15, 1990	48,800 lb	Pneumatic	001155
June 17, 1990	6,000 lb	Pneumatic	001156
	106,700 lb		

Bentonite was mixed with approximately 110,000 gallons of water to yield a slurry containing approximately 12 percent by weight.

- Density; and
- pH.

Initial tests performed to determine the Marsh funnel slurry viscosity indicated values of 62 seconds on June 15, 1990 and 67 seconds on June 16, 1990. These tests were performed to evaluate the baseline slurry viscosities and to also identify the impacts of evaporation resulting from the extremely high temperatures (in excess of 100 degrees daily). Water was added periodically to the slurry to maintain values of less than 70 seconds. Throughout the mixing, hydration, and water addition activities, the slurry was mixed daily using 3- and 4-inch diameter trash pumps to recirculate the slurry in the pond. This mixing, coupled with the periodic addition of water, resulted in typical slurry viscosities ranging between 40 and 50 seconds up until the slurry was actually introduced into the trench. A summary of the slurry characteristics as determined over the course of the project is presented on Table 2.

The bentonite used to make the slurry was tested to determine the gradation for evaluation of adherence to the API 13A specification for bentonite oil well drilling fluid materials. The results of these evaluations are summarized on Table 3. As shown on Table 3, the sieve analyses were performed on a dry basis in the field and yielded an average of 93 percent passing a No. 200 sieve. The requirement under API 13A is 96 percent on a wet-sieve basis. The equipment appropriate for such analyses was not available in the field; however, subsequent wet-sieve analysis on a jumbo bag sample indicated that 96.5 percent of the bentonite passed through the No. 200 sieve. Therefore, the bentonite used for the slurry met the API 13A specification.

The filtrate loss of the bentonite was tested during the project. Initial tests were not performed until CO_2 could be obtained for the filtrate test

TABLE 2

POND SLURRY TEST RESULTS

DATE	TIME	VISCOSITY	DENSITY	pH
June 15, 1990	10:00 am	62 seconds	N/A	N/A
June 16, 1990	1:30 pm	67 seconds	N/A	N/A
June 17, 1990	10:45 am	65 seconds	66 pcf	8.9
	11:05 am	48 seconds	65 pcf	8.8
	11:20 am	46 seconds	65 pcf	9.0
June 18, 1990	9:30 am	45 seconds	N/A	N/A
	2:40 pm	62 seconds	N/A	N/A
June 19, 1990	10:55 am	120 seconds*	68 pcf	8.6
	4:30 pm	78 seconds*	N/A	N/A
June 20, 1990	8:50 am	42 seconds	65 pcf	7.8
	11:00 am	55 seconds	N/A	N/A
	11:05 am	42 seconds	N/A	N/A
	3:00 pm	63 seconds	N/A	N/A
June 21, 1990	10:20 am	48 seconds	N/A	N/A
	1:30 pm	49 seconds	67 pcf	8.6
	3:10 pm	47 seconds	66 pcf	8.4
June 22, 1990	9:30 am	44 seconds	66 pcf	N/A
	11:20 am	46 seconds	66 pcf	8.5
	4:10 pm	46 seconds	66 pcf	8.5
June 23, 1990	8:40 am	44 seconds	66 pcf	N/A
	10:10 am	45 seconds	66 pcf	8.4
	3:05 pm	47 seconds	66 pcf	8.3
June 24, 1990	8:00 am	52 seconds	66 pcf	8.4
	2:20 pm	57 seconds	66 pcf	8.4
	4:15 pm	54 seconds	66 pcf	N/A
June 25, 1990	8:45 am	42 seconds	65 pcf	8.5
	N/A	44 seconds	65 pcf	8.6

*Water added to lower viscosity.

TABLE 3

SUMMARY OF BENTONITE DRY SIEVE RESULTS

SOURCE	PERCENT PASSING #40*	PERCENT PASSING #200
Pneumatic truck	100	93%
100 lb bags	100	92%
Jumbo bags*	100	93%

*Wet sieve result was 96.5% passing the #200 sieve.

Note: Unit weight of the bentonite typically ranged from 58 to 60 pcf.

apparatus. The results of the tests eventually performed are summarized on Table 4. As indicated by these test results, the bentonite slurry within the pond met the baseline requirements of the API 13A specification for less than 15 ml of loss over a period of 30 minutes, with the exception of one test. This sample was obtained from an area of the mixing pond which had not been recirculated with the pumps which explains the greater degree of filtrate loss.

As tests were obtained to determine Marsh funnel viscosities, slurry densities were also determined using a mud balance. A summary of the densities obtained within the slurry is presented on Table 2. As shown, the density of the slurry in the pond typically ranged from 65 to 67 pounds per cubic foot (pcf).

The pH of the slurry was determined on a regular basis with the results of the testing being summarized on Table 5. As indicated, the pH values typically ranged from 7.8 to 9.0.

3.4 Trench Excavation

The trench excavation required equipment with the ability to reach to a depth of approximately 25 feet, given the characteristic depths of the underlying silty clay layer into which the slurry wall was typically socketed. The available excavation equipment within the area was limited to equipment with the ability to excavate to depths of 22' 8". Therefore, to assure the necessary excavation depth could be reached, the working surface was lowered by as much as 3 feet below the original ground surface. This excavation was required only within an area directly adjacent to the crude oil storage tank and allowed a more level working area than if the natural surface contours were followed.

TABLE 4
SUMMARY OF FILTRATE ANALYSES

SLURRY ORIGIN	DATE	UNIT WEIGHT	FILTRATE LOSS	FILTER CAKE THICKNESS
Mixing pond	June 21, 1990	67 pcf	13.0 ml	1/8 in
Mixing pond	June 22, 1990	66 pcf	13.0 ml	N/A
Trench slurry	June 22, 1990	89 pcf	24.4 ml	3/16 in
Mixing pond	June 23, 1990	66 pcf	15.5 ml	N/A
Trench slurry	June 24, 1990	70 pcf	12.8 ml	1/8 in
Trench slurry	June 25, 1990	67 pcf	11.6 ml	N/A

TABLE 5

SUMMARY OF pH READINGS

DATE	TIME	pH
June 15, 1990	10:00 am	N/A
June 16, 1990	1:30 pm	N/A
June 17, 1990	10:45 am	8.9
	11:05 am	8.8
	11:20 am	9.0
June 18, 1990	9:30 am	N/A
	2:40 pm	N/A
June 19, 1990	10:55 am	8.6
	4:30 pm	N/A
June 20, 1990	8:50 am	7.8
	11:00 am	N/A
	11:05 am	N/A
	3:00 pm	N/A
June 21, 1990	10:20 am	N/A
	1:30 pm	8.6
	3:10 pm	8.4
June 22, 1990	9:30 am	N/A
	11:20 am	8.5
	4:10 pm	8.5
June 23, 1990	8:40 am	N/A
	10:10 am	8.4
	3:05 pm	8.3
June 24, 1990	8:00 am	8.4
	2:20 pm	8.4
	4:15 pm	N/A
June 25, 1990	8:45 am	8.5
	N/A	8.6

The excavation of the trench was performed using both Komatsu PC-200 and PC-220 excavators. The PC-220 was used predominantly because of its ability to excavate more deeply than the PC-200. The PC-200 was used primarily for mixing the backfill with bentonite to the consistency required for use as backfill.

The excavation of the trench began on Sunday, June 17, 1990 and was completed on June 25, 1990. The depth of the trench varied as anticipated by the construction drawings with the deepest reaches of the trench being located within the northernmost area of the site. A summary of the depth of excavation is presented on Figure 4, while a revised, as-built alignment station map is shown on Figure 5.

During the excavation, two alterations in the alignment were required. The first was a slight curve adjacent to a tank near Station 1+50 to accommodate the swing of the excavator. The second deviation was at the northwest corner of the slurry wall at Station 0+00. This modification was made to better facilitate the turn of the slurry wall alignment. The turn was made in two increments to lessen the angle turned and the potential stability problems that could occur because of such an angle, as shown on Figure 5.

During the excavation operations, three obstacles were encountered. The first was located at approximately Station 1+90, and was discovered to be a subsurface electrical conduit encased in concrete. The concrete and conduit were removed with minimal disruption of the surface area adjacent to the trench.

The second subsurface obstacle was located at approximately Station 8+75, in line with the alignment of a drainage ditch located in an adjacent field. The location of this obstacle is shown on Figure 5, while the drainage ditch alignment is shown as being east and west on Figure 5. The identification of the obstacle in line with the ditch indicated that it could be a buried culvert pipe. This observation was supported by the equipment operator on the excavator that thought that it felt like a corrugated metal pipe.

Potential alternatives for dealing with the suspected pipe were discussed with the Resident Project Representative. These alternatives included a recommendation for the excavation of the pipe outside of the slurry wall alignment and sealing to prevent loss of slurry from within the trench. The reason for this recommendation was because of the penetration that would be present if the obstacle were a pipe and it was left in place. Such a pipe could form a conduit for migration of ground water contained within the slurry wall containment system.

The Resident Project Representative contacted supervisory personnel and discussed the situation. The resultant decision was to excavate the trench as planned, around the obstacle in a manner that would leave nothing in the trench but the obstacle. The intent behind this approach was to allow future evaluation of the potential presence of a pipe and the means to provide proper removal or sealing.

The third obstacle was a located at approximately Station 5+15 and was suspected to be an electrical conduit. This conduit was crossed in the same fashion as the suspected pipe at Station 8+75.

3.5 Backfill Mixing Sequence

As the slurry wall excavation progressed, materials removed were sidecast by the excavator adjacent to the trench alignment. The materials excavated were mixed with bentonite to meet the specified requirement for addition of 3 percent by weight, prior to placement as backfill within the trench.

The mixing sequence for the backfill typically began with moisture conditioning using bentonite slurry from either the trench or the pond. The backfill was then amended with bentonite from one of three sources, including:

- Dumpsters (as deposited by pneumatic trucks);
- 100 lb. bags; and
- Jumbo bags.

The proportioning of the bentonite added to the excavated soils was performed by ongoing evaluation of the panel lengths and depths. A material balance for the bentonite used during the project is presented on Table 6, while a summary of the bentonite characteristics and delivery tickets are presented in Appendix A. As indicated, the average dry, by-weight bentonite addition was in excess of 3 percent. Coupled with the estimated average of 10 to 12 percent bentonite in the slurry used for moisture conditioning, the total resultant bentonite content within the backfill is estimated to be approximately 4 percent based upon slurry usage.

The backfill mixing was accompanied by periodic monitoring using a variety of quality control tests, including:

- Unit weight;
- Slump; and
- Gradation.

A summary of the results of these tests is provided on Table 7, while the results of the gradation tests are summarized in Appendix B.

TABLE 6
SUMMARY OF BENTONITE USAGE*

DATE OF DELIVERY	NET WEIGHT	TYPE OF TRUCK	FORM	STORAGE	INVOICE NO.
June 14, 1990	51,900 lbs	Pneumatic	Bulk	Slurry pond	001152
June 15, 1990	48,800 lbs	Pneumatic	Bulk	Slurry pond	001155
June 17, 18, 1990	51,900 lbs	Pneumatic	Bulk	6,900 lb slurry pond 45,000 lb Dumpster 1	001156
June 18, 1990	49,800 lbs	Pneumatic	Bulk	Dumpster 2	000745
June 20, 1990	54,000 lbs	Flat Bed	100 lb bags	Pallets	001159
June 21, 1990	55,400 lbs	Flat Bed	Jumbo bags	Jumbo bags	001160
	311,800 lbs or 156 tons				

Summary of Allocation:		
	Mixing Pond Slurry	- 107,600 lbs or 53.8 tons
	Backfill	- 191,000 lbs or 95.5 tons
	Unused**	- 13,400 lbs or 6.7 tons

---

*See Appendix B for delivery tickets.

**Equivalent to 4 pallets and 8 bags, plus 1, 400 lbs remaining in Dumpster 2.

TABLE 6 (CONT.)

SUMMARY OF BENTONITE USAGE IN BACKFILL

Interval	Bentonite Usage	
Station 3+50 to 12+42	Dumpster 1	- 45,000 lbs
	1 pallet	- 2,800 lbs
	Dumpster 2	- 16,200 lbs
		64,000 lbs
		or 32 tons

Bentonite Required: (2.5)(350)(20)(110)(.03) = 57,750 lbs or 28.88 tons
Net: 11% extra

Interval	Bentonite Usage	
Station 12+42 to 10+00	Dumpster 2	- 28,350 lbs
	4 pallets	- 11,200 lbs
		39,550 lbs
		or 19.78 tons

Bentonite Required: (2.5)(242)(18)(110)(.03) = 35,937 lbs or 17.97 tons
Net: 10% extra

Interval	Bentonite Usage	
Station 10+00 to 7+25	Dumpster 2	- 4,050 lbs
	10 pallets	- 28,000 lbs
		32,050 lbs
		or 16 tons

Bentonite Required: (2.5)(275)(14)(110)(.03) = 31,762.5 lbs or 15.88 tons
Net: 1% extra

Interval	Bentonite Usage	
Station 7+25 to 3+10	Jumbo bags	- 55,400 lbs
		55,400 lbs
		or 27.7 tons

Bentonite Required: (2.5)(415)(15)(110)(.03) = 51,356 lbs or 25.60 tons
Net: 8% extra

Total Bentonite Required in Backfill: 88.4 tons

Total Bentonite Used in Backfill: 95.5 tons

Net: 8% extra

TABLE 7

SUMMARY OF TESTS ON BACKFILL

DATE	STATION	SLUMP	DENSITY
June 17, 1990	3+13 to 3+48	4.0 in	108 pcf
	3+50	4.5 in	N/A
June 19, 1990	3+13 to 1+75	5.0 in	115 pcf
		3.5 in	118 pcf
		4.0 in	117 pcf
		4.5 in	119 pcf
June 20, 1990	1+75 to 1+50	2.5* in	119 pcf
		3.5* in	120 pcf
		4.75 in	N/A
	1+00	5.0 in	N/A
	1+00	4.5 in	N/A
June 21, 1990	1+50	2.75* in	119 pcf
	0+50	3.0* in	121 pcf
	12+00	5.0 in	N/A pcf
June 22, 1990	11+00	2.0* in	120 pcf
	11+00	3.5* in	120 pcf
	10+50	5.0 in	120 pcf
June 23, 1990	9+75	2.0* in	119 pcf
	9+25	4.0 in	119 pcf
	8+75	4.5 in	120 pcf
June 24, 1990	7+50	4.0 in	122 pcf
	5+75	4.5 in	121 pcf
June 25, 1990	4+20	5.0 in	N/A
	3+75	5.25 in	121 pcf

*Slurry added to provide moisture conditioning.

As shown, the backfill typically ranged in density from 108 to 121 pcf. The densities measured did not vary significantly because of the uniform gradation and composition of the soils excavated.

The measured slumps of the backfill varied from approximately 2 to 6 inches. The specification requirement for slumps to range from 4 to 6 inches resulted in work being performed to increase the slump whenever slumps were below the 4-inch requirement. This often necessitated the use of slurry to provide moisture conditioning, especially because of the extremely hot weather.

The gradation of the backfill was evaluated on an occasional basis to determine the percentage of fines. The uniformity of the soil gradations and the high degree of fines found even within the sandy site soils resulted in a fines contents typically greater than the required 25 percent. Further, the soft nature of the silty clays excavated and the mixing performed with both the bulldozer and the excavator resulted in the clayey fragments being reduced to a size that met the specification requirement for 95 percent passing the No. 40 sieve.

The mixing of the backfill material involved meeting a variety of specified requirements with the most important being the quantity of bentonite added and the mixing effort required to provide a homogeneous backfill with the proper slump. The mixing efforts were enhanced by using both a bulldozer and an excavator. The excavator would amend the excavated soil with bentonite, provide moisture conditioning using slurry from the trench, and provide final mixing and placement in the trench. The bulldozer would move through the excavated materials to aid mixing and would move materials to the excavator for placement in the trench. This sequence resulted in a well-mixed homogeneous backfill.

3.6 Backfill Placement

As outlined in the previous section, both the bulldozer and excavator were used for mixing of the backfill. Once mixed, all backfill placement was performed with the excavator. Using the excavator allowed placement to proceed in a manner that allowed gradual advancement of the backfill face. This placement method also kept equipment away from the edge of the trench, as the surficial soils had no cohesion and were subject to potential wedge failures in areas adjacent to the trench.

The backfill placement was accompanied by ongoing evaluation of slurry densities within the bottom of the trench. In accordance with the specifications, the slurry density in the trench was maintained at least 15 pcf less than the density of the backfill. The critical consideration was the tendency, at times, for the slurry at the bottom of the trench to exceed the specified 90 pcf maximum value that could prevent proper displacement by the backfill. The density of the slurry was subject to increasing beyond this maximum allowed density because of the very sandy nature of the site soils.

In instances where slurry densities became excessive, the excavator was used to bucket the dense slurry from the bottom of the trench. The slurry recovered was then sidecast into the backfill to facilitate moisture conditioning. An attempt was made to use a desanding cyclone; however, a broken mount on the pump precluded building sufficient pressure to operate the cyclone.

The slurry densities were checked on a routine basis to assure proper displacement by the backfill. A summary of the measured densities is presented on Table 8. In instances where the 90 pcf specification was exceeded, trench desanding operations were performed with the excavator until the slurry density was found to be at an acceptable level.

TABLE 8
SUMMARY OF TRENCH BACKFILL DENSITIES

DATE	STATION	DEPTH	DENSITY	VISCOSITY	pH
June 17, 1990	3+20	5 ft	66 pcf	118 sec	8.7
June 19, 1990	3+25	Top	68 pcf	100 sec	N/A
	2+80	Mid	78 pcf	120 sec	8.0
June 20, 1990	1+75	21 ft	89 pcf	90 sec	7.7
	0+75	11 ft	85 pcf	65 sec	7.7
	0+25	21 ft	91 pcf	70 sec	7.5
	12+00	21 ft	94* pcf	85 sec	7.4
	11+85	Top	68 pcf	75 sec	8.2
June 21, 1990	11+75	Top	69 pcf	90 sec	8.0
	11+00	18.3 ft	97* pcf	120 sec	7.2
	10+50	16 ft	95* pcf	95 sec	7.2
	10+00	Bottom	96* pcf	120 sec	7.2
June 22, 1990	10+00	Bottom	95* pcf	120 sec	7.3
	9+50	Bottom	94 pcf	120 sec	7.3
June 23, 1990	7+50	Bottom	104* pcf	120 sec	7.5
	7+40	Bottom	75 pcf	47 sec	N/A
June 24, 1990	6+85	Bottom	100* pcf	125 sec	7.5
	6+50	Bottom	99* pcf	110 sec	7.5
	5+75	Top	76 pcf	70 sec	7.9
	5+75	Bottom	88 pcf	76 sec	7.6
	5+00	Bottom	99* pcf	120 sec	7.2
	4+75	Top	67 pcf	71 sec	7.6
June 25, 1990	3+75	Bottom	85 pcf	50 sec	7.7

*Slurry at bottom of trench removed and used for moisture conditioning.

The backfill placement along the entire length of the slurry wall followed the protocol for progressive placement from a single point to allow horizontal displacement, with one exception. In the area adjacent to the crude oil storage tank (approximately Station 0+25 to 1+00) a large tension crack began to develop at the end of the working day (Wednesday, June 20, 1990). The backfill at the time had been placed at the surface up to approximately Station 1+75. Because of the suspected deep-seated instability of the tension crack, bentonite amendment, mixing and backfill operations were performed at approximately Station 0+50 until the backfill was within approximately 3 feet of the trench surface. The placement of the backfill was successful in preventing a major trench collapse. The following morning, the remaining material required to finish backfilling to the ground surface between Stations 0+50 and 1+75 was mixed and placed.

Evaluation of backfill soundings between Stations 0+50 and 1+75 indicated that the placement of backfill from two points created overlapping mounds of backfill which should have no impact upon the integrity of the slurry wall. Backfill placement within this area would have likely been constrained to the method used to some extent because of the tank adjacent to the slurry wall.

During the course of the project, soundings were made daily of the backfill placed in various portions of the trench. A summary of these soundings is presented on Table 9.

3.7 Structural Backfill Placement

Once the trench was backfilled, the upper 12 inches of material was removed and a minimum three-foot width vapor barrier was placed. The vapor barrier used was a 20-mil very low density polyethylene (VLDPE). Data on this material is provided in Appendix A. The vapor barrier was then covered with a minimum of 12 inches of structural backfill.

TABLE 9

SUMMARY OF BACKFILL SOUNDINGS

DATE	STATION	DEPTH
June 19, 1990	2+37	9.5 ft
	2+50	13.5 ft
	2+75	10.0 ft
	3+00	8.25 ft
	3+25	4.8 ft
	3+50	1.0 ft
June 20, 1990	2+00	10.0 ft
	2+37	5.5 ft
	3+00	1.5 ft
	3+00	0 ft
	2+75	2.4 ft
	2+50	9.5 ft
	2+25	13.2 ft
	2+00	14.25 ft
	1+75	19.6 ft
	2+75	0 ft
	2+50	3.0 ft
	2+25	11.0 ft
	2+00	16.3 ft
	1+75	18.3 ft
	1+50	20.3 ft
	1+25	20.7 ft
	2+25	0 ft
	2+00	8.0 ft
	1+75	10.2 ft
	1+50	17.2 ft
	1+25	18.5 ft
	0+25	18.5 ft
	12+50	19.5 ft

TABLE 9

SUMMARY OF BACKFILL SOUNDINGS

DATE	STATION	DEPTH
	12+25	19.8 ft
	12+00	21.0 ft
June 21, 1990	1+75	0 ft
	1+25	10.0 ft
	1+50	4.6 ft
	0+50	10.8 ft
	0+50	0 ft
	0+25	8.1 ft
	12+75	11.25 ft
	12+50	18.3 ft
	12+25	18.7 ft
	12+00	19.0 ft
	11+75	19.0 ft
	11+50	18.3 ft
	11+25	19.0 ft
	0+50	0 ft
	0+25	3.1 ft
	12+40	13.3 ft
	12+25	15.8 ft
	12+00	20.25 ft
	11+75	18.6 ft
	11+50	17.6 ft
	11+25	18.7 ft
	11+00	18.4 ft
	12+25	0 ft
	12+00	8.6 ft
	11+75	11.3 ft
	11+50	13.75 ft
	11+25	16.2 ft

TABLE 9

SUMMARY OF BACKFILL SOUNDINGS

DATE	STATION	DEPTH
	11+00	17.25 ft
	10+75	16.8 ft
June 22, 1990	10+25	0 ft
	10+00	7.6 ft
	9+75	13.8 ft
	9+50	14.0 ft
	9+25	14.0 ft
	9+00	12.0 ft
June 23, 1990	9+25	0 ft
	9+00	2 ft
	8+75	11.5 ft
	8+50	12.6 ft
	8+25	12.25 ft
June 24, 1990	7+90	0 ft
	7+75	5.2 ft
	7+50	11.25 ft
	7+25	12.3 ft
	7+00	12.6 ft
	7+25	0 ft
	7+00	3.0 ft
	6+75	9.4 ft
	6+50	12.2 ft
June 25, 1990	4+75	0 ft
	4+50	5.75 ft
	4+25	11.2 ft
	4+00	13.9 ft
	3+75	15.25 ft

The structural backfill used was obtained locally and was evaluated for accordance with the specifications. A summary of the sieve analyses performed is provided on Table 10, while copies of the test results are presented in Appendix A.

Once placed, the structural backfill was compacted with a vibratory plate compactor after attempts at compaction using heavy equipment on site were unsuccessful. The compaction of the structural backfill resulted in a stable cap for the slurry wall.

3.8 Site Restoration

Upon completion of compaction operations for the structural backfill, the site was cleaned of construction debris, grading was performed to facilitate future site operations, and contaminated materials excavated adjacent to the slurry wall were graded to within the perimeter of the slurry wall.

3.9 Equipment Decontamination

Upon completion of work with the various pieces of equipment, decontamination operations were performed. Decontamination of heavy equipment was performed by Brian's Power Wash because of a local water district request that no water be used from the fire hydrants at the facility. The protocol used for decontamination provided for gross material removal and decontamination by Envirocon personnel within the exclusion zone established by the perimeter of the slurry wall. This decontamination included that for pumps, hoses, and other small pieces of equipment used during the project. Following decontamination, the two excavators were removed from the exclusion zone for final steam cleaning. Remaining

TABLE 10

STRUCTURAL BACKFILL SIEVE ANALYSIS

SIEVE NO.	SPECIFICATION PERCENT PASSING	ACTUAL PERCENT PASSING
3 inch	100%	100%
1.5 inch	85-95%	85%
3/4 inch	75-95%	74%
No. 4	55-75%	51%
No. 40	20-45%	22%
No. 200	<25%	6%

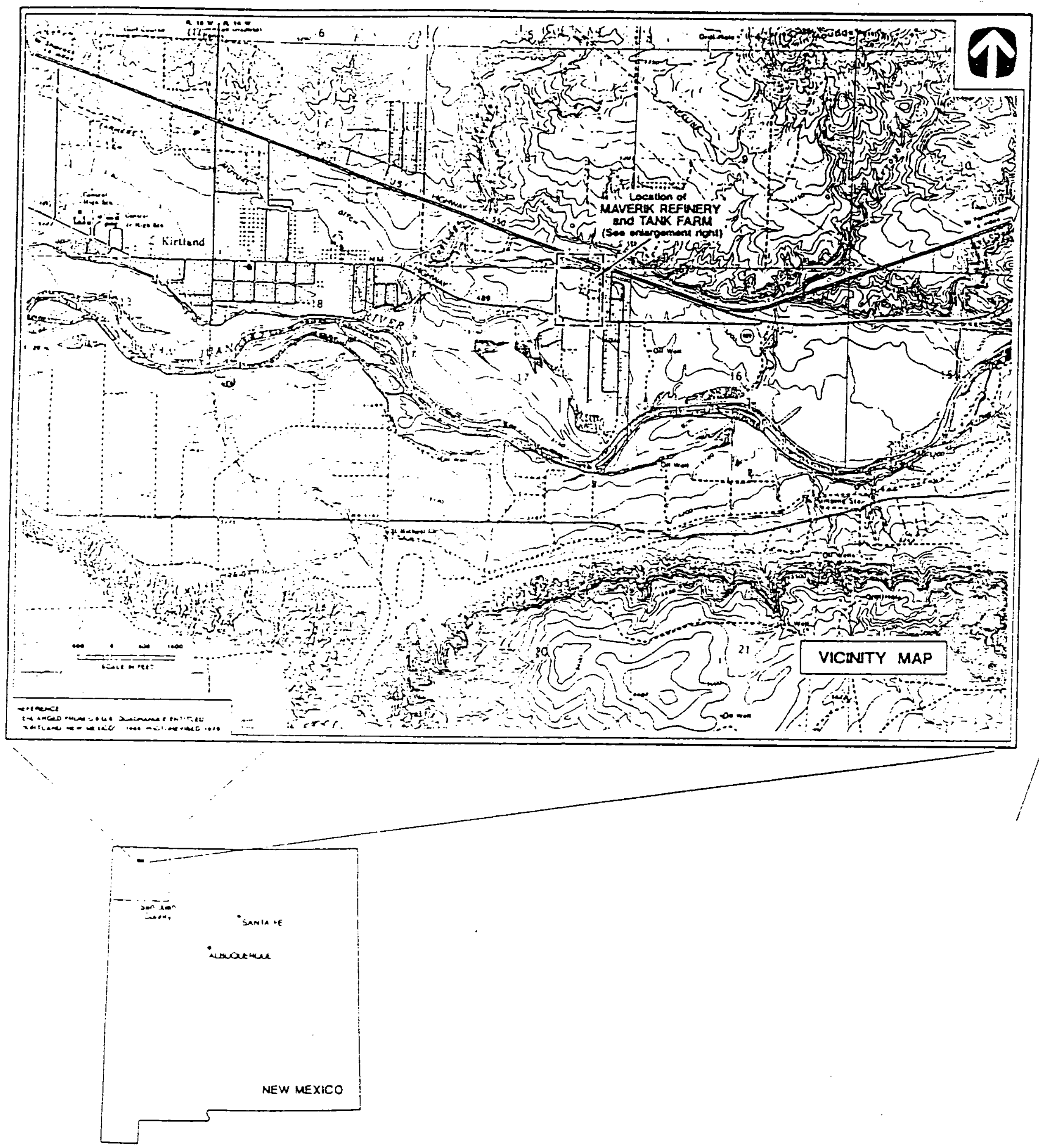
equipment was decontaminated and cleaned, all within the exclusion zone once the site restoration activities were completed.

