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REPORTS

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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

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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:

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

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

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

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%