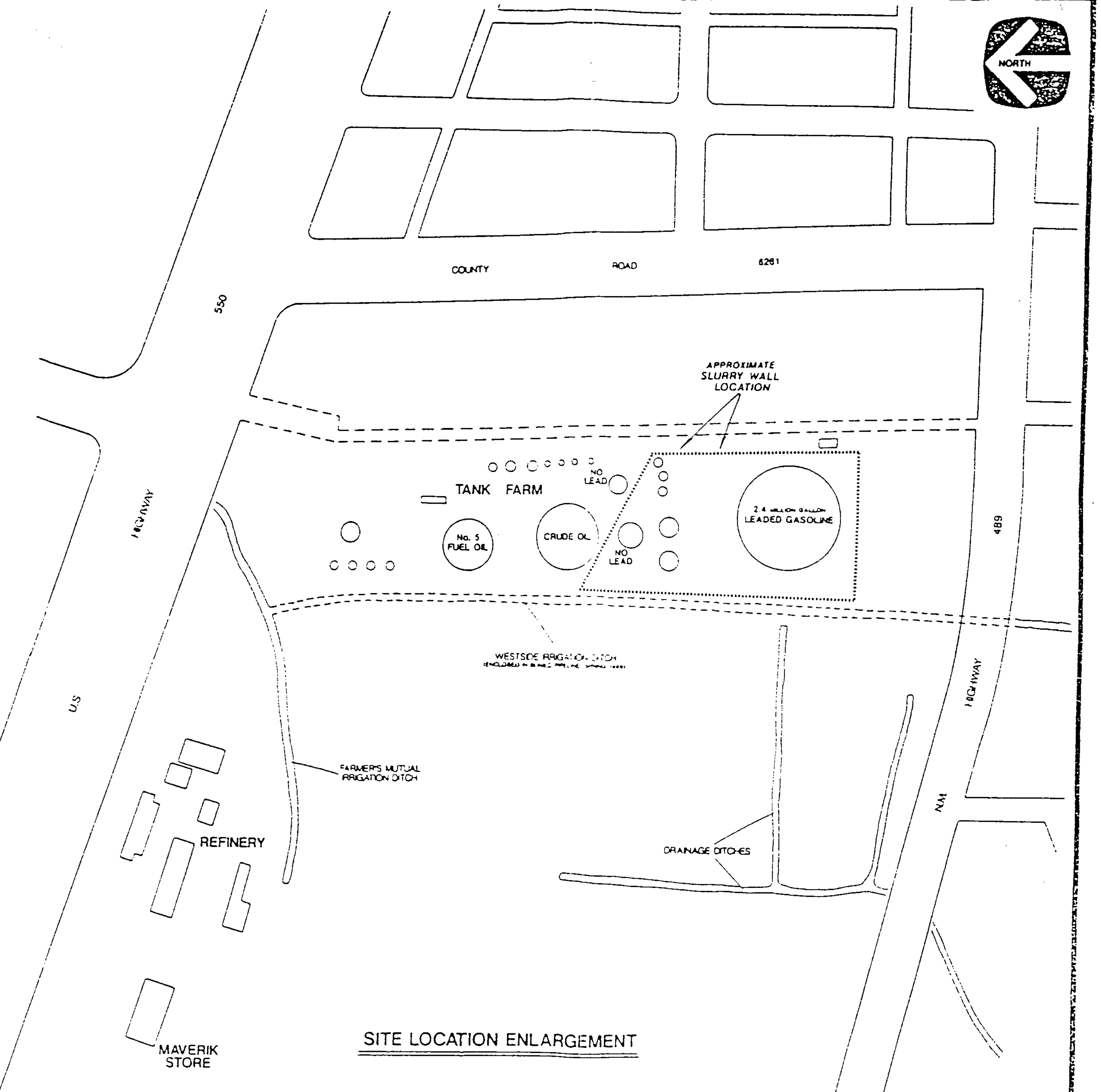
4.0 HEALTH AND SAFETY OPERATIONS SUMMARY

The slurry wall construction operations were performed following a strict protocol for site-specific health and safety as required by the Envirocon Corporate Health and Safety Plan. This section outlines the site-specific health and safety considerations for the project and a brief summary of the training activities.

4.1 Site-Specific Health and Safety Training

The site-specific health and safety program, as shown in Appendix C, was implemented by commencement of activities after performance of a site-specific health and safety orientation. The site-specific orientation was supported by daily health and safety tailgate meetings. The focus of the meetings was on the levels of protection anticipated, proper respiratory protection, and heat stress prevention and monitoring.





SITE LOCATION ENLARGEMENT

NOT TO SCALE: ENLARGEMENT DEVELOPED FROM OBLIQUE AERIAL PHOTOGRAPH SHOT FACING NORTH TO SOUTH RESULTING IN A DISTORTED SCALE ACROSS THE PHOTOGRAPH.

AERIAL SUPPLIED BY THE DARK ROOM FARMINGTON NEW MEXICO PHOTO DATED JULY 1987

INDEX TO DRAWINGS

DESCRIPTION	DRAWING NUMBER
GENERAL VICINITY and SITE LOCATION	1
SLURRY TRENCH ALIGNMENT	2
SUBSURFACE CONDITIONS and SLURRY WALL DETAILS	3

FIGURE 1

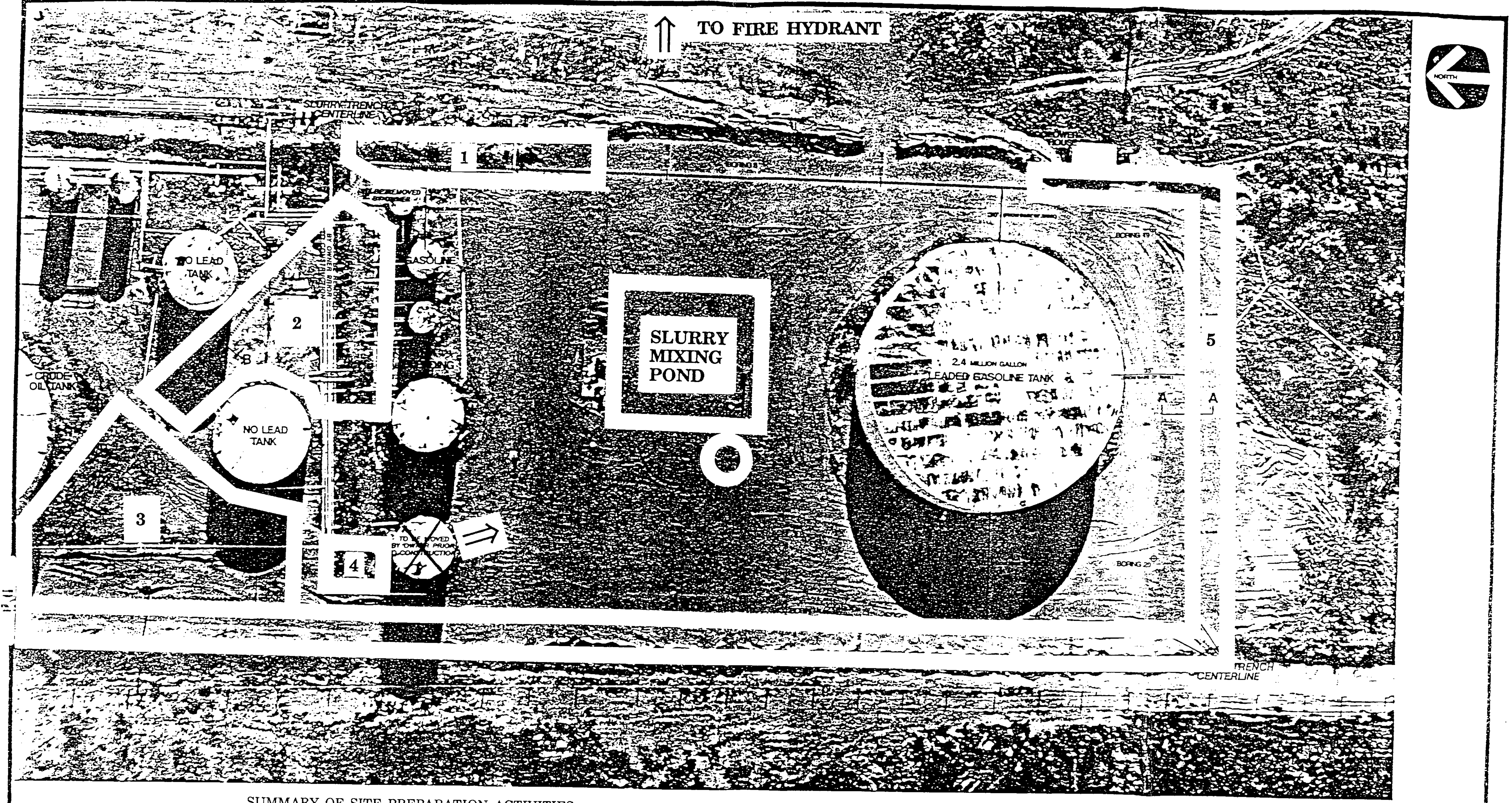
TANK FARM SLURRY WALL CONSTRUCTION
[illegible]
KIRTLAND, NEW MEXICO

GENERAL VICINITY and
SITE LOCATION MAPS

Dames & Moore
Salt Lake City, Utah

Job No. 14819-005-031

Drawing No. 1



SUMMARY OF SITE PREPARATION ACTIVITIES

1. Berm movement - The berm, as shown, required movement to allow adequate room for slurry wall excavation. The excavation work performed encountered some subsurface pipes and electrical conduits, none of which were in service.
2. The control tank storage area required site grading to provide a level working platform as a result of open excavations from which subsurface pipes were removed. Soils within this area were very odorous.
3. Soils adjacent to the crude oil tank were visibly contaminated and were graded away from the slurry wall and backfill mixing areas to minimize their likelihood of being introduced into the slurry wall during backfilling. Only surface contamination was removed as underlying soils were very odorous, once exposed.
4. The berm was removed in the area to minimize impacts on slurry mixing activities. This berm contained pieces of pipe and concrete that made excavation difficult.
5. The berm, within the areas shown, was graded back to allow adequate room for the excavator digging the trench.

20 0 20 40
SCALE IN FEET
(APPROXIMATE)

REFERENCE:
AERIAL PHOTO BASE SUPPLIED BY
DAVE TAYLOR, SPECIAL PHOTOGRAPHY,
FARMINGTON, N.M. - DATED MAY 5, 1990

(SEE DRAWING No. 3 FOR
BORING LOG DESCRIPTIONS)

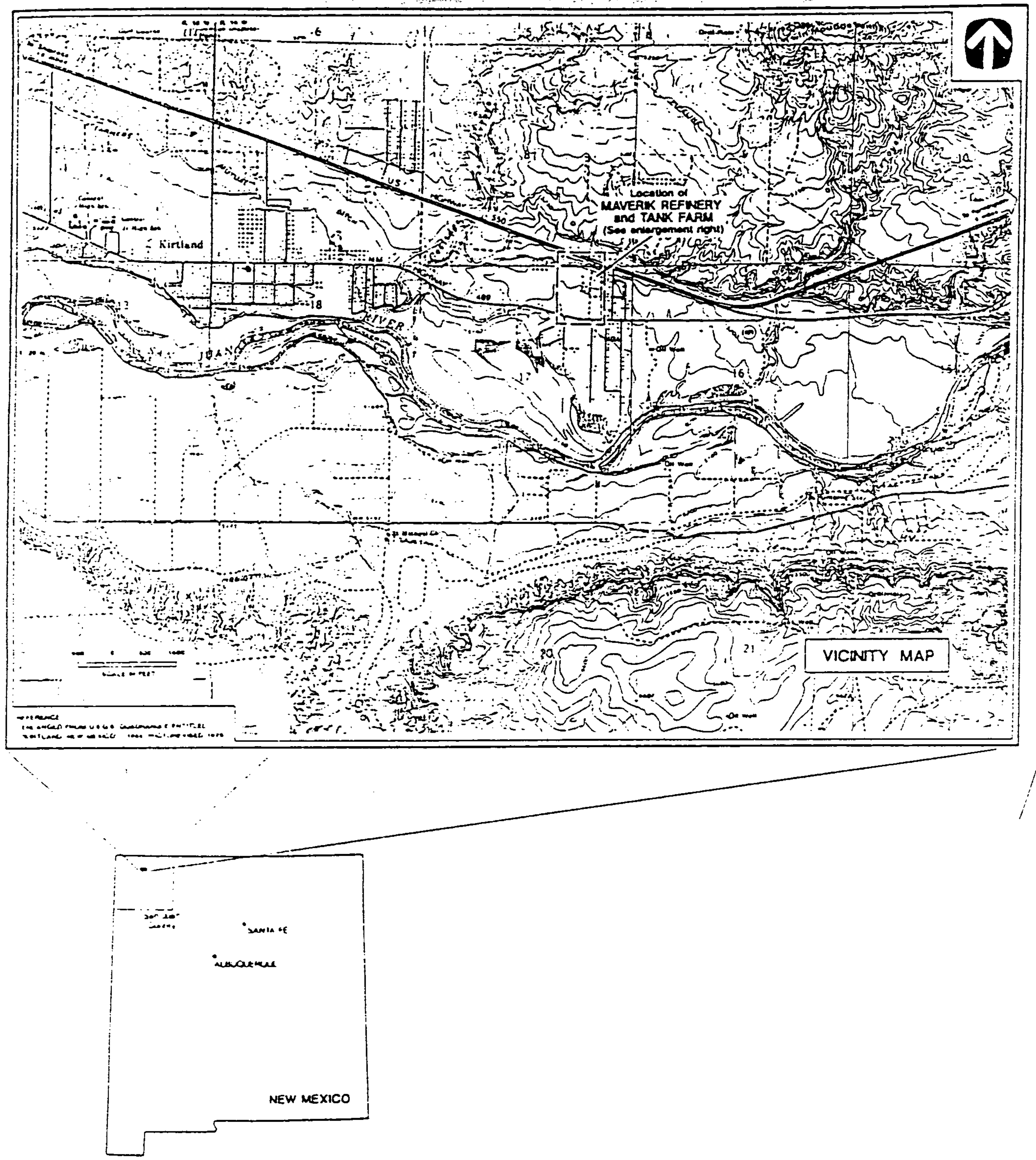
FIGURE 2

TANK FARM SLURRY WALL CONSTRUCTION
MAVERIK COUNTRY STORES, INC.
KIRTLAND, NEW MEXICO

SLURRY TRENCH ALIGNMENT

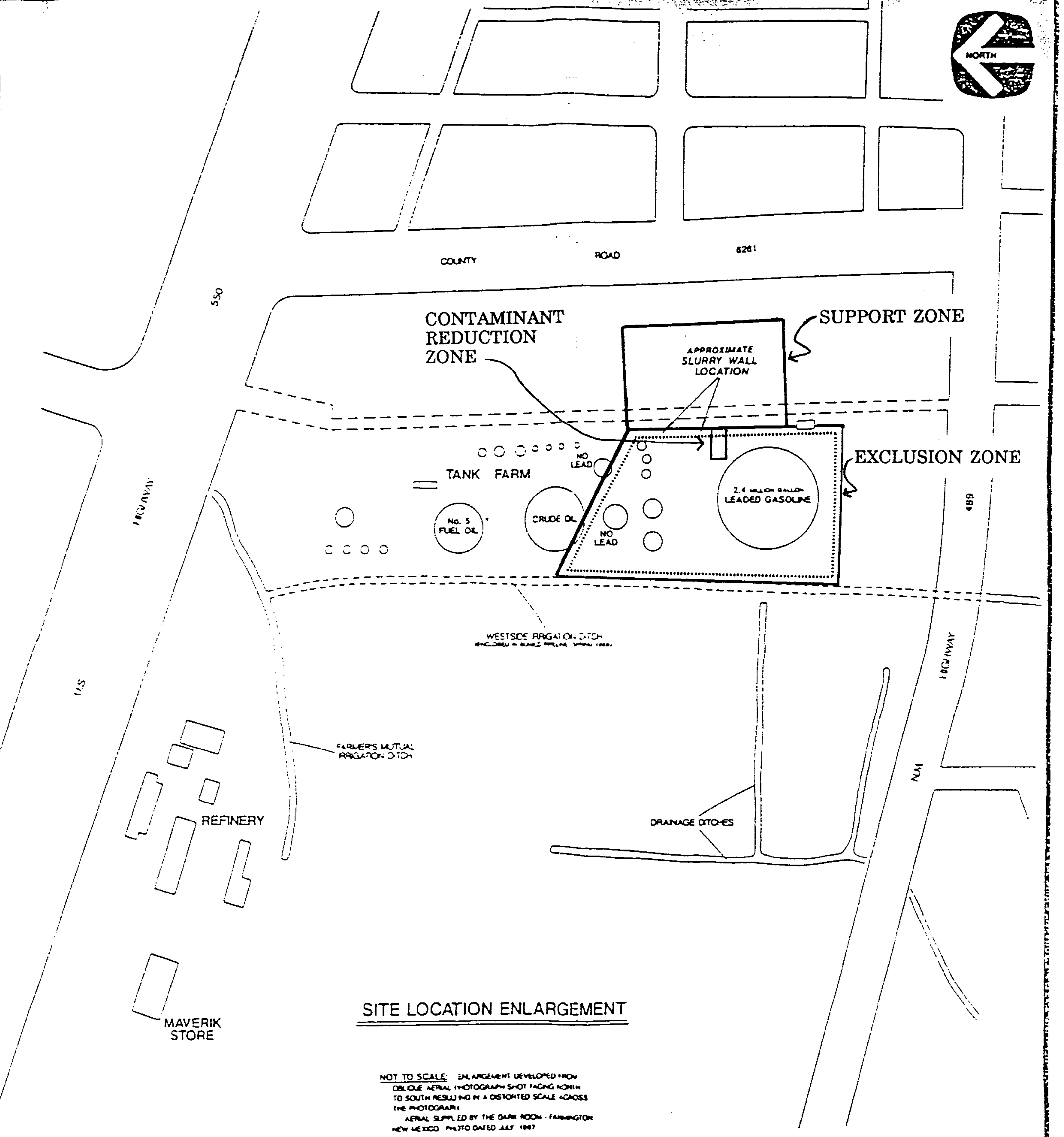
Dames & Moore
Salt Lake City, Utah

JOB No. 14819-005-031
Drawing No. 2



INDEX TO DRAWINGS

DESCRIPTION	DRAWING NUMBER
GENERAL VICINITY and SITE LOCATION	1
SLURRY TRENCH ALIGNMENT	2
SUBSURFACE CONDITIONS and SLURRY WALL DETAILS	3



SITE LOCATION ENLARGEMENT

NOT TO SCALE: ENLARGEMENT DEVELOPED FROM
OBLIQUE AERIAL PHOTOGRAPH SHOT FACING NORTH
TO SOUTH RESULTING IN A DISTORTED SCALE ACROSS
THE PHOTOGRAPH.
AERIAL SUPPLIED BY THE DARK ROOM - FARMINGTON
NEW MEXICO PHOTO DATED JULY 1987

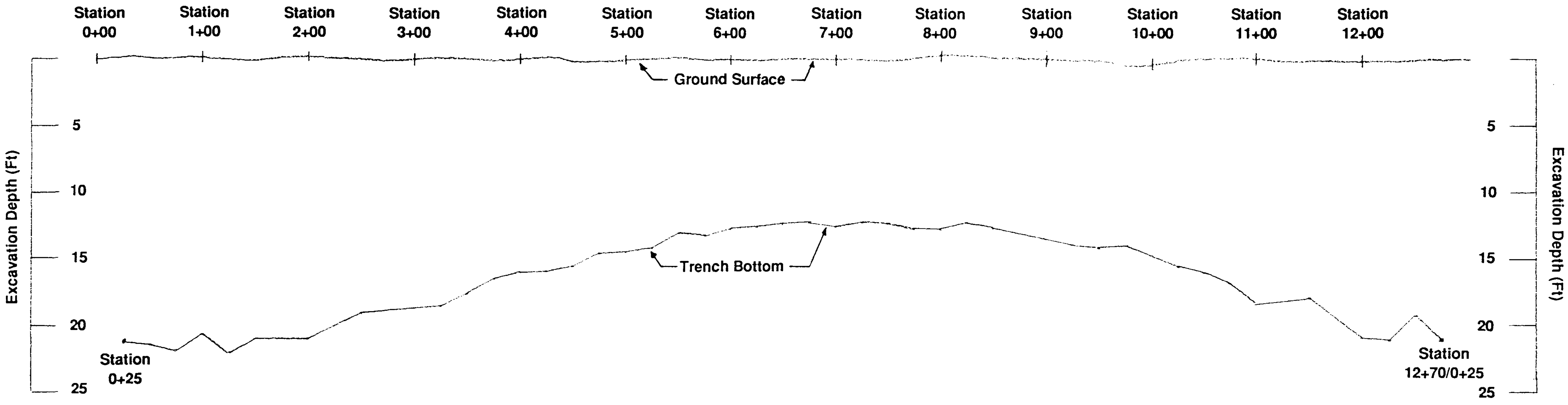
FIGURE 3 - WORK ZONE LOCATIONS

TANK FARM SLURRY WALL CONSTRUCTION
MAVERIK [illegible]
KIRTLAND, NEW MEXICO

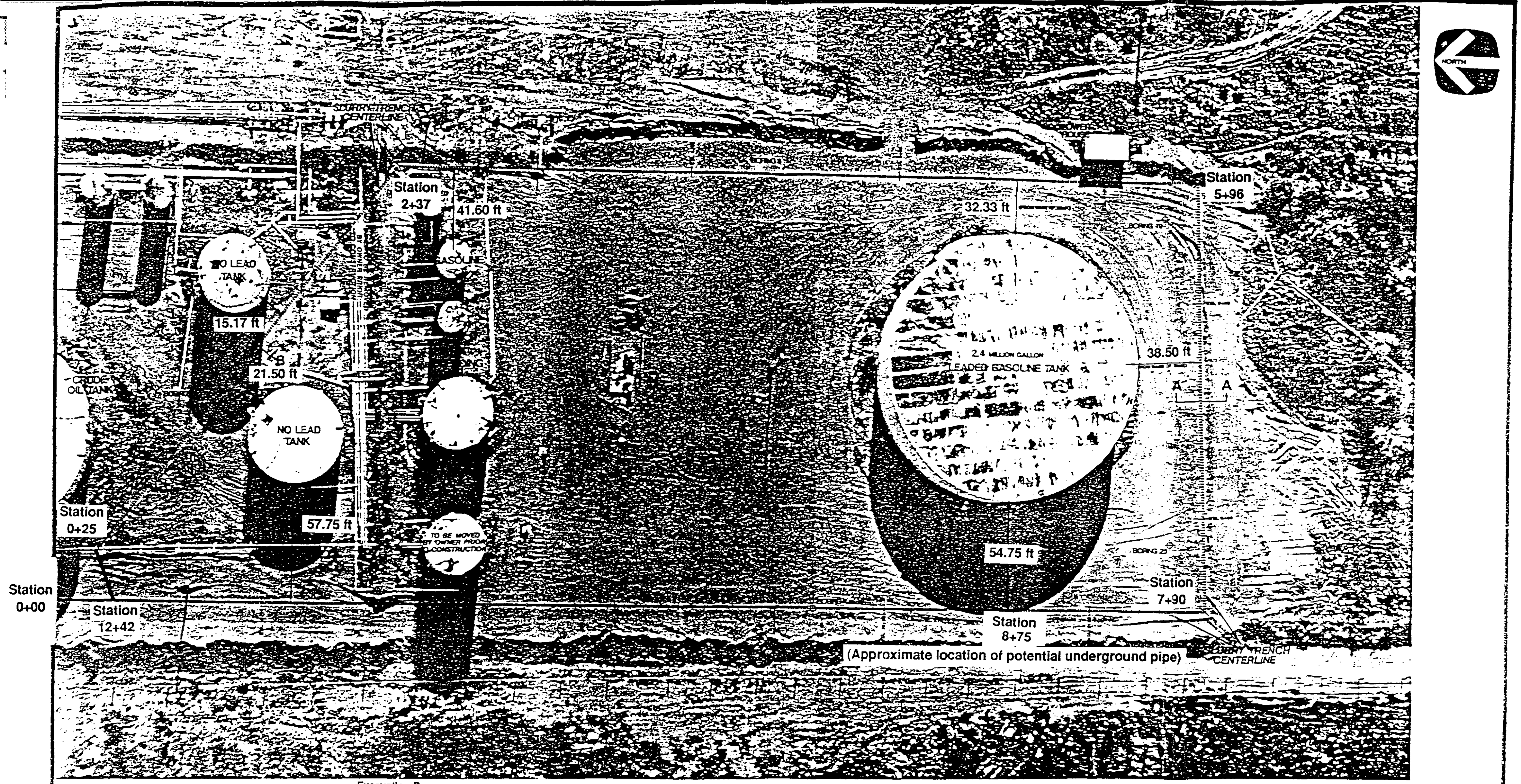
GENERAL VICINITY and
SITE LOCATION MAPS

Dames & Moore
Salt Lake City, Utah

Job No. 14819-005-031
Drawing No. 1



PROJECT No.	ENVIROCON	FIGURE 4 SUMMARY OF EXCAVATION DEPTHS
DATE		
REVISION		



20 0 20 40
SCALE IN FEET
(APPROXIMATE)

REFERENCE-
AERIAL PHOTO BASE SUPPLIED BY
DAVE TAYLOR, SPECIAL PHOTOGRAPHY -
FARMINGTON, N.M. - DATED MAY 5, 1990

Excavation Progress:

Date	Starting Station	Ending Station	Excavation (Ft)
6/17/90	3+50	3+13	37
6/19/90	3+13	1+75	138
6/20/90	1+75	11+75	288
6/21/90	11+75	10+00	175
6/22/90	10+00	8+25	175
6/23/90	8+25	7+25	100
6/24/90	7+25	3+90	335
6/25/90	3+90	3+10	80*

* Approximately 40 ft of excavation conducted within key-in trench.

(SEE DRAWING No. 3 FOR
BORING LOG DESCRIPTIONS)

FIGURE 5 - AS-BUILT ALIGNMENT AND STATIONING

TANK FARM SLURRY WALL CONSTRUCTION
MAVERIK COUNTRY STORES, INC.
KIRTLAND, NEW MEXICO

SLURRY TRENCH ALIGNMENT

Dames & Moore
Salt Lake City, Utah

JOB NO. 14819-005-031
Drawing No. 2

APPENDIX A
MATERIAL SUBMITTALS

- BENTONITE
- STRUCTURAL BACKFILL
- VAPOR BARRIER

BENTONITE SUBMITTAL

As supplied by:
H&H Bentonite
Grand Junction, Colorado

REDMOND CLAY & SALT CO., INC. - Redmond, Utah

17880

Date 6-15-90
Material API Bentonite
80 000
31 200
48,800
Gross
Tare
Net
______On ______Off

Purchased From Redmond C&S
Sold To H-H
Ship To
Truck Name/Truck # Lw miller #173
John Schmidt Driver
LARRY Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

REDMOND CLAY & SALT CO., INC. - Redmond, Utah

17883

Date 6-16-90
Material API Bulk
79 900
28 000
51,900
Gross
Tare
Net
______On ______Off

Purchased From RCS
Sold To
Ship To H+H
Truck Name/Truck # L.W. miller
Driver
JP Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

REDMOND CLAY & SALT CO., INC. - Redmond, Utah

17893

Date 20 Jun 90
Material API Super Bags
82 000
26 600
55400
Gross
Tare
Net
______On ______Off

Purchased From
Sold To
Ship To Farmington
Truck Name/Truck # High County
Bert Driver
Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

H & H BENTONITE & MUD, INC.
P. O. Box 4187
GRAND JUNCTION, CO 81502
(303) 243-9650

INVOICE

001160

DATE: 6-18-90

SOLD TO

SHIP TO
505-327-4706 ext 234
Enviro-con
Caribou Rig % Mike
Farmington, NM

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
1511		Bus Crowley				

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
1 T/L	API ~~100# PR~~ bulk bags		
55,400	lbs		
29	~~pallets~~ Bags		
	Late Load Fee		25.00
	Driver : E. L. Colclas III		
	Customer :		

INV CC 755-4

INVOICE

0745

H & H BENTONITE & MUD INC.
P. O. Box 4167
GRAND JUNCTION, CO 81502
(303) 243-9680

DATE

SOLD TO

SHIP TO

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
	6-17-90	Lis Miller #93		BARRY		

QUANTITY	DESCRIPTION	PRICE	AMOUNT
T/L	Bulk A.P.I		
80,000			
30,200			
47,800			

INV CC 755-4

INVOICE

DATE [illegible]

SOLD TO [illegible]

SHIP TO [illegible]
Farmington [illegible]

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

		DESCRIPTION				
[illegible]	APS	not PR				
[illegible]	pallets					
[illegible]	Bags					

Driver [illegible]

Customer [illegible]

INV. CC 7 [illegible]

H & H BENTONITE & MUD, INC.
P. O. Box 4187
GRAND JUNCTION, CO 81502
(303) 243-9680

INVOICE

001156

DATE: 6-15-90

SOLD TO	SHIP TO

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS Driver Name	SALESMAN	F.O.B.	OUR ORDER NO.
[illegible]	6-16-90	L W Miller #165	Ralph			

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
1 T/L	Bulk API		
Scale	# 17883		
Weight	51,900		
	Driver		
	Customer		

INV CC 755-4

H & H BENTONITE & MUD, INC.
P. O. Box 4107
GRAND JUNCTION, CO 81502
(303) 243-9660

INVOICE

0U1155

DATE: 6-14-90

SOLD TO

SHIP TO

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
	6-15-90	L W Miller	#173	JP		

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
TL	Bulk API		
80,000	JP		
31,200			
48800			

John Schmidt

INV CC 755-4

H & H BENTONITE & MUD, INC.
P. O. Box 4187
GRAND JUNCTION, CO 81502
(303) 243-9660

INVOICE

001152

DATE: 6-14-90

SOLD TO

SHIP TO

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
	6-14-90	J.W. Miller - Larry #171		[illegible]		

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
T/L	bulk API		
	51,900 # API Bentonite		
	Scale Tick # 17749		

Ennis INV CC 755-4

BILL-OF-LADING & FREIGHT BILL

Farmington Office
607 South Miller
Farmington, New Mexico 87401
Phone: 505-326-2267

L. W. MILLER TRANSPORTATION, INC.

Liquid Transporter – General Transportation

9617

Home Office
P. O. Box 512
Logan, Utah 84321
Phone: 801-753-8350

RECEIVED, SUBJECT TO THE TARIFF(S) IN EFFECT ON THIS DATE.

SHIPPER Redmond Clay + Salt Co.

ORIGIN Redmond Utah **COUNTY**

DATE 6-15 1990

SHIPPER NO. 001152

CARRIER UNIT 171 P-17

ORDER NO.

P.O. NO.

THE PROPERTY DESCRIBED BELOW, IN APPARENT GOOD ORDER, EXCEPT AS NOTED, MARKED, CONSIGNED, AND DESTINED AS SHOWN BELOW, WHICH THE CARRIER (CARRIER BEING UNDERSTOOD AS MEANING ANY PERSON OR CORPORATION IN POSSESSION OF THE PROPERTY) AGREES TO CARRY TO ITS DESTINATION. IT IS MUTUALLY AGREED THAT SERVICES PERFORMED HEREUNDER SHALL BE SUBJECT TO ALL CONDITIONS NOT PROHIBITED BY LAW, INCLUDING THE CONDITIONS ON BACK HEREOF, BY THE SHIPPER AND HIS ASSIGNS.

CONSIGNED TO H + H Bentonite

DESTINATION Envirocon Inc. Kirkland N.M. **COUNTY**

ROUTING **TOTAL MILEAGE:**

NUMBER MILES ON STATE AND FEDERAL HIGHWAYS OR IMPROVED ROADWAYS ______ UNIMPROVED ROADWAYS ______

NAME OR DESCRIPTION OF POINT WHERE SHIPMENT LEFT OR ENTERED STATE OR FEDERAL HIGHWAY OR IMPROVED ROADWAY ______

COMMODITY DESCRIPTION	RATE FACTOR (BBL, GALS, WT, MILES OR HRS.)	RATE PER FACTOR	CHARGE
1 T/L Bulk A.P.I. Bentonite	51,900		
		TOTAL	

SUBJECT TO SECTION 5 OF CONDITIONS, IF THIS SHIPMENT IS TO BE DELIVERED TO THE CONSIGNEE WITHOUT RECOURSE ON THE CONSIGNOR THE CONSIGNOR SHALL SIGN BELOW: THE CARRIER SHALL NOT MAKE DELIVERY WITHOUT PAYMENT OF FREIGHT AND ALL OTHER LAWFUL CHARGES.

(SIGNATURE OF CONSIGNOR)

(IF TO BE PREPAID, WRITE OR STAMP "TO BE PREPAID" ABOVE

RECEIVED $ TO APPLY ON PRE-PAYMENT

AGENT OR CASHIER PER

CONSIGNEE
BY
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY
DRIVER

NON NEGOTIABLE

san juan repr Form 214-1 (85)

White-Original, Yellow—Copy, Pink—Consignee's Copy, Goldenrod—Office Copy

BILL-OF-LADING & FREIGHT BILL

Farmington Office
607 South Miller
Farmington, New Mexico 87401
Phone: 505-326-2267

L. W. MILLER TRANSPORTATION, INC.

Liquid Transporter – General Transportation

9381
9253

Home Office
P. O. Box 512
Logan, Utah 84321
Phone: 801-753-8350

RECEIVED, SUBJECT TO THE TARIFF(S) IN EFFECT ON THIS DATE.

SHIPPER H + H Bentonite + Mud Inc

ORIGIN Redmond UT **COUNTY**

THE PROPERTY DESCRIBED BELOW, IN APPARENT GOOD ORDER, EXCEPT AS NOTED, MARKED, CONSIGNED, AND DESTINED AS SHOWN BELOW. WHICH THE CARRIER (CARRIER BEING UNDERSTOOD AS MEANING ANY PERSON OR CORPORATION IN POSSESSION OF THE PROPERTY) AGREES TO CARRY TO ITS DESTINATION. IT IS MUTUALLY AGREED THAT SERVICES PERFORMED HEREUNDER SHALL BE SUBJECT TO ALL CONDITIONS NOT PROHIBITED BY LAW, INCLUDING THE CONDITIONS ON BACK HEREOF, BY THE SHIPPER AND HIS ASSIGNS.

CONSIGNED TO H+ Envoris Con

DESTINATION Kirtland N.M. **COUNTY**

ROUTING **TOTAL MILEAGE:**

DATE 6-15 19 90

SHIPPER NO. 001155

CARRIER UNIT 173 - P-5

ORDER NO.

P.O. NO.

NUMBER MILES ON STATE AND FEDERAL HIGHWAYS OR IMPROVED ROADWAYS ______ UNIMPROVED ROADWAYS ______

NAME OR DESCRIPTION OF POINT WHERE SHIPMENT LEFT OR ENTERED STATE OR FEDERAL HIGHWAY OR IMPROVED ROADWAY ______

COMMODITY DESCRIPTION	RATE FACTOR (BBL, GALS, WT, MILES OR HRS.)	RATE PER FACTOR	CHARGE
T/k Buick APG	48,800	29.00	707.60
2.7 hrs. @ 45.00			121.50
Started unloading at 3:45 finished at 5:15	Total		829.10
			TOTAL

SUBJECT TO SECTION 5 OF CONDITIONS, IF THIS SHIPMENT IS TO BE DELIVERED TO THE CONSIGNEE WITHOUT RECOURSE ON THE CONSIGNOR THE CONSIGNOR SHALL SIGN BELOW: THE CARRIER SHALL NOT MAKE DELIVERY WITHOUT PAYMENT OF FREIGHT AND ALL OTHER LAWFUL CHARGES.

______
(SIGNATURE OF CONSIGNOR)

______
(IF TO BE PREPAID, WRITE OR STAMP "TO BE PREPAID" ABOVE

______
RECEIVED $ TO APPLY ON PREPAYMENT

______
AGENT OR CASHIER PER

CONSIGNEE
BY ______
BY ______
Above Goods, Inspected and Received in Good Order

SHIPPER ______
PER ______

L.W. MILLER TRANSPORTATION, INC.
BY ______
DRIVER John Schmidt

NON NEGOTIABLE

san juan repr Form 214-1 (85)

White-Original, Yellow—Copy, Pink—Consignee's Copy, Goldenrod—Office Copy

BILL-OF-LADING & FREIGHT BILL

Farmington Office
607 South Miller
Farmington, New Mexico 87401
Phone: 505-326-2267

L. W. MILLER TRANSPORTATION, INC.

9722

Liquid Transporter – General Transportation

Home Office
P. O. Box 512
Logan, Utah 84321
Phone: 801-753-8350

RECEIVED, SUBJECT TO THE TARIFF(S) IN EFFECT ON THIS DATE.

SHIPPER H+H BENTONITE

ORIGIN RIDMOND UT **COUNTY**

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CONSIGNED TO

DESTINATION FARMINGTON NM **COUNTY**

ROUTING **TOTAL MILEAGE:**

DATE 06 - 16 1990
SHIPPER NO. 1156
CARRIER UNIT 165/P16
ORDER NO.
P.O. NO.

NUMBER MILES ON STATE AND FEDERAL HIGHWAYS OR IMPROVED ROADWAYS ______ UNIMPROVED ROADWAYS ______

NAME OR DESCRIPTION OF POINT WHERE SHIPMENT LEFT OR ENTERED STATE OR FEDERAL HIGHWAY OR IMPROVED ROADWAY ______

COMMODITY DESCRIPTION	RATE FACTOR (BBL, GALS, WT, MILES OR HRS.)	RATE PER FACTOR	CHARGE
BENTONITE	51900		
2 HOURS SUNDAY 2½ HOURS MONDAY			
NET 51900			TOTAL

SUBJECT TO SECTION 5 OF CONDITIONS, IF THIS SHIPMENT IS TO BE DELIVERED TO THE CONSIGNEE WITHOUT RECOURSE ON THE CONSIGNOR THE CONSIGNOR SHALL SIGN BELOW: THE CARRIER SHALL NOT MAKE DELIVERY WITHOUT PAYMENT OF FREIGHT AND ALL OTHER LAWFUL CHARGES.

(SIGNATURE OF CONSIGNOR)

(IF TO BE PREPAID, WRITE OR STAMP "TO BE PREPAID" ABOVE

RECEIVED $ TO APPLY ON PREPAYMENT

AGENT OR CASHIER PER

CONSIGNEE
BY
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY
DRIVER

NON NEGOTIABLE

san juan repr Form 214-1 (85)

White-Original, Yellow—Copy, Pink—Consignee's Copy, Goldenrod—Office Copy

BILL-OF-LADING & FREIGHT BILL

Farmington Office
607 South Miller
Farmington, New Mexico 87401
Phone: 505-326-2267

L. W. MILLER TRANSPORTATION, INC.

Liquid Transporter – General Transportation

9432

Home Office
P. O. Box 512
Logan, Utah 84321
Phone: 801-753-8350

RECEIVED, SUBJECT TO THE TARIFF(S) IN EFFECT ON THIS DATE.

SHIPPER Red mon Clay & Sand

ORIGIN Redman Utah **COUNTY**

DATE 6-18 19 90

SHIPPER NO. 17885

CARRIER UNIT 93 P-24

ORDER NO.

P.O. NO.

THE PROPERTY DESCRIBED BELOW, IN APPARENT GOOD ORDER, EXCEPT AS NOTED, MARKED, CONSIGNED, AND DESTINED AS SHOWN BELOW. WHICH THE CARRIER (CARRIER BEING UNDERSTOOD AS MEANING ANY PERSON OR CORPORATION IN POSSESSION OF THE PROPERTY) AGREES TO CARRY TO ITS DESTINATION. IT IS MUTUALLY AGREED THAT SERVICES PERFORMED HEREUNDER SHALL BE SUBJECT TO ALL CONDITIONS NOT PROHIBITED BY LAW, INCLUDING THE CONDITIONS ON BACK HEREOF, BY THE SHIPPER AND HIS ASSIGNS.

CONSIGNED TO H & H Bentonite

DESTINATION Farmington NM **COUNTY**

ROUTING Kirtland **TOTAL MILEAGE:**

NUMBER MILES ON STATE AND FEDERAL HIGHWAYS OR IMPROVED ROADWAYS ________ UNIMPROVED ROADWAYS ________

NAME OR DESCRIPTION OF POINT WHERE SHIPMENT LEFT OR ENTERED STATE OR FEDERAL HIGHWAY OR IMPROVED ROADWAY ________

COMMODITY DESCRIPTION	RATE FACTOR (BBL, GALS, WT, MILES OR HRS.)	RATE PER FACTOR	CHARGE
Bentonite 80,000 Gross 30,200 Tare 49,800 Net			
		TOTAL	

SUBJECT TO SECTION 5 OF CONDITIONS, IF THIS SHIPMENT IS TO BE DELIVERED TO THE CONSIGNEE WITHOUT RECOURSE ON THE CONSIGNOR THE CONSIGNOR SHALL SIGN BELOW: THE CARRIER SHALL NOT MAKE DELIVERY WITHOUT PAYMENT OF FREIGHT AND ALL OTHER LAWFUL CHARGES.

(SIGNATURE OF CONSIGNOR)

(IF TO BE PREPAID, WRITE OR STAMP "TO BE PREPAID" ABOVE

RECEIVED $ TO APPLY ON PREPAYMENT

AGENT OR CASHIER PER

CONSIGNEE
BY
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY
DRIVER

NON NEGOTIABLE

san juan repr Form 214-1 (85)

White-Original, Yellow—Copy, Pink—Consignee's Copy, Goldenrod—Office Copy

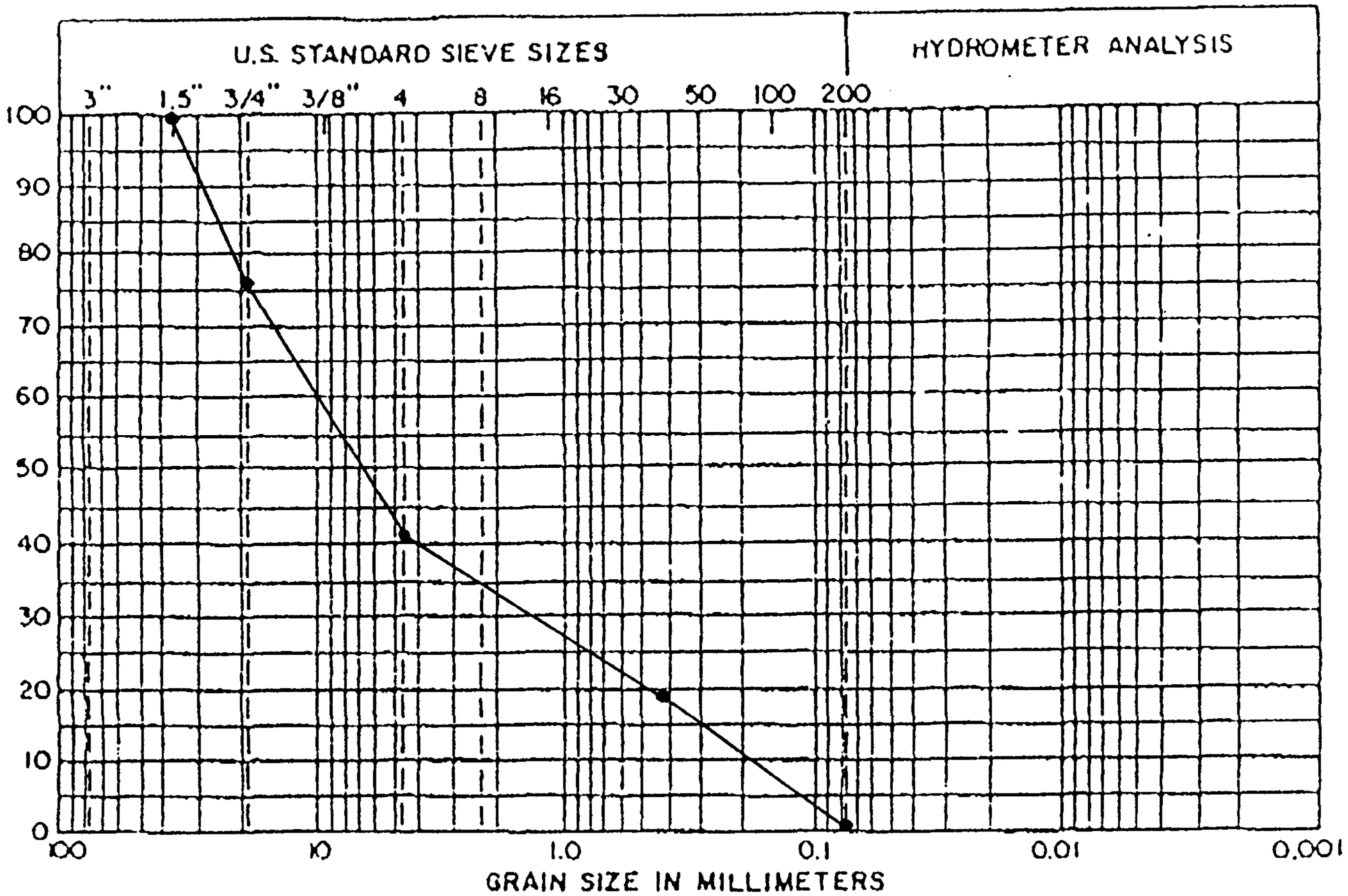
STRUCTURAL BACKFILL SUBMITTAL

As supplied by:
Doug Foutz Construction
Farmington, New Mexico

ENVIROCON

LAB ______ LAB NO. ______
CLIENT Maverik PROJECT Caribou Refinery
FEATURE Structural Backfill PROJECT NO. 2001
SAMPLE NO. 1-B DATE TESTED 06/23/90
Submittal #1

GRAIN SIZE ANALYSIS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

LIQUID LIMIT ______ PLASTICITY INDEX ______

DESCRIPTION ______ USCS ______

U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	Particle Size mm	Percent Finer
			3/4"	19.00	76	40	.590	19	.019	
			3/8"	9.50		50	.297		.009	
5.0"	126.7		4	4.750	41	100	.149		.005	
3.0"	76.0	100	8	2.380		200	.074	1	.002	
1.5"	38.0	100	16	1.190		—	.037		001	

ENV 06/90

FIGURE NO. ______

ENVIROCON

LAB ____________ LAB NO. ____________

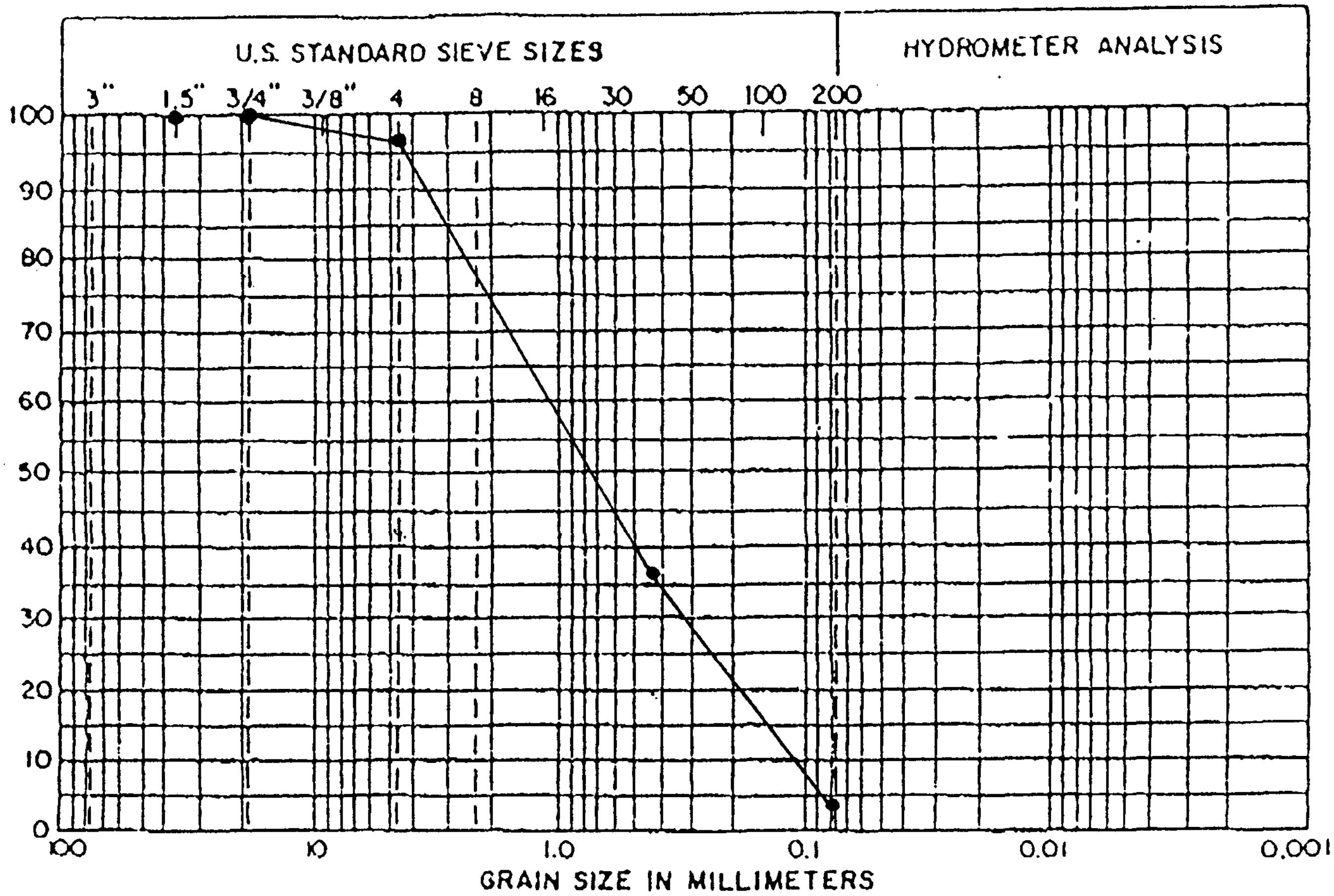
CLIENT Maverik PROJECT Caribou Refinery

FEATURE Structural Backfill PROJECT NO. 2001

SAMPLE NO. 2-B DATE TESTED 06/23/90

Submittal #2

GRAIN SIZE ANALYSIS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

LIQUID LIMIT ____________ PLASTICITY INDEX ____________

DESCRIPTION ____________ USCS ____________

U.S. Sieve	Particle Size mm	Percent Finer
5.0"	126.7	
3.0"	76.0	100
1.5"	38.0	100

U.S. Sieve	Particle Size mm	Percent Finer
3/4"	19.00	100
3/8"	9.50	
4	4.750	97
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
40	.590	37
50	.297	
100	.149	
200	.074	4
—	.037	

Particle Size mm	Percent Finer
.019	
.009	
.005	
.002	
001	

ENV 06/90

FIGURE NO. ____________

ENVIROCON

LAB ______________ LAB NO. ______________

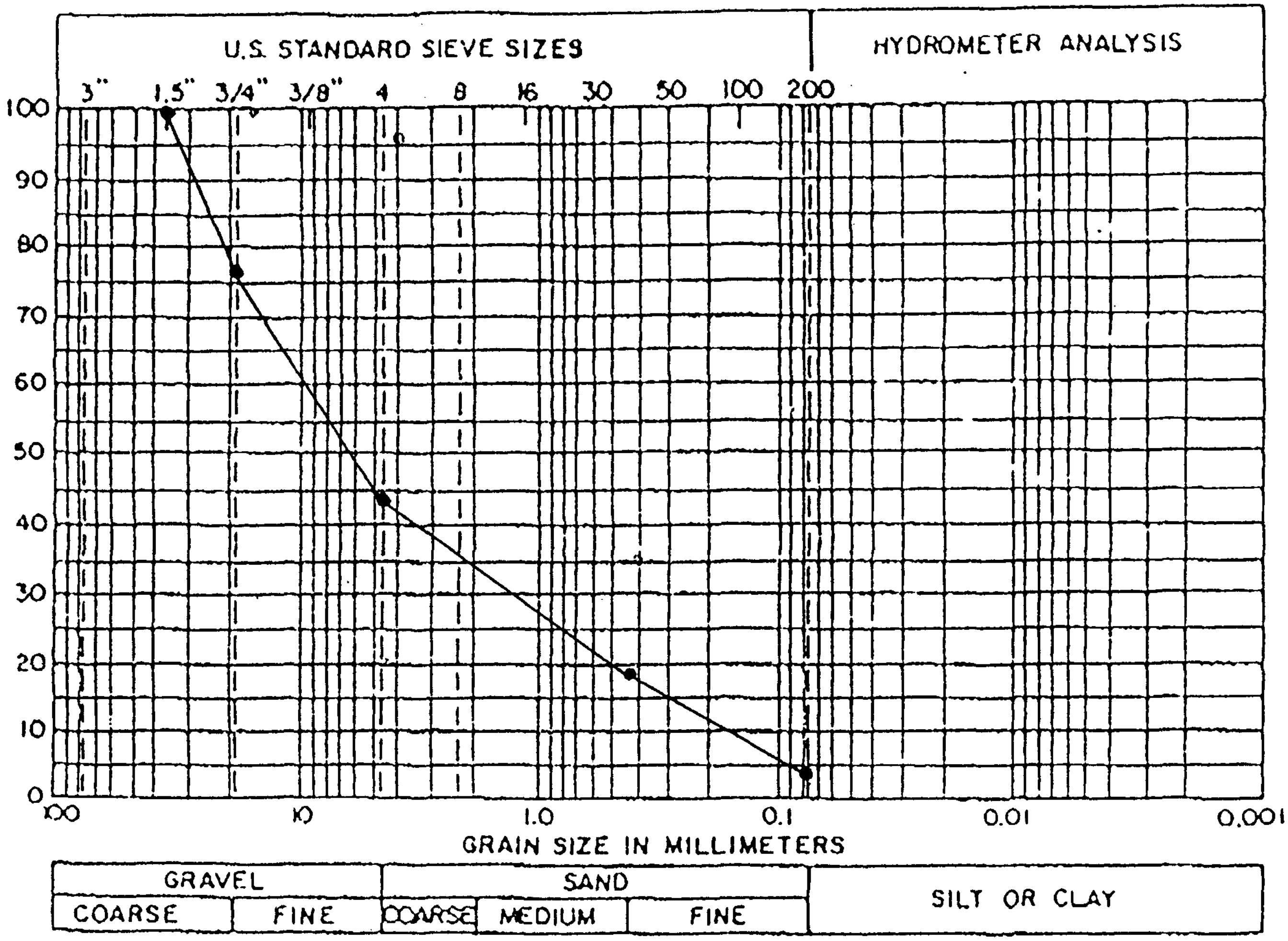
CLIENT Maverik PROJECT Caribou Refinery

FEATURE Structural Backfill PROJECT NO. 2001

SAMPLE NO. Mixed 1 DATE TESTED 06/25/90

Mixed Submittal #1

GRAIN SIZE ANALYSIS



LIQUID LIMIT ______________ PLASTICITY INDEX ______________

DESCRIPTION ______________ USCS ______________

U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	Particle Size mm	Percent Finer
			3/4"	19.00	77	40	.590	19	.019	
			3/8"	9.50		50	.297		.009	
5.0"	126.7		4	4.750	44	100	.149		.005	
3.0"	76.0	100	8	2.380		200	.074	4	.002	
1.5"	38.0	100	16	1.190		—	.037		001	

Note: Material does not meet specification.

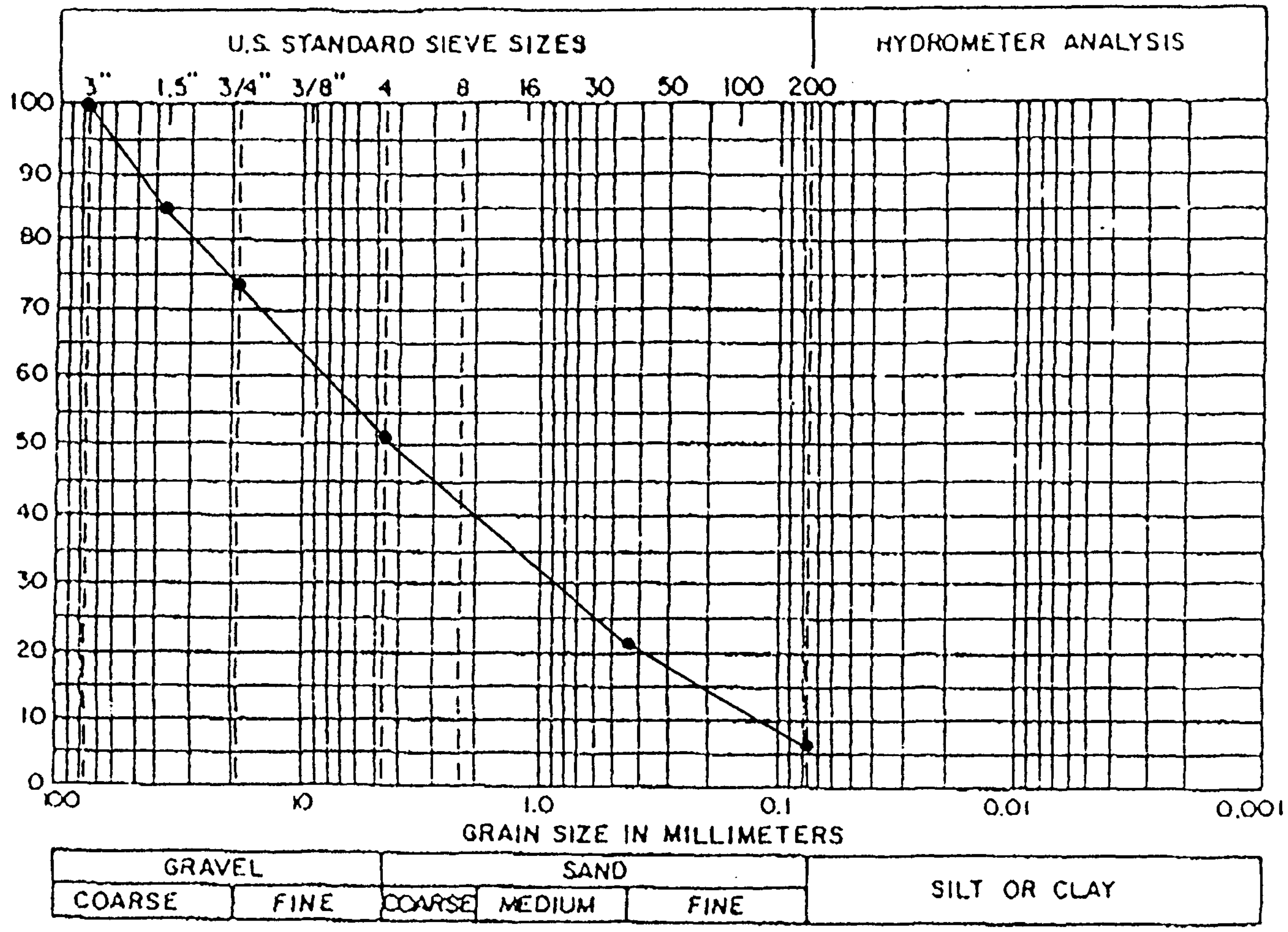
ENV 06/90

FIGURE NO. ______

ENVIROCON

LAB ______ LAB NO. ______
CLIENT Maverik PROJECT Caribou Refinery
FEATURE Structural Backfill PROJECT NO. 2001
SAMPLE NO. Mixed - 2 DATE TESTED 06/26/90
Mixed Submittal #2

GRAIN SIZE ANALYSIS



LIQUID LIMIT ______ PLASTICITY INDEX ______

DESCRIPTION ______ USCS ______

U.S. Sieve	Particle Size mm	Percent Finer
5.0"	126.7	
3.0"	76.0	100
1.5"	38.0	85

U.S. Sieve	Particle Size mm	Percent Finer
3/4"	19.00	74
3/8"	9.50	
4	4.750	51
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
40	.590	22
50	.297	
100	.149	
200	.074	6
—	.037	

Particle Size mm	Percent Finer
.019	
.009	
.005	
.002	
001	

Note: Material from previous sample was shaken manually for additional time as some clogging was noted from too large a sample. Material does not meet specification on No. 4 sieve, but is very close and was accepted by Brett Mickelson.

VAPOR BARRIER SUBMITTAL
20-MIL VERY LOW DENSITY POLYETHYLENE

As manufactured by:
Poly-America, Inc.
Grand Prairie, Texas

AN INNOVATION IN VALUE ENGINEERING
FOR THE
ENVIRONMENTAL CONTAINMENT INDUSTRY

Dura-Flex® is a specially compounded Very Low Density Polyethylene designed to meet the needs of the waste containment and water conservation industries.

The special properties exhibited by this product are:

- **Superior toughness**
- **Improved frictional characteristics over HDPE**
- **Inertness - no migrating plasticizer**
- **Weatherability - Dura-Flex® is resistant to ultra-violet light and heat aging in exposed applications**
- **Superior elastic and ultimate elongation properties**
- **Lower permeability than PVC**
- **Better dimensional stability than PVC**
- **Excellent cold weather resistance**
- **Excellent environmental stress crack resistance**

Typical Properties of Dura-Flex Geomembranes

		Dura-Flex Typical Values*			
Property	**Test Method**	20 mil (0.5 mm)	30 mil (0.75 mm)	40 mil (1.0 mm)	60 mil (1.5 mm)
Thickness, mils, minimum	ASTM D 1593	18	27	36	54
Density (g/cc), maximum	ASTM D 1505	0.935	0.935	0.935	0.935
Melt Index (g/10 minutes), max.	ASTM D 1238	0.6	0.6	0.6	0.6
Carbon Black content (percent)	ASTM D 1603	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion	ASTM D 3015	A-2	A-2	A-2	A-2
Tensile Properties	ASTM D 638 Type IV specimen at 20 inches/minute				
1. Ultimate Tensile Strength (pounds / inch width)		75	110	140	210
2. Ultimate Elongation (percent)		1000	1000	1000	1000
3. Modulus of Elasticity (secant modulus; pounds / square inch)		15,000	15,000	15,000	15,000
Tear Strength (lbs)	ASTM D 1004 Die C	9	14	17	28
Puncture Resistance (lbs)	FTMS 101C 2065	30	45	55	80
Low Temperature Brittleness	ASTM D 746	<-70° C (-94° F)	<-70° C (-94° F)	<-70° C (-94° F)	<-70° C (-94° F)
Dimensional Stability (% change max.)	ASTM D 1204 212° F, 15 min.	± 3	± 3	± 3	± 3
Resistance to Soil Burial (% change max. in orig. value)	ASTM D 3083 type IV specimen at 20 inches/minute.				
A. Ultimate Tensile Strength		10	10	10	10
B. Ultimate Elongation		10	10	10	10
Environmental Stress Crack (hours)	ASTM D 1693 Condition C (modified NSF 54)	>2000	>2000	>2000	>2000
Field Seam properties					
1. Shear Strength (lb/in), min.	ASTM D 3083 (modified NSF 54)	25 (or 20" elong.)	35 (or 20" elong.)	45 (or 20" elong.)	80 (or 20" elong.)
2. Peel Strength	ASTM D 413 (modified NSF 54)	FTB†	FTB	FTB	FTB
Roll Dimensions					
1. Width — feet		22.5	22.5	22.5	22.5
— (meters)		(6.9)	(6.9)	(6.9)	(6.9)
2. Length — feet		1000	800	600	400
— (meters)		(304.8)	(243.8)	(182.9)	(121.9)
3. Area — square feet		22,500	18,000	13,500	9000
— (square meters)		(2090)	(1672)	(1254)	(836)
4. Weight — lbs., approx.		2250	2700	2700	2700
— (kg), approx.		(1021)	(1225)	(1225)	(1225)

Dura-Flex liners are also available in 18 foot (5.5 m) widths.

*All values, except when specified as minimum or maximum, represent average lot property values.

†FTB (Film Tear Bond) is defined as the failure of one sheet by tearing, instead of by separating, from the other sheet at the weld interface area (sheet fails before weld).

INERTNESS

The Dura-Flex additive system utilizes carbon black for ultra-violet protection, anti-oxidants to prevent heat degradation and seaming enhancers for improved seamability. Dura-Flex has no migrating plasticizers and is inert to most chemicals. Such inertness also prevents deterioration by soil microorganisms.

WEATHERABILITY

Dura-Flex withstands the harmful effects of sunlight and ozone as well as competitive HDPE and Hypalon products. A twenty year limited warranty is available on Dura-Flex.

ENVIRONMENTAL STRESS CRACK RESISTANCE

Dura-Flex material has been tested in excess of 2000 hours for environmental stress cracking with zero failures under test method ASTM D 1693 Condition C at 100° C and 100% IGEPAL.

MOISTURE VAPOR TRANSMISSION RATE

Table 1 documents the superiority of Dura-Flex over PVC in MVTR. Dura-Flex is also slightly less permeable than HDPE. Absorption by membranes indicates possible transmission of gases to the atmosphere and, conversely, leakage through the membrane in containment applications under load.

PUNCTURE RESISTANCE

Puncture resistance is evaluated under Federal Test Method Standards, where the resistance is measured by the force required to puncture a restrained liner by a standard probe. The results of these tests (Figure 2) indicate that Dura-Flex elongates twice as much as HDPE or PVC before it punctures. This is a good indication of Dura-Flex's ability to maintain flexibility and absorb greater punishment before failure. A large scale hydrostatic pressure vessel was developed to evaluate the puncture resistance of these liners under simulated field conditions. In the author's opinion, this test evaluates this parameter more accurately than the standard laboratory probe puncture test, and it can be used as a guide for the selection of a membrane under various subgrade conditions.

The intent behind the development of the hydrostatic tester (Figure 3) was to evaluate the performance of geomembranes when they are placed on various subgrades under overburden waste loads replicating field conditions. In this way, a reliable recommendation could be made regarding the selection of a liner.

Energy Absorbed During Puncture Resistance
30 Mil HDPE, Dura-Flex, PVC

(Test Method: FTMS 101 C 2065)

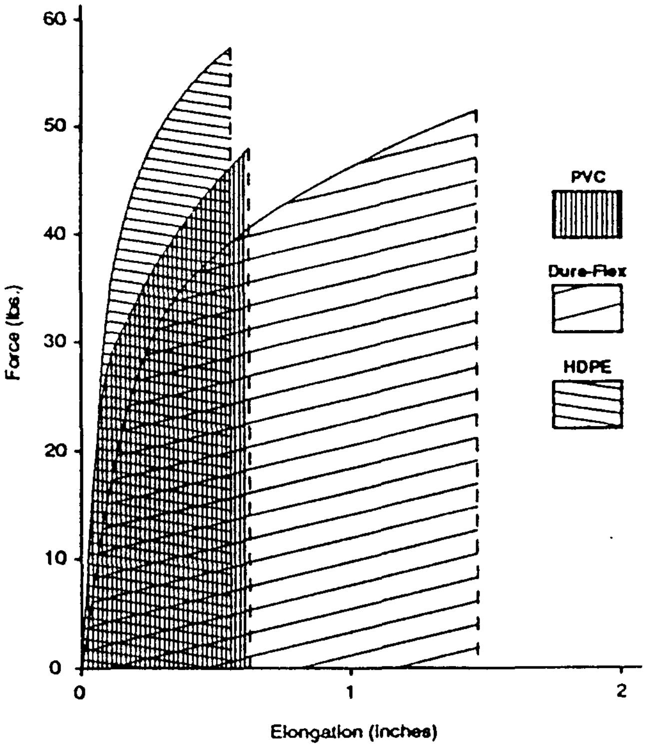


Figure 2

Table 1. Physical property comparison: 30 mil HDPE, Dura-Flex, and PVC

Property	Test Method	HDPE	Dura-Flex	PVC
Gauge, mils	ASTM D 1593	30	30	30
Density (gm/cc)	ASTM D 1505	0.950	0.925	1.2 – 1.4
Tensile Strength @ Yield (lb/in)	ASTM D 638	75	*	*
Elongation @ Yield (%)	ASTM D 638	10	*	*
Tensile Strength @ Break (lb/in)	ASTM D 638	125	110	90
Elongation @ Break (%)	ASTM D 638	800	1000	300
Secant Modulus 1% Elong. (psi)	ASTM D 638	90,000	15,000	5 – 10,000
Tear Strength (lb)	ASTM 1004	22	14	8
Puncture Resistance (lb)	FTMS 101 C 2065	50	45	42
Dimensional Stability, %	ASTM D 1204 212° F, 15 min	± 1	± 3	± 10
Moisture Vapor Transmission Rate g/m² .day	ASTM E 96 100° F @ 100% relative humidity	0.43	0.77	7.30
Cold Temperature Brittleness	ASTM D 746	<-94° F	<-94° F	-20° F

*Dura-Flex and PVC do not exhibit true yield points. Refer to figure 1.

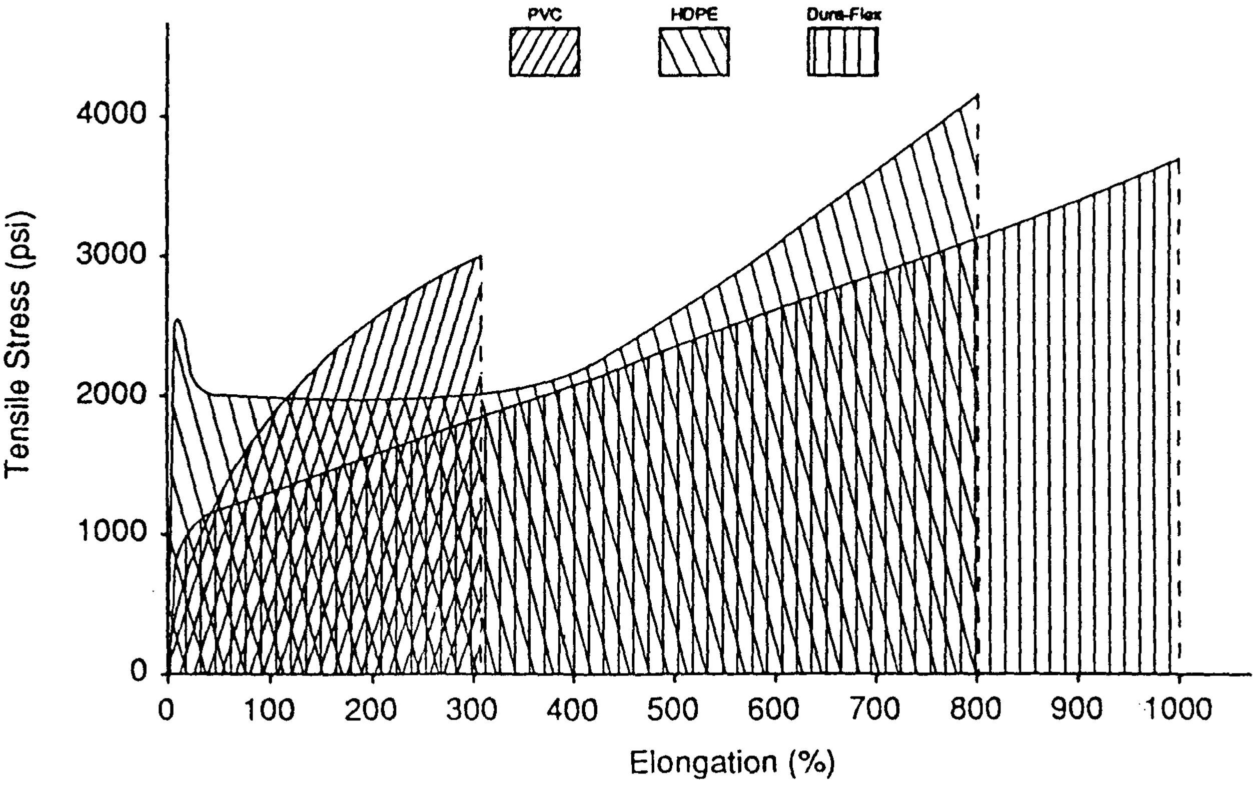


Figure 1. Stress-Strain Diagram for PVC, HDPE, and Dura-Flex

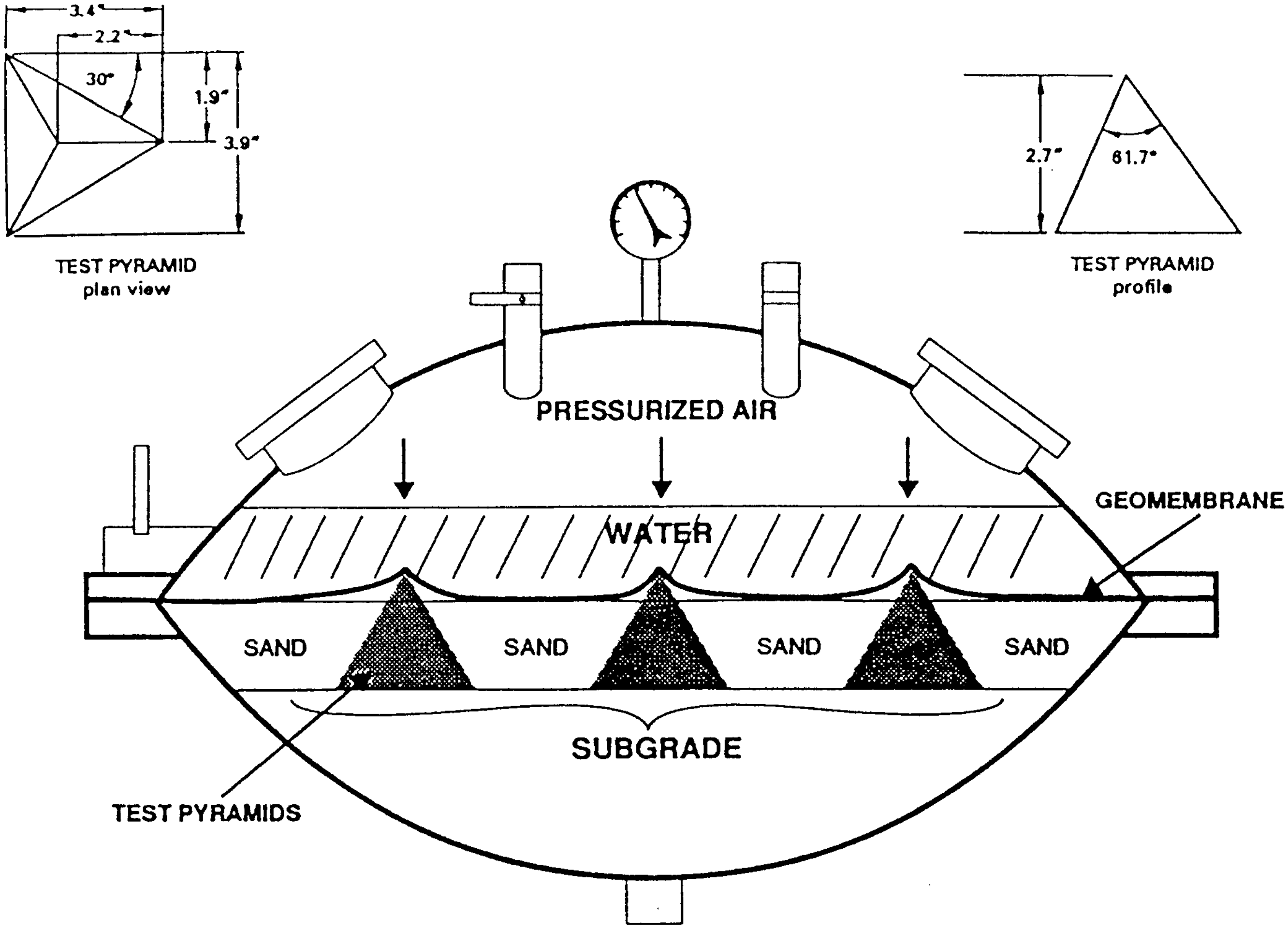


Figure 3. Hydrostatic Pressure Test Vessel

Table 2

Artificial Protrusions in the Subgrade	
Liner	Test Result
30 mil Dura-Flex	passed @ 100 psi
30 mil PVC	passed @ 100 psi
30 mil HDPE	failed @ < 10 psi
60 mil HDPE	failed @ < 10 psi

Pyramidal blocks projected 1 inch above the subgrade level. Pressure was applied hydrostatically at a rate of 5 psi per hour. The final pressure was 100 psi, maintained for four days.

The lower chamber of the hydrostatic tester is designed to hold the subgrade materials. The test area allows for 280 in^2 of subgrade to be exposed to the liner. The liner is clamped between the upper and lower chambers of the hydrostatic tester and a tight seal is created. The liner cannot slip during the test.

Water is introduced into the upper chamber through a port. A line is added to the upper chamber, through which compressed air passes to increase pressure to 100 psi. Because the lower chamber is vented to the atmosphere, any rupture to the liner will allow water to escape through the vent.

The hydrostatic tester has been used to study the following interactions of liners and subgrades:

- **Liners over artificial subgrade protrusions**
- **Liners against a specific subgrade**
- **Liners spanning subgrade voids**

Artificial Protrusions in the Subgrade Subgrades are prepared to be free of sharp and potentially damaging objects, however, any rock or sharp object that makes incidental contact with a liner may cause it to puncture or tear.

Three pyramidal (Rigo) blocks were placed in a sand subgrade at the bottom of the hydrostatic tester (Figure 3). The blocks were set around the center of the test area, equidistant from each other, and at about the same distance from its perimeter. A single liner was laid across the blocks and firmly clamped between the tester's upper and lower chambers. The sharp tips of the pyramids projected 1" above the subgrade. Pressure was increased at a rate of 5 psi per hour.

30 mil PVC and Dura-Flex were tested against these subgrade protrusions at pressures up to 100 psi. Both 30 and 60 mil HDPE failed this test at less than 10 psi. The 30 mil Dura-Flex and PVC did not fail.

It may be concluded that while HDPE is strong, it is not as tough as Dura-Flex or PVC. Dura-Flex and PVC were elastic enough to accommodate the sharp tips of the pyramidal blocks without failing. Dura-Flex and PVC are better suited to accept irregular subgrade surface conditions. Aside from evaluating the adaptability of different varieties of geomembrane, this test asserts the preeminence of the hydrostatic tester over standard laboratory puncture test devices.

Liners on Soils The criterion governing the selection of a liner by an engineer is whether it will "hold up" under actual field conditions. Many standard index tests, such as puncture resistance, tear strength, and tensile strength, were developed in the laboratory to determine this. However, results from these tests can be misleading. Results should index similarities between materials in the same lineage of liners (i.e., varieties of polyethylene).

Three subgrade types have been evaluated: sand, a sand and gravel mixture (with subangular particle size ranging up to 2"), and gravel (angular particles ranging up to 1"). The liners tested were HDPE, Dura-Flex, and PVC. Table 2 records the test results.

As will be noted, all materials performed well against sand. However, subgrades containing gravel (such as is typical around mining operations) require a more durable liner, such as Dura-Flex. It is noteworthy that Dura-Flex outperformed HDPE at half its thickness. The following test results should not establish a precedent for selection of subgrade materials interfacing with specified liners. Subgrades shall be unyielding and prepared to a finished, smooth surface free of protrusions and sharp changes in grade. Hydrostatic pressure tests shall be performed to evaluate each subgrade soil condition with regard to the proposed lining material.

Table 3. Hydrostatic test for liner performance on subgrades

Liner	Sand	Sand & Gravel	Gravel
30 mil PVC	passed @ 100 psi	failed @ 90 psi	—
60 mil HDPE	passed @ 100 psi	passed @ 100 psi*	failed @ 80 psi
30 mil Dura-Flex	passed @ 100 psi	passed @ 100 psi	passed @ 100 psi

*Severe thinning occurred in several locations where the liner had to conform to the shape of gravel.

Pressure was applied hydrostatically at a rate of 5 psi (34.5 kpa) per hour. The final pressure was 100 psi (690 kpa), maintained for 4 days.

Voids In Subgrade Although subgrades are intended to be smooth and unyielding, this condition is not always achieved. It is possible that voids will form underneath the liner at some point during the life of the system. In areas where the subgrade does not support the liner, the liner will have to support the load itself by flexurally conforming to the spatial contours of the void area.

This test evaluated the performance of the liner over two rectangular void areas. One void measured 5.5" x 9.5" x 2.5", the other, square shaped, measured 7.75" x 7.75" x 2". In each case, a single liner was placed in the hydrostatic tester across the void. Pressure was increased at the rate of 5 psi/hour until failure or 100 psi was reached.

The 30 mil Dura-Flex easily conformed to the void contour without rupturing, although some localized permanent deformations occurred. These deformations were isolated to areas directly over the void, and did not extend into areas with subgrade support.

30 and 60 mil HDPE were also tested over the rectangular pans. These liners did not stretch as dramatically as Dura-Flex into the corner contours of the square pan. Instead, a gradual, rounded contour was formed, which was maintained throughout the gradual increase to 100 psi. 30 mil HDPE ruptured over the rectangular pan, but 60 mil HDPE did not, though excessive thinning in one area suggested that failure would have occurred had the test pressure or duration been increased.

Although this information is not quantitative as such, it does determine that voids in the subgrade can contribute to the failure of a liner under stress.

The U.S. Bureau of Reclamation used Dura-Flex in a canal test program approximately two years ago. Coupons taken from above and below the normal water level after one year revealed no significant change in physical properties.

In short, Dura-Flex is a natural choice where optimum puncture resistance and flexibility are required.

SEAMABILITY

Dura-Flex may be seamed like HDPE utilizing the Poly-Flex single and double wedge method (see page 17). Seams exhibiting consistent film tear bonds are attained.

The Poly-Flex double wedge, which provides a superior seam bond, easily tested by pressurizing the continuous channel that runs within the bonded overlap of sheets to 25-30 psi. A manometer inserted into the channel records the pressure and any pressure loss indicative of a leak.

Dura-Flex combines the desirable properties of polyethylene with the flexibility and toughness of elastomeric materials such as PVC and Hypalon. Testing and development continues, to ensure a superior product for specific applications.

FRICTION TESTING

Independent studies conducted by Dr. Robert Koemer of the Geosynthetic Research Institute indicate that in 4" x 4" direct shear box tests, a Dura-Flex/sand interface yields a friction angle of 31°, while an HDPE/sand interface yields a friction angle of 22.5°. Dura-Flex is 50% more efficient than HDPE in this case (Figure 4).

In many applications, a geotextile or geonet is used for filtration and drainage purposes. A high coefficient of friction between surfaces ensures that the geotextile or geonet will not pull out of anchor trench or undergo excessive stress as the overburden loads are applied. Dr. Koerner went on to evaluate the friction characteristics of Dura-Flex combined with dry and saturated sands, polyethylene geonet, and composite drainage net (geonet with a geotextile bonded to one or both sides), using an 18" x 18" shear box friction apparatus.

TEST MATERIALS

All geosynthetics were obtained from Poly-America, while soil was obtained by GRI. The materials used were as follows:

Geomembrane (GM): Poly-America 30 mil Dura-Flex Geomembrane

Geonet (GN): Tensar DN 4 Geonet with and without Typar 3401 Geotextile

Ottawa Sand: Standard #40 Sieve Test Sand (Particulately spherical)

Concrete Sand: Approximately #40 Sieve (Particulately angular)

TEST CROSS-SECTIONS

The tests were performed on the profile which is shown in Figure 5. In all cases the shear plane was between the geomembrane and the other interface material. The tests were performed on six different combinations, as follows:

Profile A: 30 mil Dura-Flex GM - Tensar DN 4 GN

Profile B: 30 mil Dura-Flex GM - Typar GT bonded to Tensar DN 4 GN

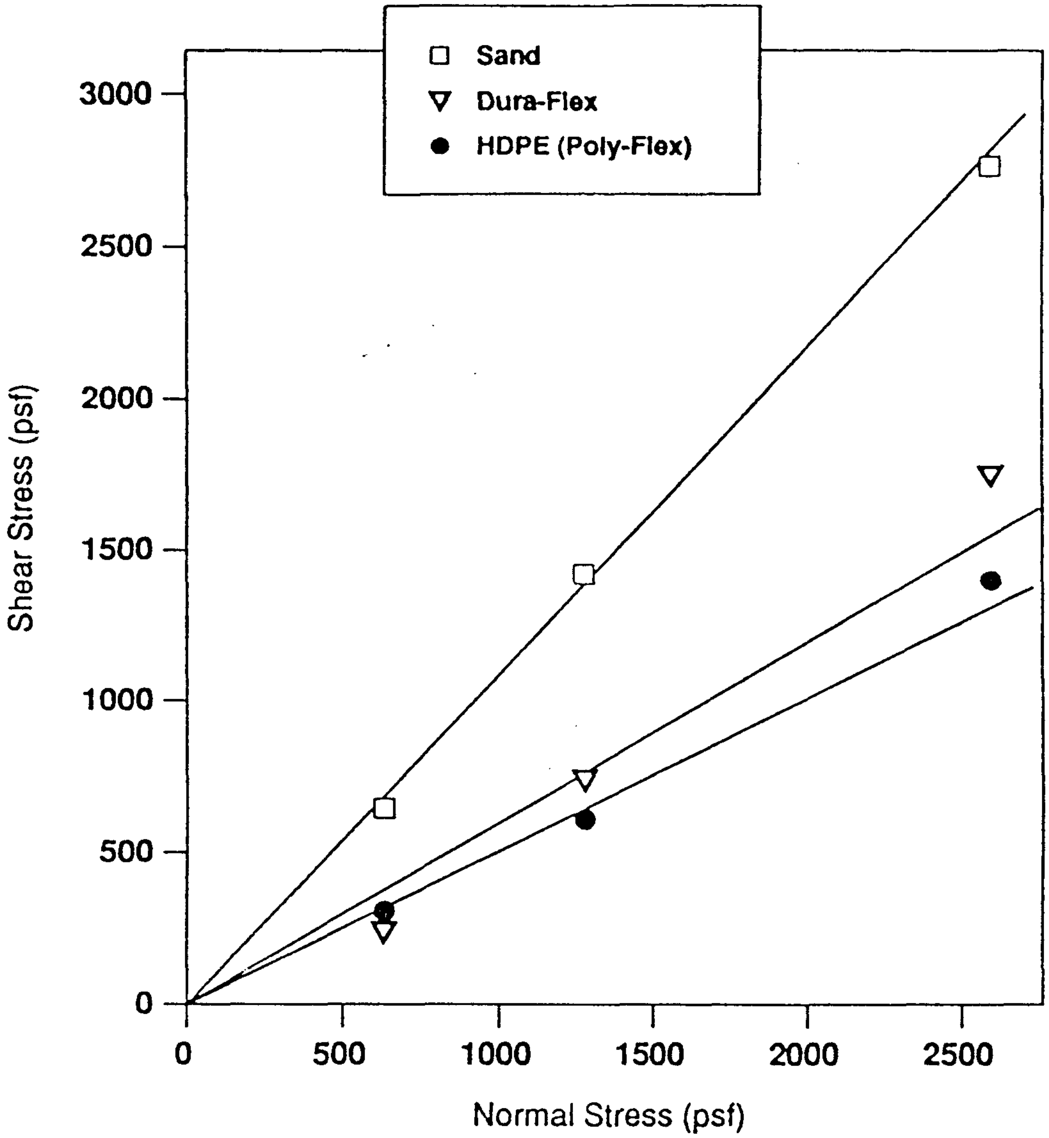
Profile C: 30 mil Dura-Flex GM - Dry Ottawa Sand

Profile D: 30 mil Dura-Flex GM - Saturated Ottawa Sand

Profile E: 30 mil Dura-Flex GM - Dry Concrete Sand

Profile F: 30 mil Dura-Flex GM - Saturated Concrete Sand

Direct Shear Friction Test
Sand / Dura-Flex & HDPE
4" x 4" Shear Box Apparatus



Condition	Friction Angle (ϕ)	Coefficient of Friction	Friction Angle (δ)	Cohesion (Adhesion)	Efficiency E_ϕ %
Sand	**48.5**	**1.13**	**—**	**0**	**100**
Dura-Flex / Sand	**—**	**0.60**	**31.0**	**0**	**53**
HDPE / Sand	**—**	**0.41**	**22.5**	**0**	**37**

$$E_\phi = \text{Efficiency} = \left({}^{\tan\delta}\!/\!_{\tan\phi} \right) 100$$

Figure 4

TEST EQUIPMENT

The apparatus is shown in Figure 6. The size of the shear box in 18" x 18" x 5". It is composed of two parts, an upper and a lower part. The upper half of the system is stationary. It contains the geomembrane fastened to a wood backup plate. The lower half (containing the opposing material) displaces laterally, creating shear stresses at the interface. The distance between upper and lower parts of the box can be adjusted by means of 4 large set screws at each corner of the upper box. Normal stress is applied via two 1/2 inch thick cascaded steel plates by a heavy duty jack system, controlled by a calibrated proving ring. The horizontal displacement is controlled by an electric motor with an adjustable drive mechanism. Lateral displacements are measured by two dial gauges from which an average value is obtained.

TEST PROCEDURE

For profiles A and B - GM to Geonet or Geotextile on Geonet

- **Bond the geonet or geotextile to a wooden backup plate**
- **Place this system in the bottom half of the shear box with the test side facing up.**
- **Place the geomembrane on its wooden backup plate**
- **Place this system in the upper half of the shear box with the test side facing down.**
- **Adjust the upper box with the four set screws to assure that the shear plane is at the desired interface.**
- **Load the test system to the desired normal stress levels, which in these tests were alternately 5, 10.1, and 15.3 psi.**
- **Set the strain rate at ≈ 0.075 in./min. and begin the test.**
- **Take continuous readings of the horizontal displacement and the mobilized shear force.**
- **Continue until a minimum shear stress is mobilized.**
- **Calculate the average displacement and shear stress and plot the results.**
- **Take the peak value of shear stress, i.e. the shear strength, and plot against the normal stress.**
- **Combine the resulting points to measure the resulting friction angle.**

For Profiles C, D, E and F - Geomembrane to soil

- **Compact the soil in the bottom box so that the level is exactly even with the top of the bottom portion of the device.**
- **For saturated testing, saturate the soil with tap water.**
- **Place the geomembrane on its wooden backup plate.**
- **Place this system in the upper half of the shear box with the test side facing down against the soil.**
- **Load the test system to the desired normal stress levels, which in these tests were alternately 5, 10.1, and 15.3 psi.**
- **Set the strain rate at ≈ 0.075 in./min. and begin the test.**
- **Take continuous readings of the horizontal displacement and the mobilized shear force.**
- **Calculate the average displacement and shear stress and plot the results.**
- **Take the peak value of shear stress, i.e. the shear strength and plot against the normal stress.**
- **Combine the resulting points to measure the resulting friction angle.**

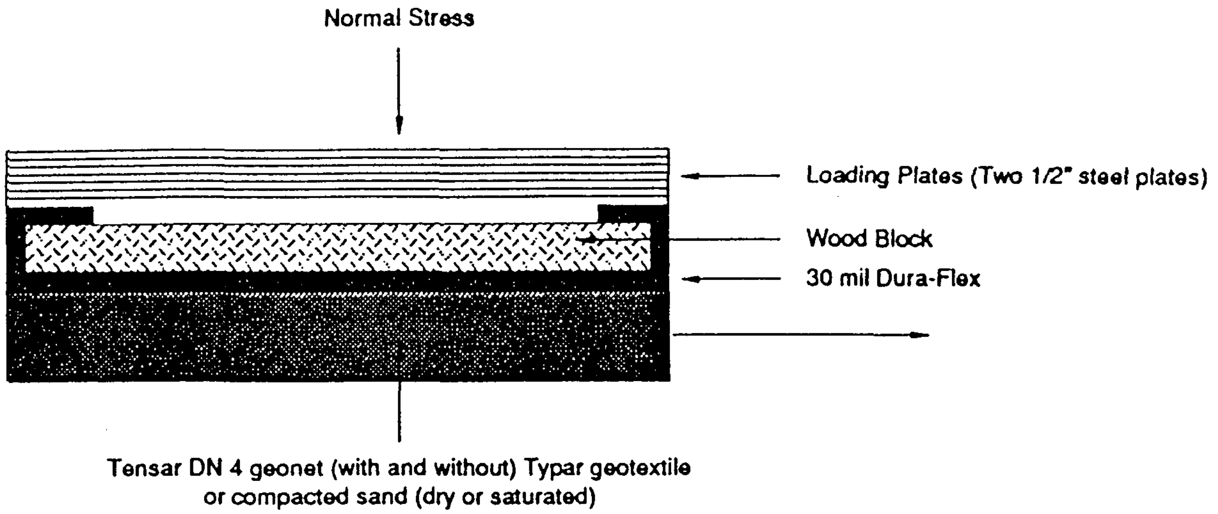


Figure 5. Test cross-section for determining the friction angle between 30 mil Dura-Flex and various interface materials

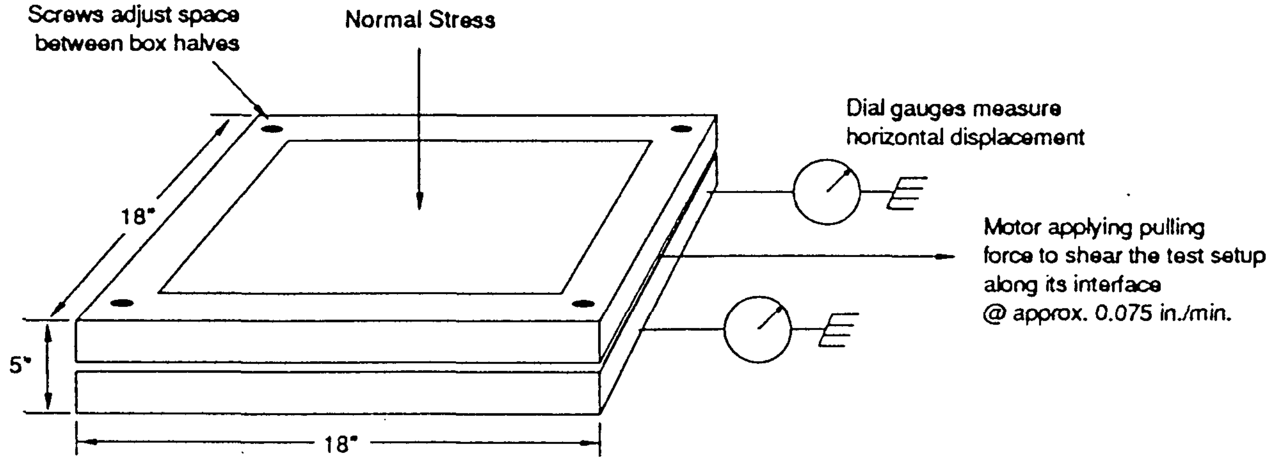


Figure 6. Test setup of GRI's 18" x 18" direct shear box

TEST RESULTS

Figures 7 — 14 are plots of normal stress versus shear strength for the specified profiles. The slopes of these data sets are the corresponding friction angles.

The resulting friction angles of each series of tests are as follows:

30 mil Dura-Flex vs Tensar DN 4 geonet: 15 degrees
30 mil Dura-Flex vs Typar geotextile on a geonet: 19 degrees
30 mil Dura-Flex vs dry Ottawa sand: 19 degrees
30 mil Dura-Flex vs saturated Ottawa sand: 17 degrees
30 mil Dura-Flex vs dry concrete sand: 21 degrees
30 mil Dura-Flex vs saturated concrete sand: 21 degrees

Table 4. Friction Test Results

Test Condition	Friction Angle, ϕ	Interface Friction Angle, δ	Coefficient of Friction	Efficiency $E_\phi =$ $(\tan\delta/\tan\phi)100$
Dry Ottawa Sand	26°	—	0.49	100%
Saturated Ottawa Sand	28°	—	0.53	100%
Dry Concrete Sand	32°	—	0.62	100%
Saturated Concrete Sand	31°	—	0.60	100%
30 mil Dura-Flex vs Tensar DN 4 geonet	—	15°	0.27	—
30 mil Dura-Flex vs Typar geotextile on a geonet	—	19°	0.34	—
30 mil Dura-Flex vs dry Ottawa sand	—	19°	0.34	71%
30 mil Dura-Flex vs saturated Ottawa sand	—	17°	0.31	57%
30 mil Dura-Flex vs dry concrete sand	—	21°	0.38	61%
30 mil Dura-Flex vs saturated concrete sand	—	21°	0.38	64%

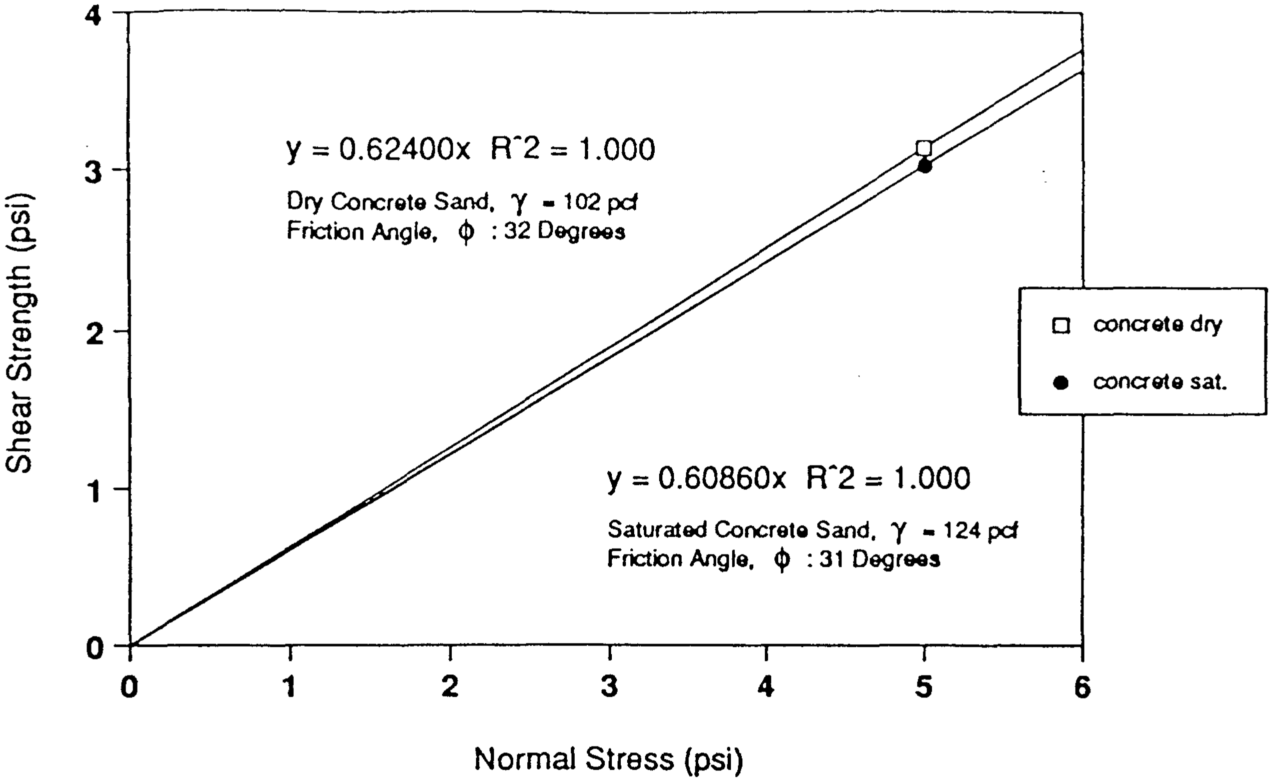


Fig. 7 - Curves for Obtaining Friction Angles of Concrete Sand (Dry and Saturated)

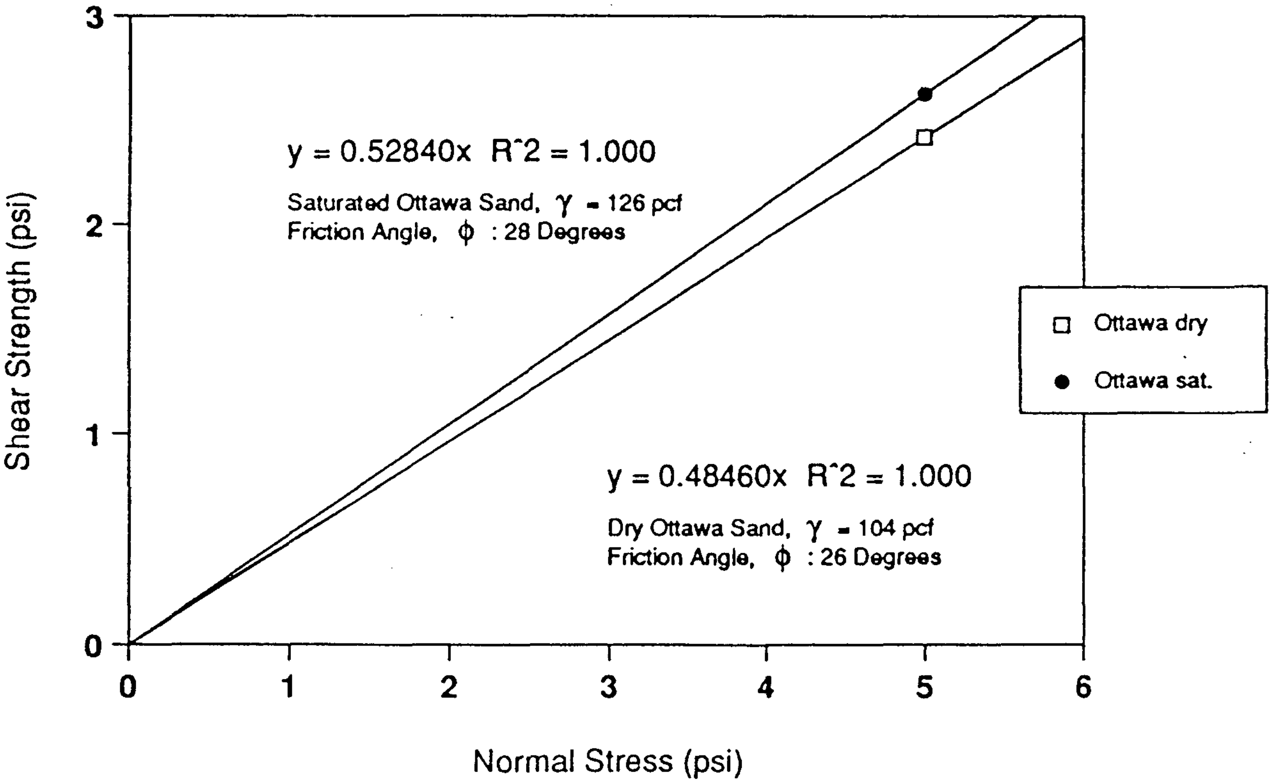


Fig. 8 - Curves for Obtaining Friction Angles of Ottawa Sand (Dry and Saturated)

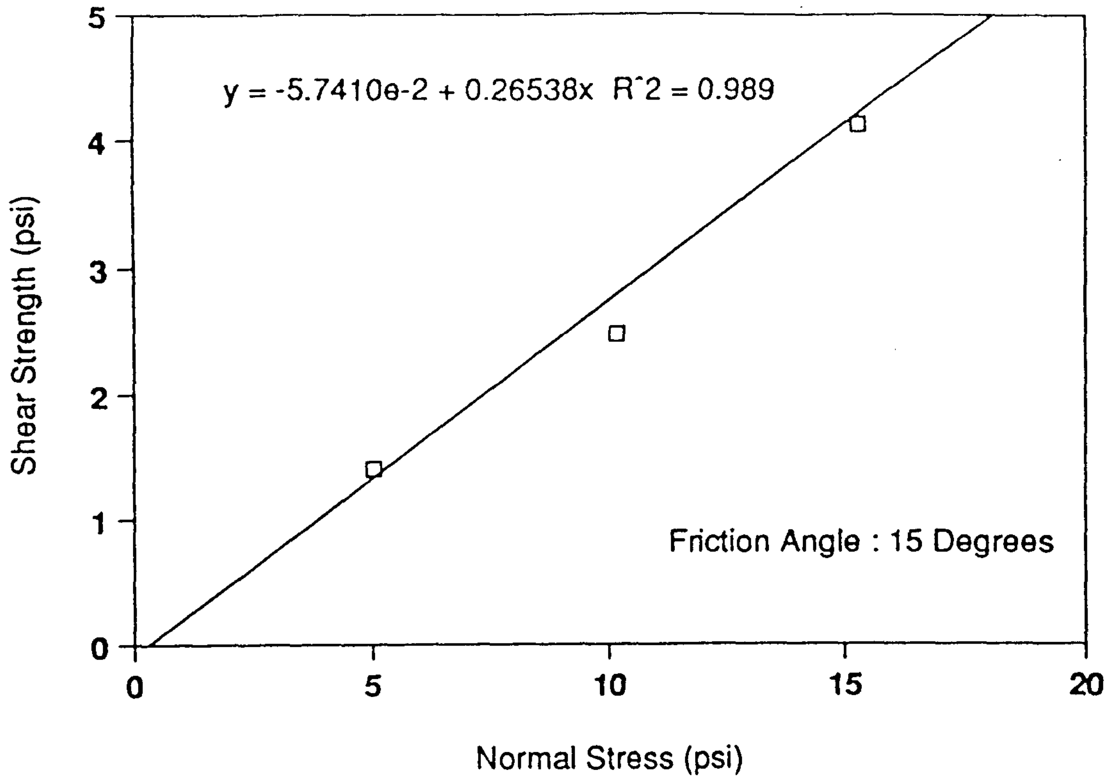


Fig. 9 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Tensar DN 4 Geonet

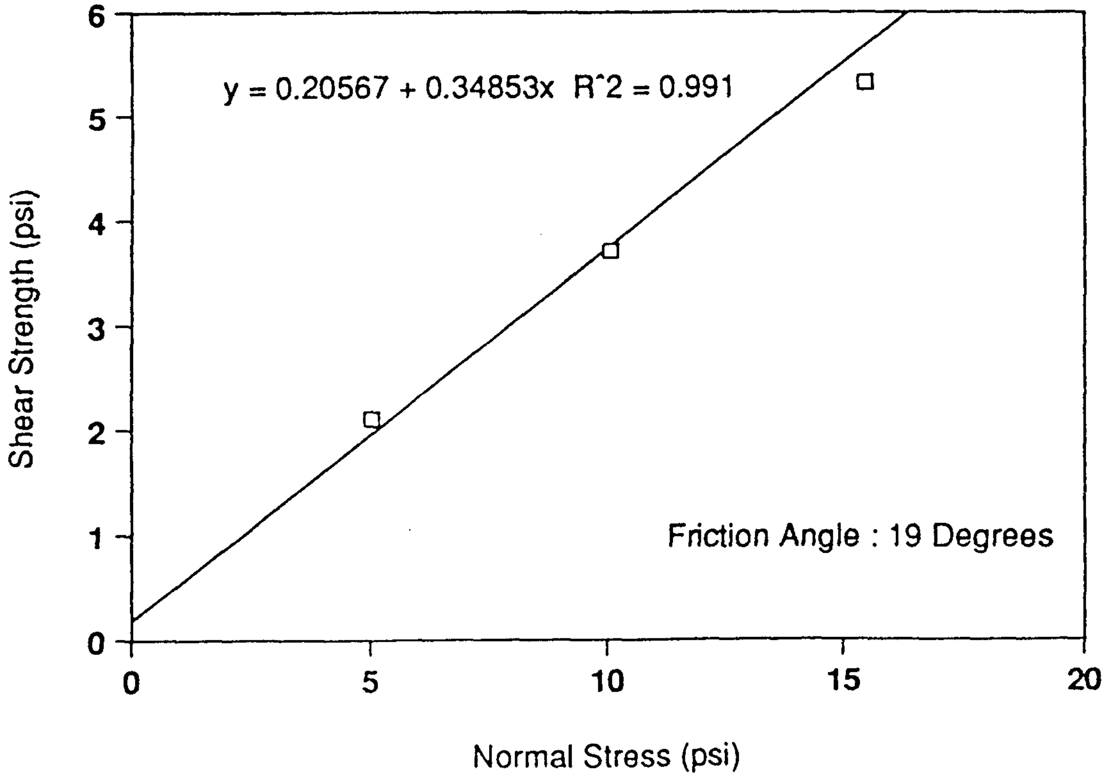


Fig. 10 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Typar 3401 Geotextile on Tensar DN 4 Geonet

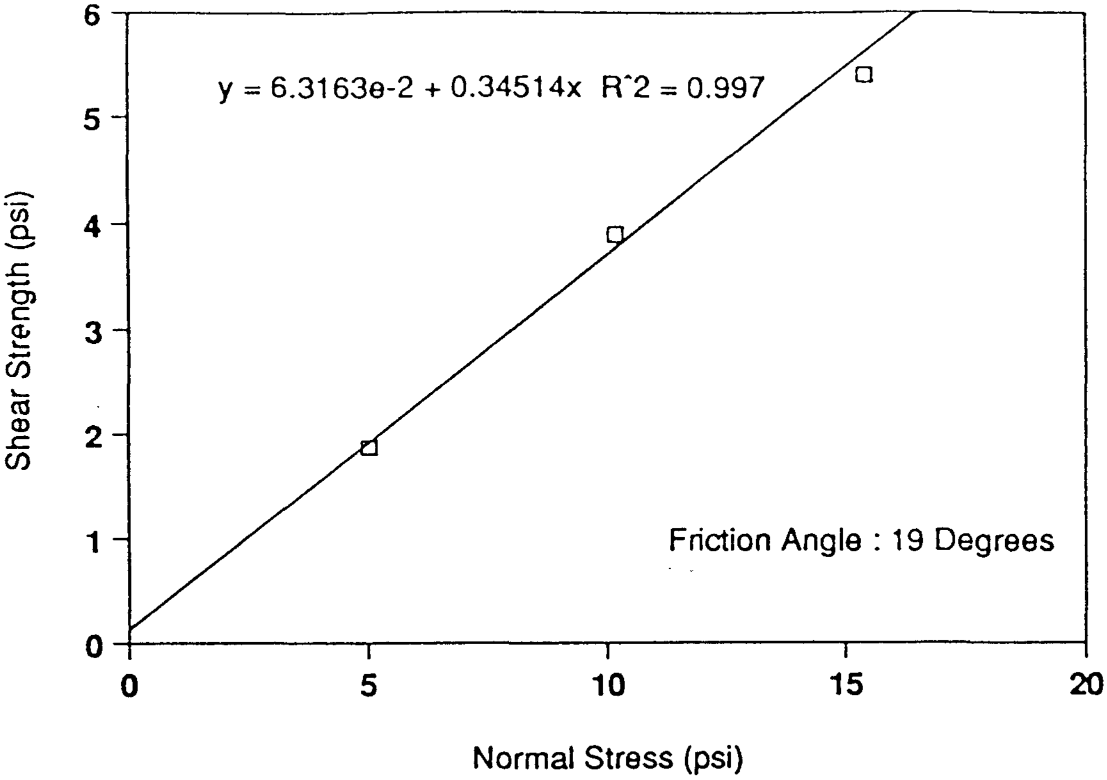


Fig. 11 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Dry Ottawa Sand

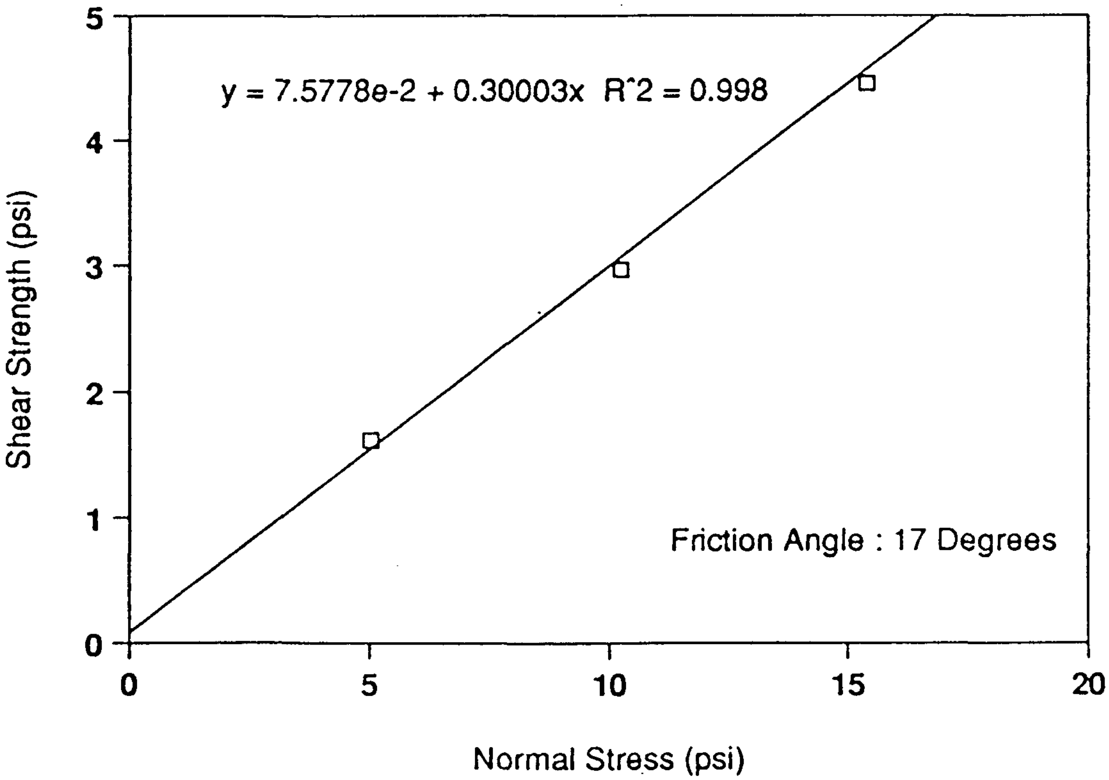


Fig. 12 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Saturated Ottawa Sand

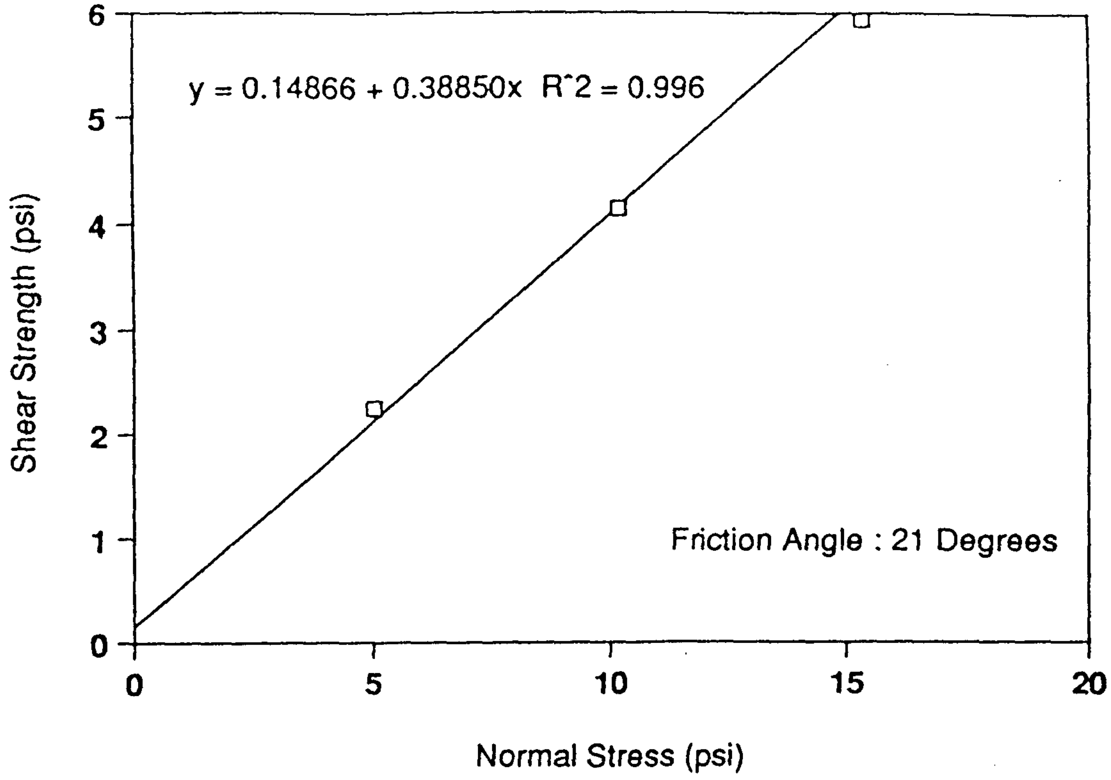


Fig. 13 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Dry Concrete Sand

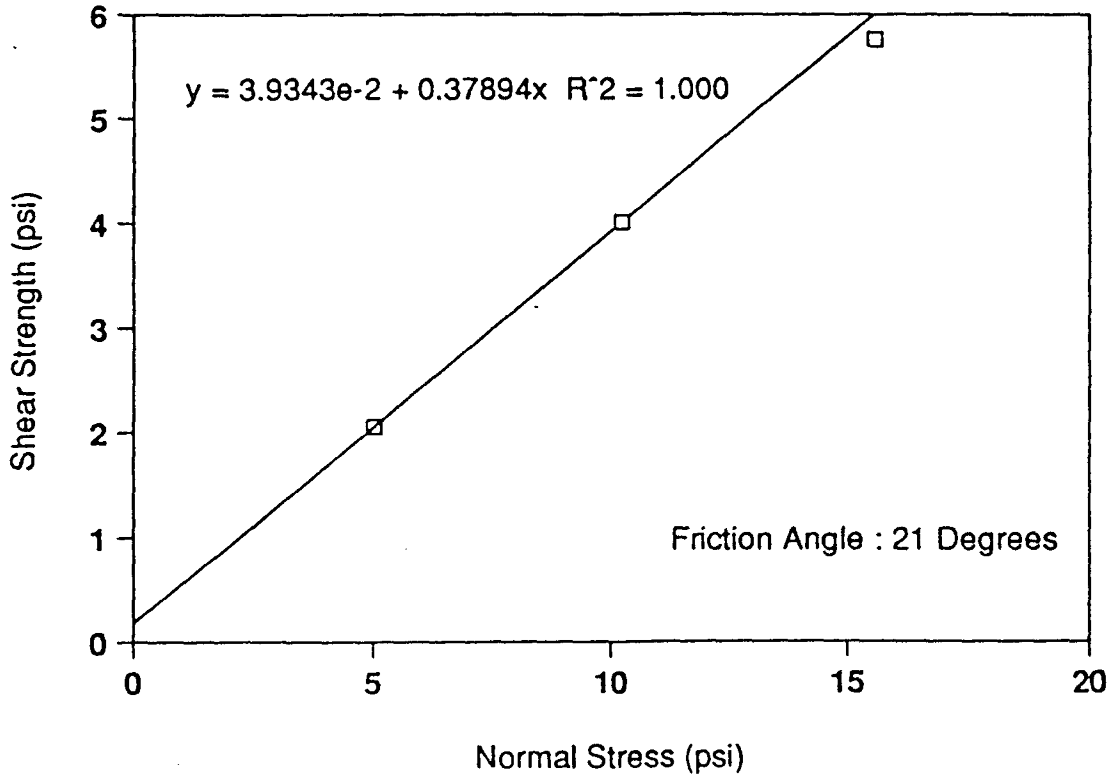
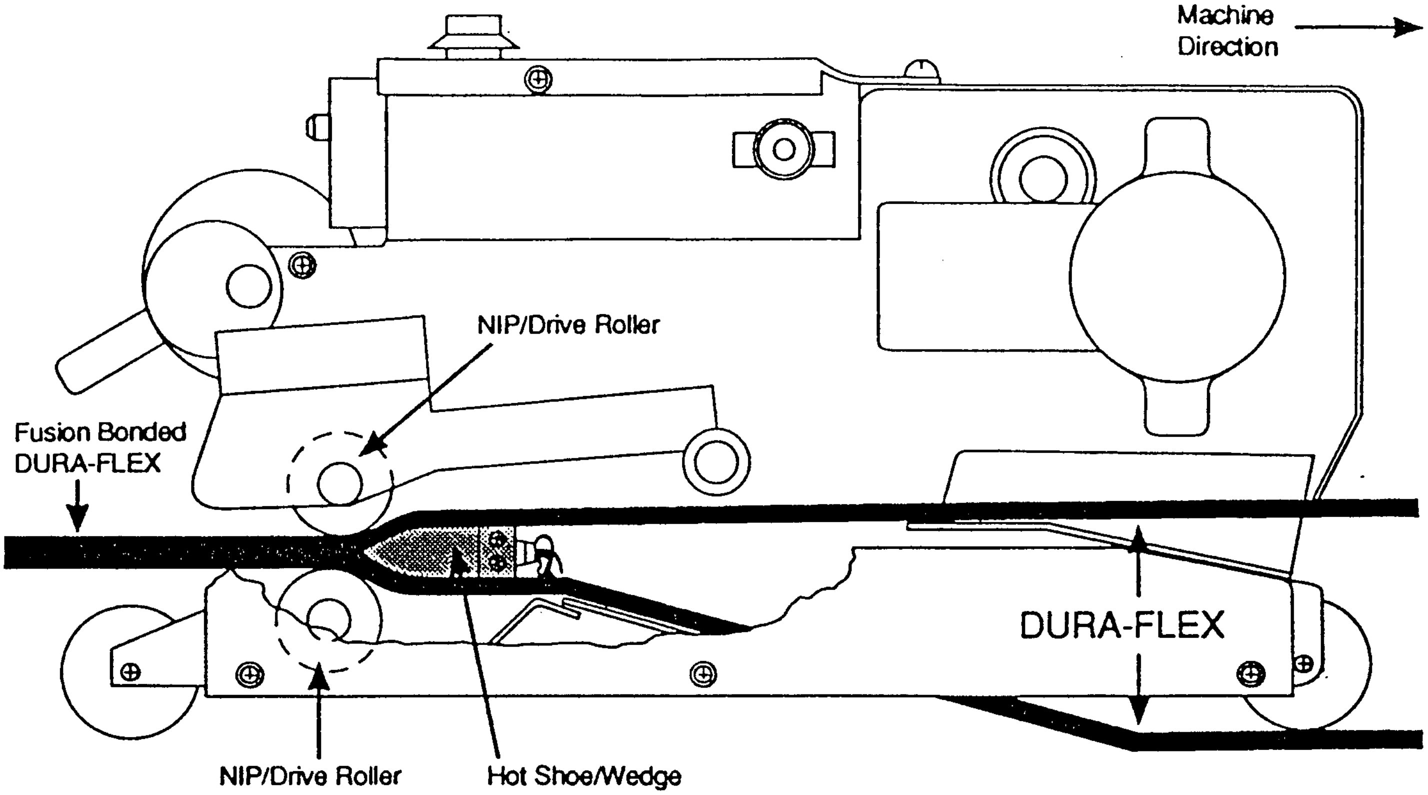
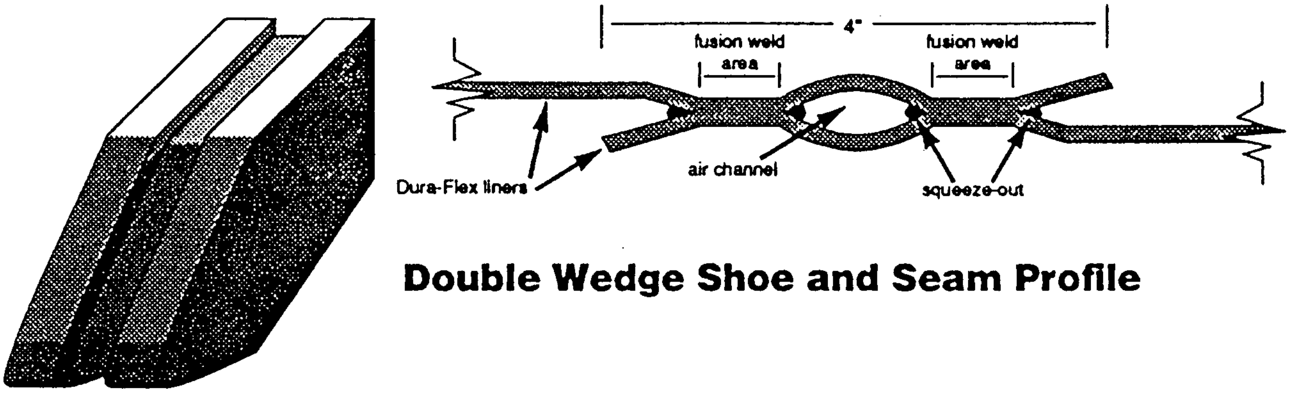


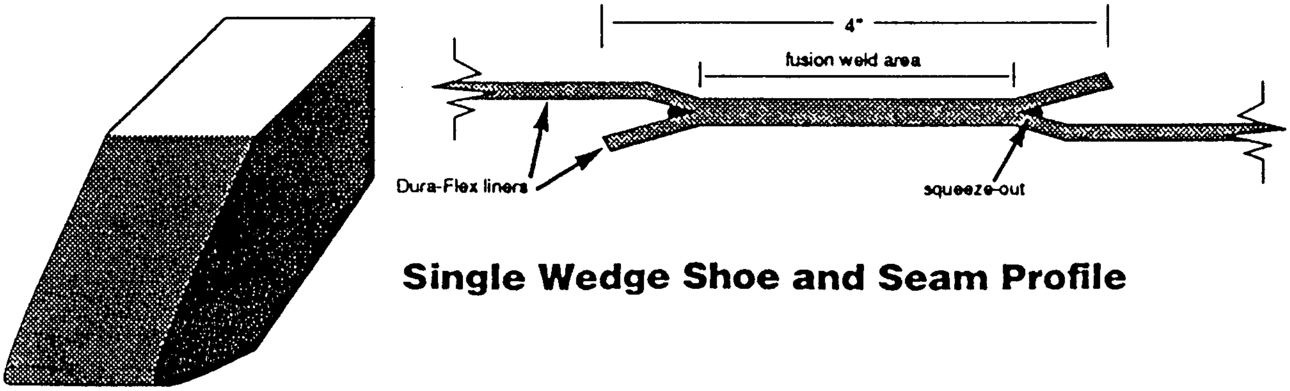
Fig. 14 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Saturated Concrete Sand

Poly-Flex Hot Shoe Welding System





Double Wedge Shoe and Seam Profile



Single Wedge Shoe and Seam Profile

CHEMICAL RESISTANCE

Dura-Flex polyethylene is primarily inert, stable, and contains no plasticizers. Since chemical resistance data for Dura-Flex is limited, the following chart (compiled by Nalgene), which documents such data for Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE), is included. The chemical resistance qualities for LDPE can be used only as a guideline for Dura-Flex material. It is important to note that chemical mixtures do not necessarily affect plastics in the same way that the component chemicals of the same mixture will individually. Chemical attack is influenced by temperature, length of contact with material, chemical concentration, and chemical composition. It is therefore recommended that immersion tests be conducted during the design stage of a project, to confirm the stability of the selected membrane type.

E — 30 days of constant exposure cause no damage. Plastic may even tolerate for years.

G — Little or no damage after 30 days of constant exposure to the reagent.

F — Some effect after 7 days of constant exposure to the reagent. Depending on the plastic, the effect may be crazing, cracking, loss of strength, or discoloration. Solvents may cause softening, swelling and permeation losses with LDPE and HDPE. The solvent effects on these resins are normally reversible; the part will ususally return to its normal condition after evaporation.

N — Not recommended for continuous use. Immediate damage may occur. Depending on the plastic, the effect will be a more severe crazing, cracking, loss of strength, discoloration, deformation, dissolution or permeation loss.

First letter of each pair applies to conditions at 20° C (68° F); the second to those at 50° C (122° F).

CHEMICAL	LDPE	HDPE
Acetaldehyde	GN	GF
Acetamide, Sat.	EE	EE
Acetic Acid, 5%	EE	EE
Acetic Acid, 50%	EE	EE
Acetic Anhydride	NN	FF
Acetone	EE	EE
Acetonitrile	EE	EE
Acrylonitrile	EE	EE
Adipic Acid	EG	EE
Alanine	EE	EE
Allyl Alcohol	EE	EE
Aluminum Hydroxide	EG	EE
Aluminum Salts	EE	EE
Amino Acids	EE	EE
Ammonia	EE	EE
Ammonium Acetate, Sat.	EE	EE
Ammonium Glycolate	EG	EE
Ammonium Hydroxide, 5%	EE	EE
Ammonium Hydroxide, 30%	EG	EE
Ammonium Oxalate	EG	EE
Ammonium Salts	EE	EE
n-Amyl Acetate	GF	EG
Amyl Chloride	NN	FN
Aniline	EG	EG
Aqua Regia	NN	NN
Benzaldehyde	EG	EE
Benzene	FN	GG
Benzoic Acid, Sat.	EE	EE
Benzyl Acetate	EG	EE
Benzyl Alcohol	NN	FN
Bromine	NN	FN
Bromobenzene	NN	FN
Bromoform	NN	NN
Butadiene	NN	FN
Butyl Chloride	NN	NN
n-Butyl Acetate	GF	EG
n-Butyl Alcohol	EE	EE
scc-Butyl Alcohol	EG	EE
tert-Butyl Alcohol	EG	EE
Butyric Acid	NN	FN
Calcium Hydroxide, Conc.	EE	EE

CHEMICAL	LDPE	HDPE
Calcium Hypochlorite, Sat.	EE	EE
Carbazole	EE	EE
Carbon Disulfide	NN	NN
Carbon Tetrachloride	FN	GF
Cedarwood Oil	NN	FN
Cellosolve Acetate	EG	EE
Chlorobenzene	NN	FN
Chlorine, 10% in Air	GN	EF
Chlorine, 10% (Moist)	GN	GF
Chloroacetic Acid	EE	EE
p-Chloroacetophenone	EE	EE
Chloroform	FN	GF
Chromic Acid, 10%	EE	EE
Chromic Acid, 50%	EE	EE
Cinnamon Oil	NN	FN
Citric Acid, 10%	EE	EE
Cresol	NN	FN
Cyclohexane	FN	FN
Cyclohexanone	NN	FN
Cyclopentane	NN	FN
DeCalin	GF	EG
n-Decane	FN	FN
Diacetone Alcohol	FN	EE
o-Dichlorobenzene	FN	FF
p-Dichlorobenzene	FN	GF
1,2-Dichloroethane	NN	NN
2,4-Dichlorophenol	NN	NN
Diethyl Benzene	NN	FN
Diethyl Ether	NN	FN
Diethyl Ketone	GF	GG
Diethyl Malonate	EE	EE
Diethylamine	NN	FN
Diethylene Glycol	EE	EE
Diethylene Glycol Ethyl Ether	EE	EE
Dimethyl Acetamide	FN	EE
Dimethyl Formamide	EE	EE
Dimethylsulfoxide	EE	EE
1,4-Dioxane	GF	GG
Dipropylene Glycol	EE	EE
Ether	NN	FN
Ethyl Acetate	EE	EE

CHEMICAL	LDPE	HDPE
Ethyl Alcohol (Absolute)	EG	EE
Ethyl Alcohol, 40%	EG	EE
Ethyl Benzene	FN	GF
Ethyl Benzoate	FF	GG
Ethyl Butyrate	GN	GF
Ethyl Chloride, Liquid	FN	FF
Ethyl Cyanoacetate	EE	EE
Ethyl Lactate	EE	EE
Ethylene Chloride	GN	GF
Ethylene Glycol	EE	EE
Ethylene Glycol Methyl Ether	EE	EE
Ethylene Oxide	FF	GF
Fatty Acids	EG	EE
Fluorides	EE	EE
Fluorine	FN	GN
Formaldehyde, 10%	EE	EE
Formaldehyde, 40%	EG	EE
Formic Acid, 3%	EG	EE
Formic Acid, 50%	EG	EE
Formic Acid, 98-100%	EG	EE
Freon TF	EG	EG
Fuel Oil	FN	GF
Gasoline	FN	GG
Glacial Acetic Acid	EG	EE
Glutaraldehyde (Disinfectant)	EG	EE
Glycerine	EE	EE
n-Heptane	FN	GF
Hexane	NN	GF
Hydrazine	NN	NN
Hydrochloric Acid, 1-5%	EE	EE
Hydrochloric Acid, 20%	EE	EE
Hydrochloric Acid, 35%	EE	EE
Hydrofluoric Acid, 4%	EG	EE
Hydrofluoric Acid, 48%	EE	EE
Hydrogen Peroxide, 3%	EE	EE
Hydrogen Peroxide, 30%	EG	EE
Hydrogen Peroxide, 90%	EG	EE
Iodine Crystals	NN	NN
Isobutyl Alcohol	EE	EE
Isopropyl Acetate	GF	EG
Isopropyl Alcohol	EE	EE
Isopropyl Benzene	FN	GF
Isopropyl Ether	NN	NN
Jet Fuel	FN	FN
Kerosene	FN	GG
Lacquer Thinner	NN	FN
Lactic Acid, 3%	EG	EE
Lactic Acid, 85%	EE	EE
Mercury	EE	EE
2-Methoxyethanol	EG	EE
Methoxyethyl Oleate	EG	EE
Methyl Acetate	FN	FF
Methyl Alcohol	EE	EE
Methyl Ethyl Ketone	EG	EE
Methyl Isobutyl Ketone	GF	EG
Methyl Propyl Ketone	GF	EG
Methyl-t-butyl Ether	NN	FN
Methylene Chloride	FN	GF
Mineral Oil	GN	EE
Mineral Spirits	FN	FN
Nitric Acid, 1-10%	EE	EE
Nitric Acid, 50%	GG	GN
Nitric Acid, 70%	FN	GN
Nitrobenzene	NN	FN
Nitromethane	NN	FN
n-Octane	EE	EE
Orange Oil	FN	GF
Ozone	EG	EE
Perchloric Acid	GN	GN
Perchloroethylene	NN	NN
Phenol, Crystals	GN	GF
Phenol, Liquid	NN	NN
Phosphoric Acid, 1-5%	EE	EE
Phosphoric Acid, 85%	EE	EE
Picric Acid	NN	NN
Pine Oil	GN	EG
Potassium Hydroxide, 1%	EE	EE
Potassium Hydroxide, Conc.	EE	EE
Propane Gas	NN	FN
Propionic Acid	FN	EF
Propylene Glycol	EE	EE
Propylene Oxide	EG	EE
Resorcinol, Sat.	EE	EE
Resorcinol, 5%	EE	EE
Salicylaldehyde	EG	EE
Salicylic Acid, Powder	EE	EE
Salicylic Acid, Sat.	EE	EE
Salt Solutions, Metallic	EE	EE
Silicone Oil	EG	EE
Silver Acetate	EE	EE
Silver Nitrate	EG	EE
Skydrol LD4	GF	EG
Sodium Acetate, Sat.	EE	EE
Sodium Hydroxide, 1%	EE	EE
Sodium Hydroxide, 50% to Sat.	GG	EE
Sodium Hypochlorite, 15%	EE	EE
Stearic Acid, Crystals	EE	EE
Sulfuric Acid, 1-6%	EE	EE
Sulfuric Acid, 20%	EE	EE
Sulfuric Acid, 60%	EG	EE
Sulfuric Acid, 98%	GG	GG
Sulfur Dioxide, Liq., 46 psig	NN	FN
Sulfur Dioxide, Wet of Dry	EE	EE
Sulfur Salts	FN	GF
Tartaric Acid	EE	EE
Tetrahydrofuran	FN	GF
Thionyl Chloride	NN	NN
Toluene	FN	GG
Tributyl Citrate	GF	EG
Trichloroacetic Acid	FN	FF
1,2,4-Trichlorobenzene	NN	NN
Trichloroethane	NN	FN
Trichloroethylene	NN	FN
Triethylene Glycol	EE	EE
2,2,4-Trimethylpentane	FN	FN
Tripropylene Glycol	EE	EE
Tris Buffer, Solution	EG	EG
Turpentine	FN	GG
Undecyl Alcohol	EF	EG
Urea	EE	EE
Vinylidene Chloride	NN	FN
Xylene	GN	GF
Zinc Stearate	EE	EE

POLY-AMERICA, INC.

DURA-FLEX INSTALLATIONS

ENGINEER: Davy McKee, Steffen Robertsen & Kirsten
PROJECT: Cove Project, Echo Bay Management Corp.
Tailing Impoundment for gold mine
LOCATION: Battle Mountain, Nevada
LINER THICKNESS: 30 mil, single-lined
QUANTITY: 8.5 million square feet, 1988
INSTALLER: Crest-Liners, Inc.

ENGINEER: Davy McKee, Steffen Robertsen & Kirsten
PROJECT: Cove Project Phase II, Echo Bay Management Corp.Tailing
Impoundment for gold mine
LOCATION: Battle Mountain, Nevada
LINER THICKNESS: 30 mil, single-lined
QUANTITY: 10 million square feet, 1989
INSTALLER: Gagle Co.

ENGINEER: Steffen Robertson & Kirsten
PROJECT: Getchell Mine, First Mississippi Gold, Inc.
Tailing ponds and pads for gold mine
LOCATION: Golcanda, Nevada
LINER THICKNESS: 30 mil, single-lined
QUANTITY: 4.4 million square feet, 1988
INSTALLER: Crest-Liners, Inc.

ENGINEER: GZA, Inc., Nanu Nobis
PROJECT: Gillette Company
Sludge lagoon landfill cap
LOCATION: Andover, Mass.
LINER THICKNESS: 30 mil
QUANTITY: 40,000 square feet, 1988
INSTALLER: Resicon, Inc.

ENGINEER: James C. Hanson Consulting Engineers
PROJECT: Royal Mountain King Project, Meridian Minerals, Inc.Leach concentrates
residues management facilities
LOCATION: Copperopolis, California
LINER THICKNESS: 40 mil
QUANTITY: 600,000 square feet, 1988
INSTALLER: Gagle Co.

ENGINEER: Bill Morrison, U.S. Bureau of Reclamation, U.S. Dept. of the Interior
PROJECT: Belle Fourche Project
Canal prototype
LOCATION: Newell, South Dakota
LINER THICKNESS: 30 mil
QUANTITY: 10,000 square feet, 1987
INSTALLER: Poly-America, Inc.

APPENDIX B

- **MATERIAL TEST DATA**

ENVIROCON, INC.

ENVIROCON

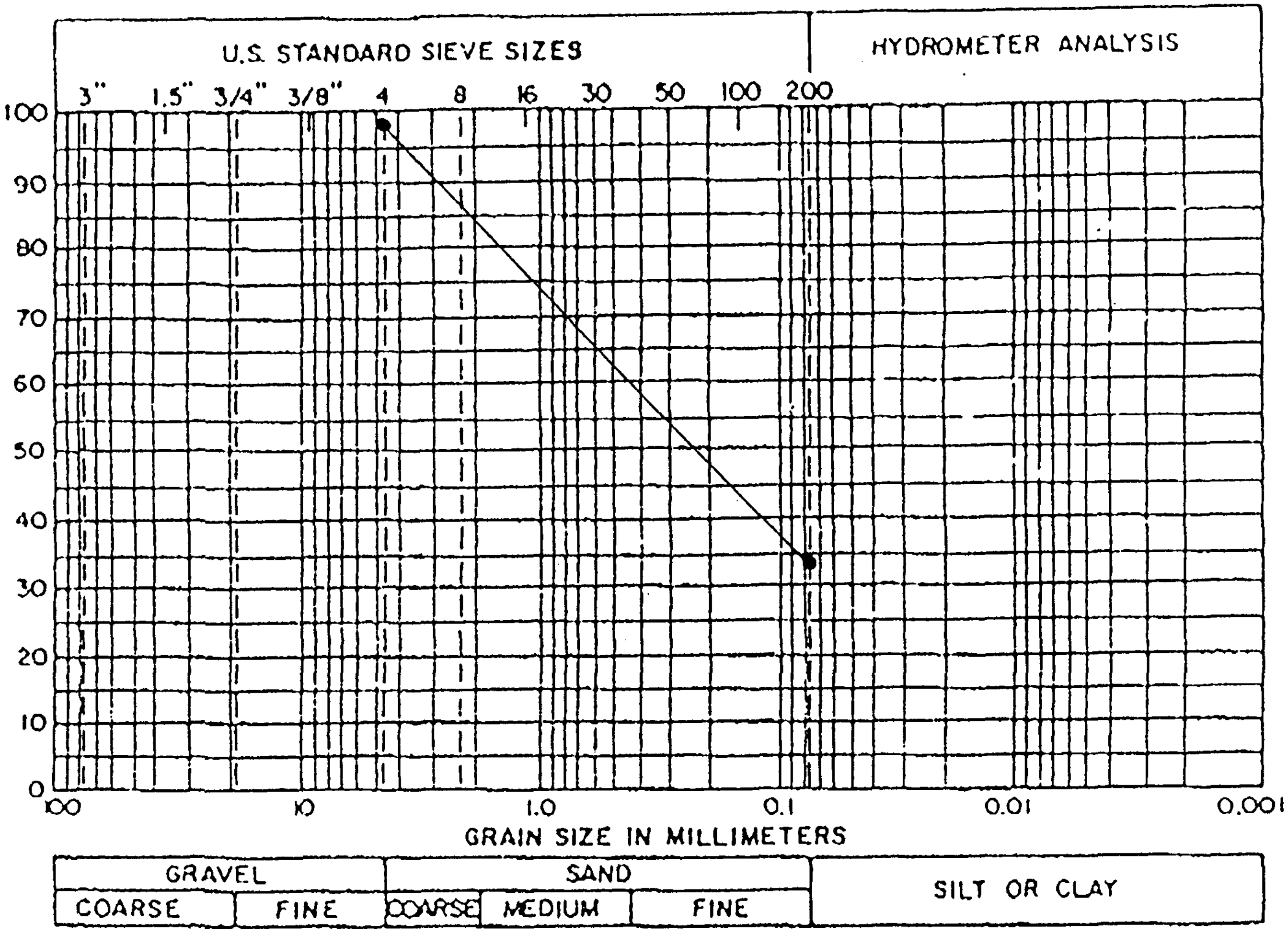
LAB ____________ LAB NO. ____________

CLIENT Maverik PROJECT Caribou Refinery

FEATURE Trench Backfill PROJECT NO. 2001

SAMPLE NO. 0+50 DATE TESTED 06/21/90

GRAIN SIZE ANALYSIS



LIQUID LIMIT ____________ PLASTICITY INDEX ____________

DESCRIPTION ____________ USCS ____________

U.S. Sieve	Particle Size mm	Percent Finer
5.0"	126.7	
3.0"	76.0	
1.5"	38.0	

U.S. Sieve	Particle Size mm	Percent Finer
3/4"	19.00	
3/8"	9.50	
4	4.750	97.6
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
30	.590	
50	.297	
100	.149	
200	.074	34.4
—	.037	

Particle Size mm	Percent Finer
.019	
.009	
.005	
.002	
001	

Moisture = 23.5%

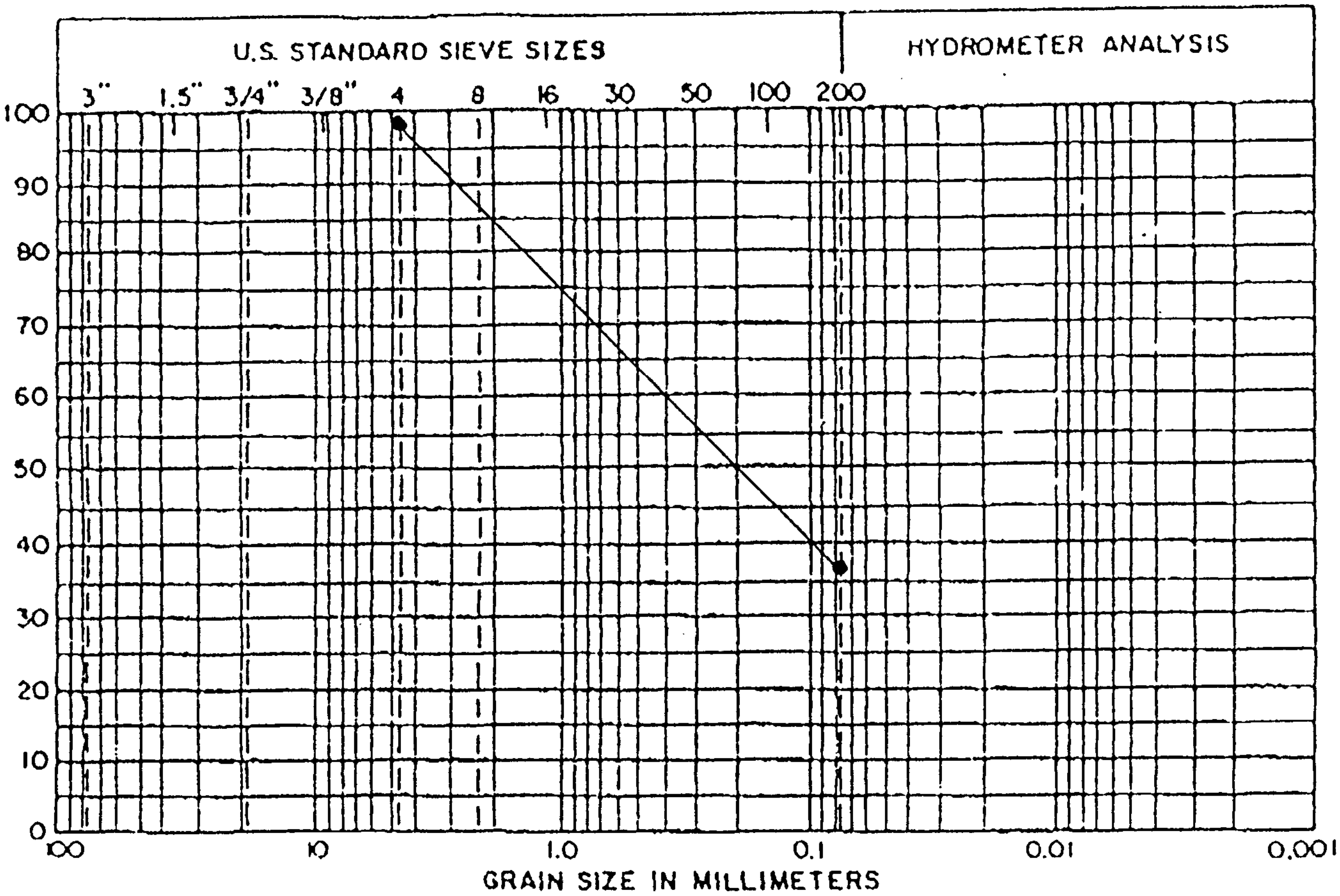
ENV 06/90

FIGURE NO. ______

ENVIROCON

LAB		LAB NO.	
CLIENT	Maverik	PROJECT	Caribou Refinery
FEATURE	Trench Backfill	PROJECT NO.	2001
SAMPLE NO.	11+00	DATE TESTED	06/22/90

GRAIN SIZE ANALYSIS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

LIQUID LIMIT ______ PLASTICITY INDEX ______

DESCRIPTION ______ USCS ______

U.S. Sieve	Particle Size mm	Percent Finer
5.0"	126.7	
3.0"	76.0	
1.5"	38.0	

U.S. Sieve	Particle Size mm	Percent Finer
3/4"	19.00	
3/8"	9.50	
4	4.750	98.3
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
30	.590	
50	.297	
100	.149	
200	.074	36.7
—	.037	

Particle Size mm	Percent Finer
.019	
.009	
.005	
.002	
001	

Moisture = 31.1%

ENV 06/90

FIGURE NO. ______

ENVIROCON

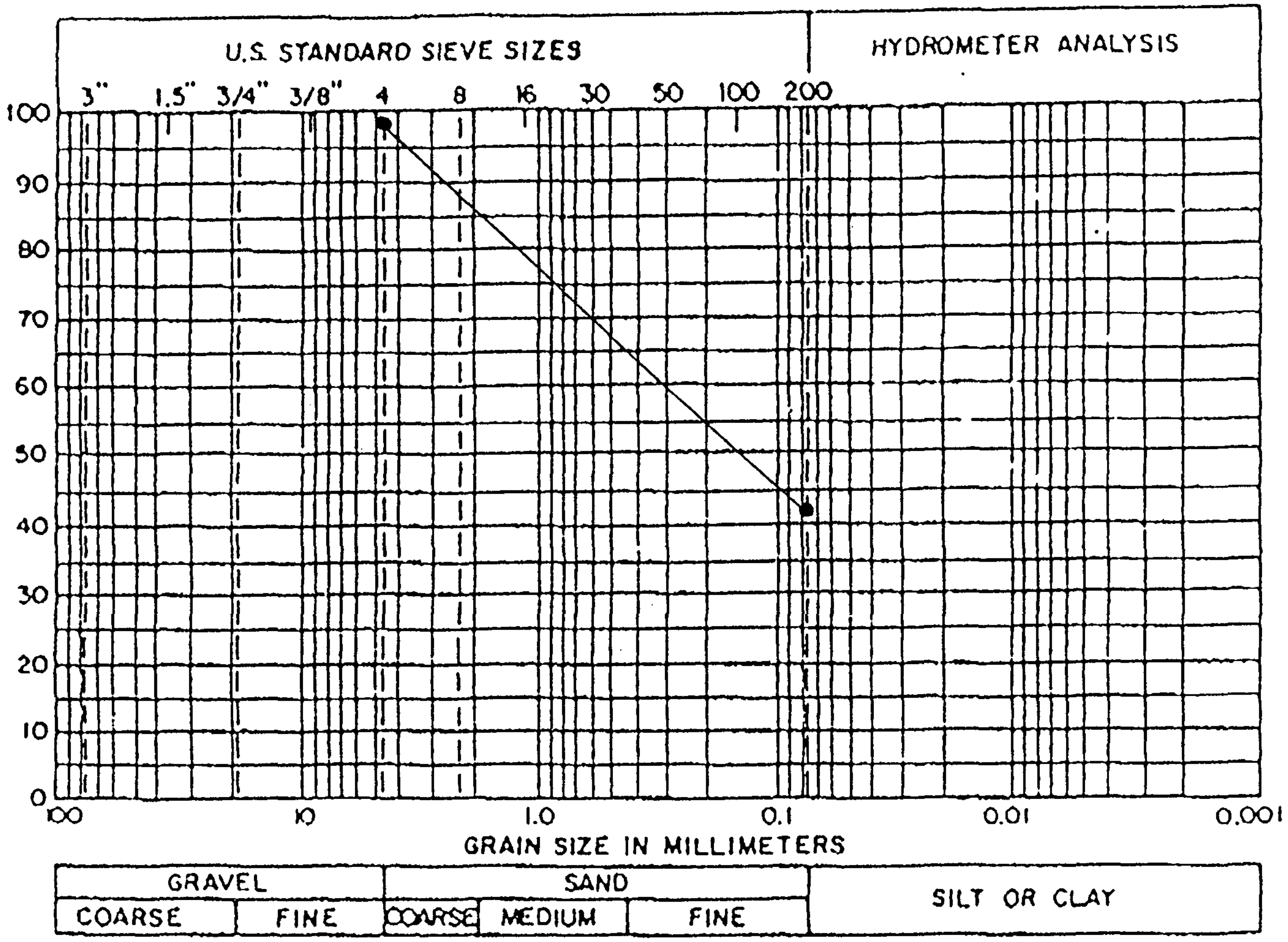
LAB ____________ LAB NO. ____________

CLIENT Maverik PROJECT Caribou Refinery

FEATURE Trench Sample PROJECT NO. 2001

SAMPLE NO. 8+50 DATE TESTED 06/24/90

GRAIN SIZE ANALYSIS



LIQUID LIMIT ____________ PLASTICITY INDEX ____________

DESCRIPTION ____________ USCS ____________

U.S. Sieve	Particle Size mm	Percent Finer
5.0"	126.7	
3.0"	76.0	
1.5"	38.0	

U.S. Sieve	Particle Size mm	Percent Finer
3/4"	19.00	
3/8"	9.50	
4	4.750	97.8
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
30	.590	
50	.297	
100	.149	
200	.074	42.9
—	.037	

Particle Size mm	Percent Finer
.019	
.009	
.005	
.002	
001	

Moisture = 33.7%

ENV 06/90 FIGURE NO. ____________

ENVIROCON

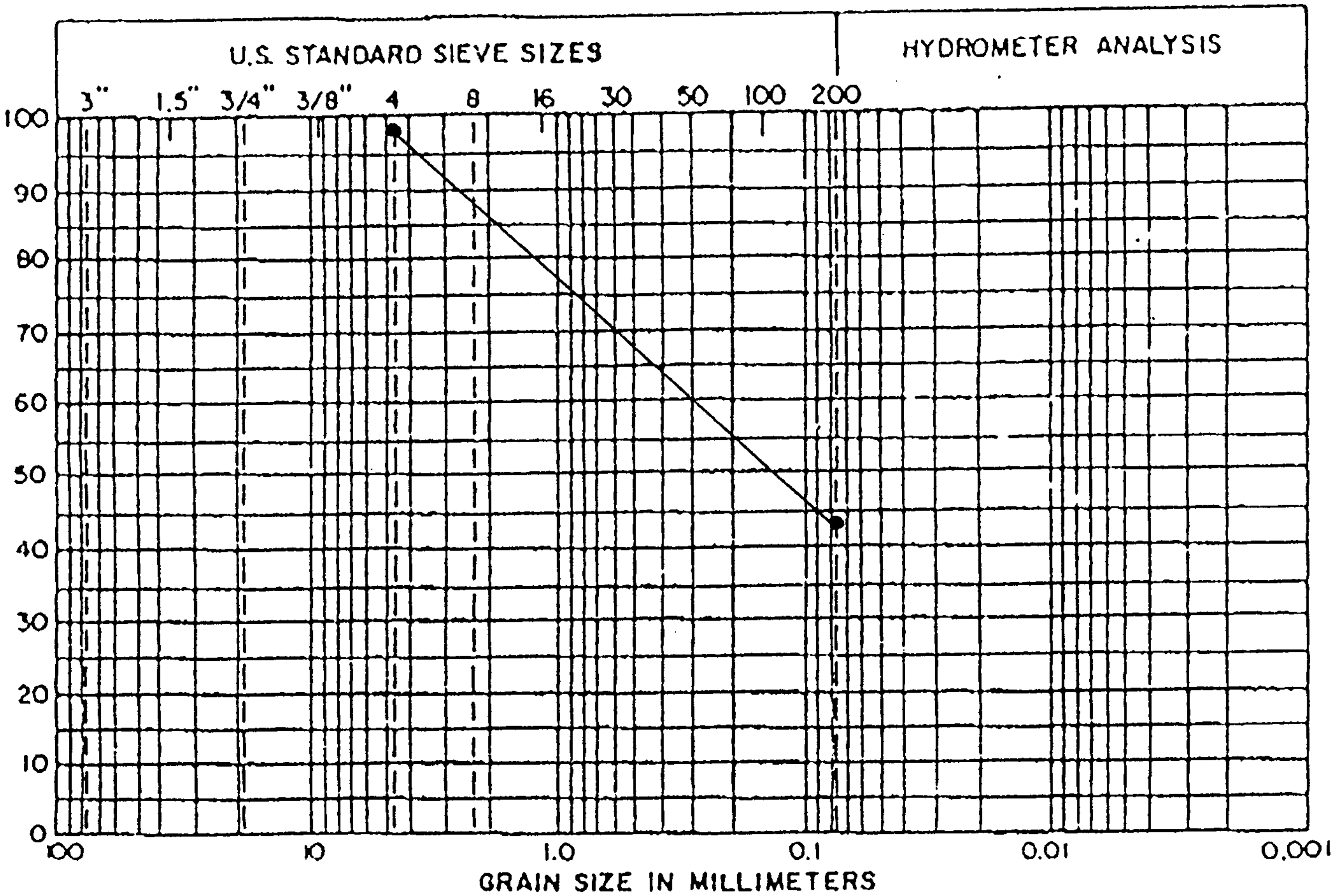
LAB ______ LAB NO. ______

CLIENT Maverik PROJECT Caribou Refinery

FEATURE Trench Backfill PROJECT NO. 2001

SAMPLE NO. 4+00 DATE TESTED 06/26/90

GRAIN SIZE ANALYSIS



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

LIQUID LIMIT ______ PLASTICITY INDEX ______

DESCRIPTION ______ USCS ______

U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	U.S. Sieve	Particle Size mm	Percent Finer	Particle Size mm	Percent Finer
			3/4"	19.00		30	.590		.019	
			3/8"	9.50		50	.297		.009	
5.0"	126.7		4	4.750	98.1	100	.149		.005	
3.0"	76.0		8	2.380		200	.074	43.6	.002	
1.5"	38.0		16	1.190		—	.037		001	

Moisture = 29.5%

ENV 06/90

FIGURE NO. ______

APPENDIX C
SITE-SPECIFIC HEALTH AND SAFETY PLAN

ENVIROCON, INC.

MAVERICK COUNTRY STORES SLURRY-WALL CONSTRUCTION
HEALTH AND SAFETY PLAN

ENVIROCON, INC.

HEALTH AND SAFETY PLAN

OVERVIEW

Envirocon has established this Health and Safety Plan (HASP) for all employees engaged in site remediation activities at the Maverick Country Stores Slurry-wall Construction Site, Kirtland, New Mexico (hereafter referred to as Kirtland Site). Prior to any work on site, a copy of this HASP will be distributed to all employees and subcontractors by the Site Safety Officer. All site work will be conducted in a safe manner and comply with EPA, OSHA, state, and local regulations.

Emergency Telephone Numbers

Emergency telephone numbers will be posted on site and made immediately available at all times. These numbers will include the following. A telephone is located at the Maverick Country Store on the highway north of the refinery property.

Emergency

FIRE	(505) 325-3501
AMBULANCE	(505) 325-3501
POLICE	(505) 327-0222
HOSPITAL	(505) 325-3501

Non Emergency

Envirocon, Inc	(406) 523-1150
County Sanitation	
Power Company	
Phone Company	
Dames and Moore	
Occupational Health Service St. Patrick Hospital (Dana Headapohl, MD)	(406) 543-7271 Ext.2676

The Occupational Health Service may be contacted for information on toxic exposures and other health and safety issues.

HEALTH AND SAFETY PLAN ADMINISTRATION

Purpose and Objectives

Envirocon will strive to provide a safe workplace and use all reasonable means to protect its employees in the ordinary course of employment from harmful exposures to known toxic substances and physical agents.

Envirocon will use all reasonable means to comply with applicable occupational and environmental health and safety laws and regulations.

The purpose of this site-specific HASP is to provide guidelines and procedures to ensure the health and physical safety of those persons working at the Kirtland Site. While it is impossible to eliminate all risks associated with site work, the goal is to provide precautionary and responsive measures for the protection of on-site personnel, the general public, and the environment.

Responsibilities

Site Safety Officer (SSO): The SSO is responsible for directing and implementing the HASP and ensuring that all Envirocon and subcontractor personnel have been trained in HASP procedures. The SSO will coordinate safety activities with subcontractors and the Medical Director of Occupational Health Service, St. Patrick Hospital, and will serve as liaison with public officials who might monitor health and safety activities on site. The SSO will also assure that proper protective equipment is available and used in the correct manner, that decontamination activities are carried out correctly, that specific site hazards are noted and accounted for in the Work Plan, and that employees have knowledge of the local emergency medical system.

The SSO will coordinate the following:

1. Identification of occupational hazards.

2. Notification of the corporate and operating departments of known health hazards.

3. Provision of technical assistance, including education and training, to minimize or control health risks.

4. Evaluation of workplace exposures for potentially adverse effects on workers.

5. Recommendations of procedures or methods for prevention of significant exposures, including protection devices, alternative work practices and engineering controls.

6. Evaluation of HASP on a regular basis.

Project Manager: Dale Evans. The Project Manager is responsible for directing all on-site hazardous waste operations, including the overall implementation of the Health and Safety Plan. He will select subcontractors that meet Envirocon Corporation Health and Safety training and experience guidelines. In addition, the Project Manager is responsible for ensuring that adequate resources and personnel protective equipment are allocated for the health and safety of site personnel. The Project Manager is also responsible for ensuring that the SSO is given free access to all relevant site information that could impact health and safety. He will correct conditions or work practices that could lead to employee exposure to hazardous materials.

SITE DESCRIPTION

Envirocon, Inc. will be excavating and installing a slurry-wall trench approximately twenty (20) feet deep into contaminated soils beneath the tank farm area of the former Caribou Refinery, now owned by Maverick Country Stores. The facility is located near Kirtland, New Mexico (see attached drawing).

Suspected Site Contamination

Previous sampling results or the review of site records indicate the following chemicals and/or metals may be encountered during this work effort:

Gasoline
1,2-Dichloroethane
Benzene
Xylene
Toluene
Ethyl Benzene
Tetraethyl Lead

PATHWAYS FOR HAZARDOUS SUBSTANCE DISPERSION

This section assesses the pathways along which chemicals could escape site boundaries during field operations in the solid or liquid phase. In this case, particles would be distributed in an area downwind from the site. Measures will be taken to assure that dust levels are kept to a minimum on site. Decontamination procedures will be implemented to prevent chemicals from being carried off site by either personnel or equipment.

Air monitoring will be utilized during field operations to determine if chemicals are being carried off site. In addition, an action level will be established and used to determine when site activities should cease. Specific air monitoring procedures and action levels are outlined in a later section.

HAZARD ASSESSMENT

Based on the available information concerning chemical hazards known or suspected to be present at the Kirtland Site, a hazard assessment has been made. Investigation and remediation may identify hazards which require special attention and updating of the HASP.

Chemical Exposure

Site workers may be exposed to petroleum hydrocarbons during field investigation and remediation. The major contaminant is gasoline. The primary routes for exposure to petroleum hydrocarbons include ingestion, inhalation, skin absorption, and eye or skin contact. Personnel protective equipment will be required to minimize personnel exposure when appropriate levels of contaminants are present or have the potential to be present.

Envirocon will inform employees about the potential effects of chemicals involved in the remediation, consistent with OSHA's Federal Hazard Communication Standard and Right to Know regulations.

Toxic exposure incidents will be reported to the SSO and Occupational Health Service, St. Patrick Hospital for review by the Medical Director, as appropriate. Reported information for each incident will include:

1. Name of workers exposed.
2. Nature and type of exposure.
3. Circumstances surrounding exposure.
4. Use of respirators or personal protective equipment.
5. Worker symptoms.
6. First aid or medical treatment and recommendations.

Fire and Explosion

The risk of fire or explosion during site activities is high for tank removal operations and work within confined areas. The lower explosive limits and flashpoints (TLV included) for selected contaminants are outlined below.

	LEL%	FLASHPOINT	TLV
Gasoline	1.4	-50 F	300
1,2-Dichloroethane	6.2	55 F	50
Benzene	1.3	12 F	10
Xylene	1.1	85 F	100
Toluene	1.2	40 F	100
Ethylbenzene	1	71 F	100

A combustible gas monitor will be utilized to determine the percent LEL during product recovery operations and work in confined areas. Personnel will be moved upwind if 10 percent LEL is reached. All work will be stopped if 50 percent LEL is reached. To limit the risk of fire or explosions, smoking will not be allowed within cleanup areas at any time.

Equipment used within areas potentially prone to fire and explosion hazards will be explosion-proof.

A 20-1b. ABC dry chemical fire extinguisher will be placed at the compressor station.

Oxygen Deficiency

The atmosphere will be monitored with an oxygen meter before entering confined spaces. Appropriate response to oxygen contents of < 19.5 percent is outlined in a later section.

HEALTH AND SAFETY TRAINING

This section describes the health and safety training requirements for participating in field operations at the Kirtland Site.

General Training Requirements

All technical personnel who may be exposed to occupational health hazards during field or laboratory work will receive training which complies with that required by OSHA in 29 CFR 1910.120. This training will include the 40-hour basic course, 8-hour supervisory course, and 8-hour annual update course. In addition, project-specific training shall be conducted to familiarize employees and subcontractors with the hazards which are likely to be encountered during work activities at a particular job site.

The 40-hour course will include at least the following topics:

first aid and CPR;
toxicology;
chemical hazards;
physical hazards;
air monitoring;
protective clothing;
respiratory protection;
EPA protection levels;
site control;
site health and safety plans;
confined spaces;
sampling and shipping of samples;

emergency procedures;
decontamination;
ionizing radiation;
heat stress;
hypothetical waste site and practical exercises;
medical monitoring;
general work rules and conditions of employment;
corporate health and safety policy;
preparation for fieldwork;
29 CFR 1910.120;
OSHA regulations.

Kirtland Site Health and Safety Information and Procedures

Envirocon employees and subcontractors will familiarize themselves with the following information and procedures prior to starting work on the Kirtland Site.

Communication

The following standard hand signals will be used while workers are in Level C or B:

Hand gripping throat ....Out of air, Can't breathe.

Grip partners wrist or both hands around waist ....Leave area immediately

Hands on top of head ....Need assistance.

Thumbs up ....OK, I am all right, I understand

Thumbs down ....Negative

The telephone number for the Command Post is __________

General Safety Procedures

- Emergency plans will be up-dated and documented as needed.
- All personnel will attend each-day tailgate safety meetings.
- All personnel working on site will attend first-day health & safety meeting.
- There will be at least one person on site with supervisor training.

Emergency Medical Care

The local medical facility is: ______________________________
____
____
____

The hospital and clinic will be briefed on the work planned at the Kirtland Site, including the potential hazards and the substances involved.

Local ambulance service is available in ____________________ . The estimated response time is ___ minutes to the site and another ____ minutes to the ______________________ Hospital.

First-aid equipment, eye-wash bottles, and fire extinguishers are available on site and will be located adjacent to the Work Zone. At least one person on site will be certified in First Aid and CPR.

Emergency Medical Information for Substances Present

GASOLINE

PEL/TLV-TWA = 300 ppm PEL/TLV-STEL = 500ppm

Gasoline is an eye and throat irritant at levels around the PEL, and causes narcotic effects (with symptoms including headache, nausea, dizziness, and blurred vision) at higher levels. Long-term exposure can effect liver and kidney function. Some studies indicate a potential for gasoline to be an animal carcinogen, but this has not been fully established. Because gasoline is a mixture of varying proportions of dozens of hydrocarbons, a mean odor threshold has not been determined.

1,2-DICHLOROETHANE (1,2-DCA)

PEL-TWA = 1 ppm PEL-STEL = 2 ppm
TLV-TWA = 10 ppm

1,2-DCA is a central nervous system depressant. Exposure to 10 to 37 pm may produce nausea, vomiting, and dizziness. At higher levels, 1,2-DCA produces narcosis.

Chronic effects include liver and kidney damage and blood changes; 1,2-DCA is considered to be a probable human carcinogen.

Excessive skin contact may produce defatting of the skin and subsequent dermatitis. The mean odor threshold is 88 ppm, which is not adequate to prevent exposure above the PEL. Therefore, air monitoring will be used to prevent overexposure. The 1,2-DCA ionization potential is 11.12 eV.

BENZENE

PEL-TWA = 1 ppm, TLV = 10 ppm
PEL-STEL = 5 ppm

Benzene is a central nervous system depressant. Symptoms include headache, nausea, tremors, and fatigue, but these typically do not occur until exposure concentrations are in excess of 150 ppm. There is significant evidence that chronic exposures are carcinogenic, causing a progressively malignant disease of the blood-forming organs (leukemia). Benzene is poorly absorbed through intact skin, but contact with liquid benzene may cause blistering and dermatitis. Benzene vapors can cause transient eye irritation. The mean air odor threshold for benzene is 12 ppm, which yields unsatisfactory warning properties. Benzene's ionization potential is 9.25 eV.

XYLENE

PEL/TLV-TWA = 100 ppm, PEL = 150 ppm

Xylene is an eye, nose, and throat irritant at concentrations nearing 200 ppm. At higher concentrations, it is a central nervous system depressant, with symptoms including nausea, fatigue, and headaches. Liquid xylene acts on the skin as an irritant and can cause dermatitis. Exposure to vapor can cause eye irritation. Xylene is not considered carcinogenic. Xylene's mean odor threshold is 1 ppm, which gives it excellent warning properties. The ionization potential for the Xylene isomers are 8.56, and 8.44, respectively.

TOLUENE

PEL/TLV-TWA = 100 ppm, PEL/TLV-STEL = 150 ppm

Toluene is a central nervous system depressant. Symptoms include headache, nausea, dizziness and fatigue, but such symptoms typically do not occur at exposures below 200 ppm. Repeated and prolonged contact with liquid toluene may cause drying of the skin and dermatitis. Mild, transitory eye irritation may be experienced with exposure to vapors above 200 ppm. Toluene is not considered carcinogenic. Toluene's mean odor threshold is 3 ppm, which gives it excellent warning properties. Toluene's ionization potential is 8.82 eV.

ETHYL BENZENE

PEL/TLV-TWA = 100 ppm PEL/TLV-STEL = 125 ppm

Ethyl benzene is an eye and mucous membrane irritant at levels well above the TLV. Liquid ethyl benzene is a significant skin irritant, and can cause defatting and blistering with repeated exposures. Vapors can cause transitory eye irritation at concentrations above 200 ppm. Ethyl benzene is not considered carcinogenic. The mean odor threshold is 2 ppm, which gives it excellent warning properties. Ethyl benzene's ionization potential is 8.76 eV.

TETRAETHYL LEAD

PEL-TWA = 0.075 mg/m-skin TLV-TWA = 0.1 mg/m

Absorption of tetraethyl lead may cause intoxication. Milder toxic effects are sleeplessness, tiredness, wild dreams, anxiety, trembling, spasms, slow heart beat,low body temperature, paleness, nausea, and loss of appetite. More severe intoxification can cause disorientation, hallucinations, grimacing, violent activity, leading to convulsive seizures, unconsciousness, and death. May cause eye irritation. Can cause damage to developing fetus. Onset of symptoms may be delayed.

A manual will be prepared describing both acute and chronic health problems which could result from exposures to these substances. Information on immediate first aid, emergency department, and recommended medical follow-up will be included. This manual will be made available to local treating physicians.

Emergency Procedures

The following standard emergency procedures will be used by on-site personnel. The Site Safety Officer or Project Manager will be notified of any on-site emergencies and will be responsible for ensuring that the appropriate procedures are followed.

Personal injury in the Work Zone: Upon notification of an injury in the Work Zone, the designated emergency signal of an automobile horn will be sounded. All site personnel will assemble and the rescue team allowed to enter the Work Zone (if required) to remove the injured person. The Site Safety Officer and Project Manager should evaluate the nature of the injury, and the affected person decontaminated to the extent possible prior to movement. On-site first aid will be provided until medical help is obtained. Contact will be made for an ambulance and with the designated medical facility (if required). No persons will re-enter the Work Zone until the cause of the injury or symptoms are determined and the area stabilized.

Fire/Explosion: Upon notification of a fire or explosion on site, the designated emergency signal of an automobile horn will be sounded and all site personnel will assemble for decontamination, if feasible, and work operations discontinued. The fire department will be alerted and all personnel moved to a safe distance from the involved area.

Personal Protective Equipment Failure: If any site worker experiences a failure or alteration of protective equipment that affects the protection factor, that person and his/her work companion will immediately leave the Work Zone. Re-entry will not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure: If any other equipment on site fails to operate properly, the Project Manager and Site Safety Officer will be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel will leave the Work Zone until the situation is evaluated and appropriate actions taken. In all situations when an on-site emergency results in evacuation of the Work Zone, personnel will not return on site until:

- The conditions resulting in the emergency have been corrected;
- The hazards have been reassessed;
- The Site Health and Safety Plan has been reviewed; and,
- Site personnel have been briefed on any changes in the Site Safety Plan.

PERSONNEL PROTECTIVE EQUIPMENT

This section details the level of personnel protection to be used during field operations at the Kirtland Site. Appropriate levels of protection will be determined for specific areas of the site based on established information and air monitoring consistent with 29 CFR Section 1910.120 (c).

General

During field operations, personnel will wear hard hats, safety glasses, and steel-toe safety boots, as appropriate. All persons will wear either poly-coated Tyvek or rain suits when working around liquid bentonite for Level D work or greater. Rubber boots, nuke boots, nitrile outer gloves, latex inner gloves, and 3M half-face respirators will be standard issue.

Modified Level D Operations

Modified Level D operations will include personnel working around heavy equipment and potentially hazardous environments: Level D Protection will include hard hat, safety glasses, steel- toed boots, and full body clothing.

Level C Operations

Level C protection will be used in areas where the action level is reached, Level C protective clothing will consist of modified Level D equipment plus air purifying respirators with organic vapor cartridges. All respiratory protective equipment shall be NIOSH-approved equipment. It is expected that all personnel will use half mask of full-face masks, depending upon the action level reached.

Level B Operations

Level B protection will be used in areas where air monitoring results indicate levels above the protection factor given for air purifying respirators. Level B will consist of all personnel protective equipment described above in Level C Operations with the substitution of a pressure demand SCBA or supplied air system with full-face piece.

The above levels of protection will be utilized during initial field operations. Upon receiving data from air, soil, and water sampling, these levels of protection will be re-evaluated to provide sufficient employee protection while maximizing productivity.

MEDICAL MONITORING PROGRAM

A medical monitoring program has been instituted by Envirocon for all employees with potential exposure to hazardous substances. The purpose of the medical monitoring program is to evaluate health status of workers occupationally exposed or potentially exposed to hazardous and to meet OSHA and other requirements for employee health monitoring.

An initial medical examination is given upon initiation of employment, annually thereafter, and upon termination. Medical examinations will verify that the employee is physically able to use protective equipment (including respirators), work in hot or cold environments, and have no predispositions to occupationally-induced disease.

FREQUENCY:

1. Prior to assignment.
2. Annually.
3. At termination or reassignment from area of potential or actual exposure to hazardous substances.
4. As soon as possible after an exposure above recommended standards or if patient exhibiting signs or symptoms of possible exposure.

EXAM CONTENT :

1. Review of systems.
2. Medical history.
3. Occupational and hobby exposure history
4. Physical examination.
5. Chest X-ray (every 3-5 years).
6. Pulmonary function test (FVC and FEV-1).
7. Urinalysis.
8. CBC with differential and platelet count.

9. Blood chemistry panel including liver and kidney screen.
10. Medical certification for respirator use.
11. Other chemistry Parameters may be added as needed based on exposure history, exam findings, and assigned jobs (e.g. carboxy hemoglobin, blood or urine metals, blood cholinesterase, serum PCB, etc.)
12. EKG/stress test (optional - but usually recommended for respirator test).
13. Audiogram.
14. Physician's written opinion.

AIR MONITORING

Air monitoring will be performed to document exposure levels and to assure that all necessary precautions are taken to protect on-site personnel and the general public. Real-time air monitoring will be conducted during all site activities that have a potential for chemical exposure. Excavation activities will be monitored most stringently. In general, the following action levels will be utilized, and will be subject to modification based on site experience or weather conditions.

- Total Volatile Organics (TVO) Vapors using a Photoionization Detector (PID)

Reading sustained for > 5 min breathing zone	Level of protection and appropriate response.
0 to 9 ppm	Level D -
10 to 24ppm	Level C - half mask with organic vapor cartridges.
25 to 50	Level C - Full-face mask with organic vaporcartridge

>50 ppm	Level B - or move personnel upwind and contact the Project Manager
>250	Stop work and modify work to reduce contaminant levels.

- <u>Combustible gas Monitoring</u> (% of LEL)

0 to 10%	Personnel protection based on PID and colorimetric tube readings.
10 to 50% > 50%	Move personnel upwind. Shut down engines, power tools, and suspend all spark-producingactivities and contact the Project Manager.

- <u>Oxygen Meter Readings</u>

>19.5% oxygen	No action necessary.
< 19.5% oxygen	NIOSH-approved supplied air respirator or departure of personnel from work area and contact Project Manager.

Heat Stress Monitoring

Heat stress monitoring will be conducted for individuals engaged in heavy manual labor in Level C/B protection if outside temperatures exceed 70°F. Heat stress monitoring may include pulse rate monitoring to determine the frequency of rest breaks. Symptoms of heat stress include light headedness, loss of coordination, headache, nausea, fatigue, flushed skin color, and unconsciousness. All workers will be encouraged to remain aware of their physical condition, and to watch for symptoms in fellow workers. Workers will be encouraged to take breaks, as necessary. Additional mandatory breaks will be implemented at the discretion of the HSO. All workers will be trained on the symptoms and recognition of heat exhaustion.

SITE CONTROL

Site Security

No one will be allowed to enter the site Exclusion Zones (see below) unless they have been given permission to do so by the Project Manager and SSO and follow applicable portions of this HASP.

An armed security guard has been hired to police the area when Envirocon personnel are not present on the work site between the periods of 7 p.m. and 6 a.m.

Site Work Zones

Work zones will be established within principal remediation areas at the Kirtland Site. Each work zone will be clearly delineated and posted and will include the following:

Exclusion Zone: Includes area(s) which contain, or are suspected of containing, hazardous materials. The exclusion zones will be clearly marked with red flagging and barricades, as appropriate. Only personnel authorized by this HASP may enter the exclusion zone. The exclusion zone will be a minimum of 25 feet around the trench area during removal of natural soil, based upon micro-tip readings.

Contamination Reduction Zone (CRZ): This zone will be established to act as a transition zone for decontamination of equipment and personnel just outside the exclusion zone or other areas of suspected contamination and will be located at a point of ingress and egress through the berm surrounding the work zone.

Support Zone: This zone includes all site areas which are not contaminated. This area will be used to stage clean equipment and other support facilities.

Decontamination Procedures

To assure that contamination is controlled and not spread from the site, decontamination procedures will be employed for both equipment and personnel. All decontamination activity will be monitored to assure compliance with the procedures described below.

Personnel: All personnel known to be, or suspected of being, contaminated with hazardous material will decontaminate fully before re-entry into the Support Zone. Decontamination will consist of the following steps:

- Placement of equipment on a plastic sheet or in an approved receptacle at the exit of exclusion zone;
- Washing and rinsing of outer boot and gloves with cleaning solution and brush;
- Removal of outer gloves and boots and deposit in marked containers with plastic liners;
- Removal of protective suits and disposal into marked containers with plastic liners;
- Removal of respirator and disposal (if worn) into container with plastic liner;
- Removal of inner gloves and disposal into container with plastic liner;
- Washing of hands and face; and,
- Showering immediately after work shift as possible.

Containers of contaminated protective clothing will be packaged in seated 55-gallon drums for eventual off-site disposal.

Equipment: All equipment must be decontaminated before leaving the Contamination Reduction Zone. Heavy equipment ,shovels, PPE, and other contaminated material will be washed with a 2" fire hose within the perimeter of the trench. If necessary, accessible parts will be washed with a concentrated detergent/water solution under pressure. Particular care will be given to tires, buckets, tracks, and other components in possible direct contact with contaminated materials.

Sampling instruments and other nondisposable equipment should be kept clean in disposable protective covers. Equipment used for liquid and solid sampling should be placed in plastic bags or metal drums for disposal or later decontamination.

Disposal of Waste: All contaminated articles will stay within the perimeter at all times during work activities. Disposable contaminated supplies and unused samples will be securely drummed on site, for disposal according to applicable regulations.

Trenching Procedures

In the construction of this slurry trench, there will be a need for the constant surveillance of surface sloughing down into the pit. This will be a closed-trench evacuation. As trenching progresses, the trench will be filled with back-fill material as natural soil is removed.

All personnel will stay back a minimum of 4 feet from the edge of the trench. If stress cracking occurs, this distance will be increased. No person will be allowed to enter the slurry pond unless they are wearing one piece, waterproof clothing and then only when the SSO is observing. When the final cap is to be placed, personnel will remain 4 feet from the sides of the slurry trench.

Dust Control

The control of dusts generated by the excavation operations will be the biggest concern to off-site risk/impact. If a cloud of dust is

APPENDIX C

LETTER DATED JULY 18, 1990 TO THE OIL CONSERVATION DIVISION, BILL OLSON FROM DAMES & MOORE, PETER F. OLSEN AND TERRY D. VANDELL REGARDING "STATUS: REMEDIATION/STABILIZATION PLAN."

DAMES & MOORE
127 SOUTH 500 EAST, SUITE 300, SALT LAKE CITY, UTAH 84102-1959 (801) 521-9255

July 18, 1990

State Land Office Building, Room 206
Oil Conservation Division
310 Old Sante Fe Trail
Santa Fe, NM 87501

Attention: Mr. William Olson

Subject: STATUS: REMEDIATION/STABILIZATION PLAN
Maverik Country Stores, Inc.
Tank Farm
Kirtland, New Mexico

Dear Bill:

This letter summarizes our telephone conversation of July 16, 1990 regarding regulatory concerns with implementation of the Remediation/Stabilization Plan at the Maverik Country Stores Inc. Tank Farm in Kirtland, New Mexico. The federal Environmental Protection Agency (EPA) Toxicity Characteristic (TC) Rule which goes into effect on September 25, 1990 impacts the scheduled remediation plan at the Maverik Tank Farm. Any pumping and treating of the ground water (which will, after September 25, 1990 be considered a hazardous waste) will require an EPA-RCRA Permit for the treatment, storage and disposal of a hazardous waste. Consequently, if the remediation plan is implemented as planned (in early September 1990), remediation work would have to stop on September 25, 1990 or the facility, and Maverik Country Stores, Inc., would be in violation of federal EPA regulations. Based on conversations with both the EPA and the New Mexico EID Hazardous Waste Bureau, because the ground water will be classified as a hazardous waste, remediation work will be regulated initially by the federal EPA, and eventually by both the EPA and the New Mexico EID.

Over the past two years, on-site and off-site surface and subsurface tank farm-related contamination has been and still is being cleaned up and controlled (Figure 1). The work that has been completed to date includes the following:

- Significant on-site subsurface free product contamination was cleaned up via pumping and product removal from the interceptor trench which was installed in March of 1988.
- All of the remaining and significant potential sources of contamination (sludge and product in the storage tanks) were removed and properly disposed of in 1989.

OFFICES WORLDWIDE

- Sludge and associated contaminated soils on-site are scheduled to be removed and properly disposed of, either to the Thriftway Refinery or to CSI within the next few months.
- The Westside Irrigation Ditch waters were piped in April 1989, thereby eliminating free product seepage off-site into the local irrigation water systems.
- An existing on-site deep well was grouted in 1989 in order to prevent potential vertical movement of shallow aquifer contaminants to the underlying deep aquifer.
- Construction of the slurry wall was completed in June 1990. This wall encloses the upper shallow contaminated aquifer in the south-western corner of the Tank Farm, the site of the leaded gasoline spill. The final "As-Built" alignment and construction data for this slurry wall are enclosed as Attachment 1 as provided by Envirocon, Inc. Please note that the approximate location of the potential underground pipe shown in Figure 5 of the report is 50 feet west of the 8+75 station.

In addition to the above remedial measures that have been implemented to clean up and control on-site and off-site contamination from the Tank Farm, Maverik has been conducting soil, ground and surface water quality monitoring since November of 1987, and has installed and monitored a total of 5 monitor wells on-site and 10 monitor wells off-site. The results of the sampling and laboratory analyses have been reported to the New Mexico EID, and to the OCD since March of 1990 (when site regulatory authority was granted to the OCD). The water quality data show that on-site ground water contamination from the Tank Farm has decreased significantly since initial monitoring in 1987. Contaminant constituents in the ground and surface waters located immediately downgradient from the facility both on and off-site are either non-detectable or are at or near laboratory analytical detection limits and do not present a threat to human health or the environment.

In conclusion, the remediation work conducted since 1988 has resulted in continued improvement in the quality of both the surface and ground waters on and off-site. Recent completion of the on-site slurry wall will virtually eliminate the potential for any further off-site releases of contamination from the Tank Farm. Therefore, as a result of September 25, 1990 EPA TC Rule which would force cessation of the remediation plan as currently designed (June 7, 1990 letter to OCD from Dames & Moore), we propose that no additional remediation work be implemented at this time. We do however propose that the existing on and off-site monitor wells (MW-10 and MW-9, 13, 14 and 15) continue to be monitored, and that 6 additional ground water monitoring wells be installed this year, both inside and outside the boundaries of the slurry wall and monitored and sampled, on a semiannual basis (See Figure 1). The new monitor wells would be located at strategic points to monitor: the on-site ground water quality (and biodegradation processes) in the highly contaminated zone within the slurry wall; the ground waters outside and adjacent to the slurry wall boundaries (to detect any lateral contaminant movement around the slurry wall); and the ground waters at points downgradient and on-site which will serve as "Early Warning" monitor points for subsurface contaminant migration downgradient of the slurry wall, to the south.

We appreciate your time and consideration of this matter and hope that in the near future the EPA will be in a better position of defining the regulatory roles of the states in implementing the TC Rule. If you have any questions or comments regarding the enclosed information, please do not hesitate to contact me at (801) 521-9255.

Very Truly Yours,

DAMES & MOORE

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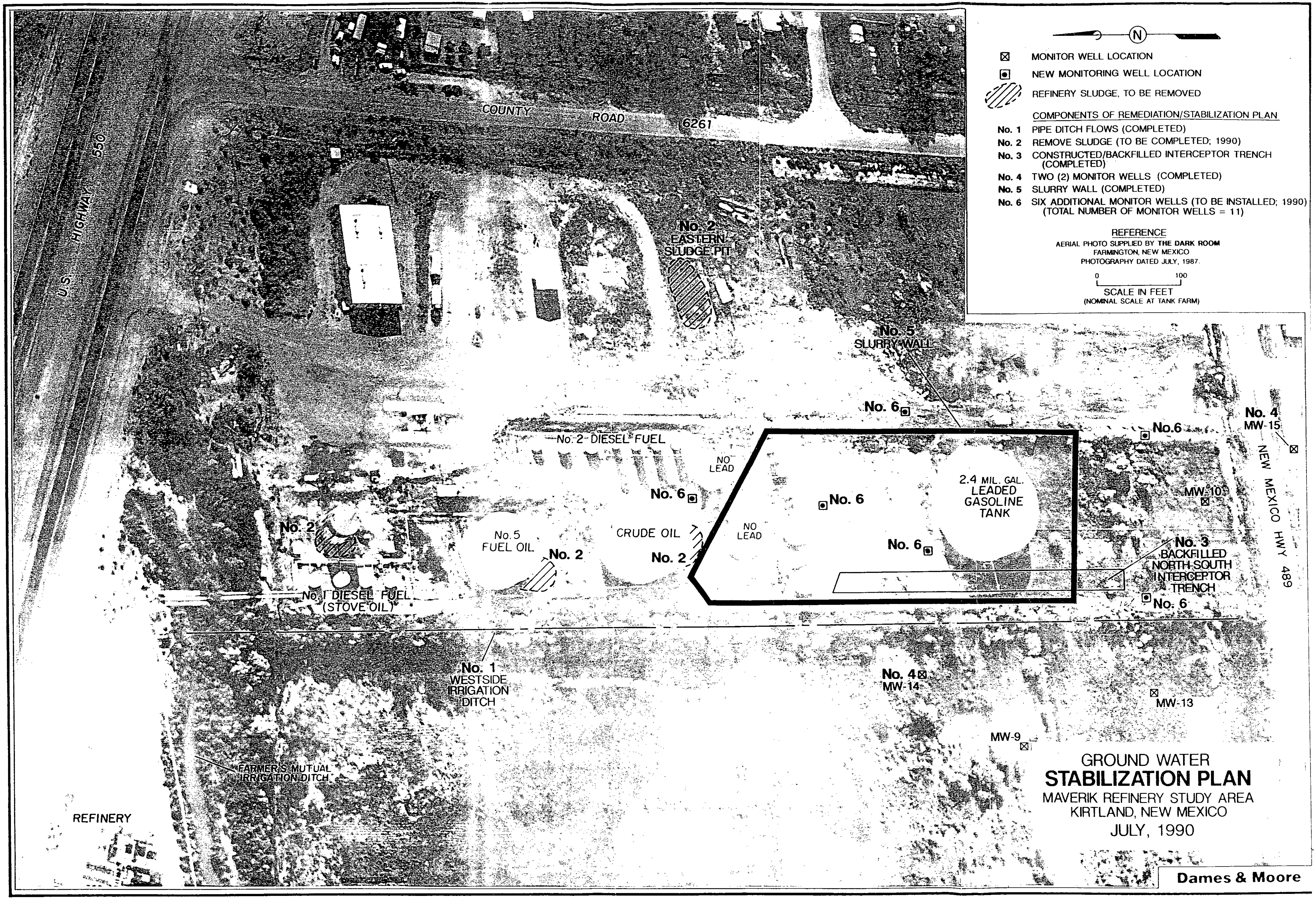

☒ MONITOR WELL LOCATION

⊡ NEW MONITORING WELL LOCATION

▨ REFINERY SLUDGE, TO BE REMOVED

COMPONENTS OF REMEDIATION/STABILIZATION PLAN

No. 1	PIPE DITCH FLOWS (COMPLETED)
No. 2	REMOVE SLUDGE (TO BE COMPLETED; 1990)
No. 3	CONSTRUCTED/BACKFILLED INTERCEPTOR TRENCH (COMPLETED)
No. 4	TWO (2) MONITOR WELLS (COMPLETED)
No. 5	SLURRY WALL (COMPLETED)
No. 6	SIX ADDITIONAL MONITOR WELLS (TO BE INSTALLED; 1990) (TOTAL NUMBER OF MONITOR WELLS = 11)

REFERENCE

AERIAL PHOTO SUPPLIED BY **THE DARK ROOM**
FARMINGTON, NEW MEXICO
PHOTOGRAPHY DATED JULY, 1987.

0 100
SCALE IN FEET
(NOMINAL SCALE AT TANK FARM)

GROUND WATER
STABILIZATION PLAN
MAVERIK REFINERY STUDY AREA
KIRTLAND, NEW MEXICO
JULY, 1990

Dames & Moore

FIGURE 1

46612 (11-82)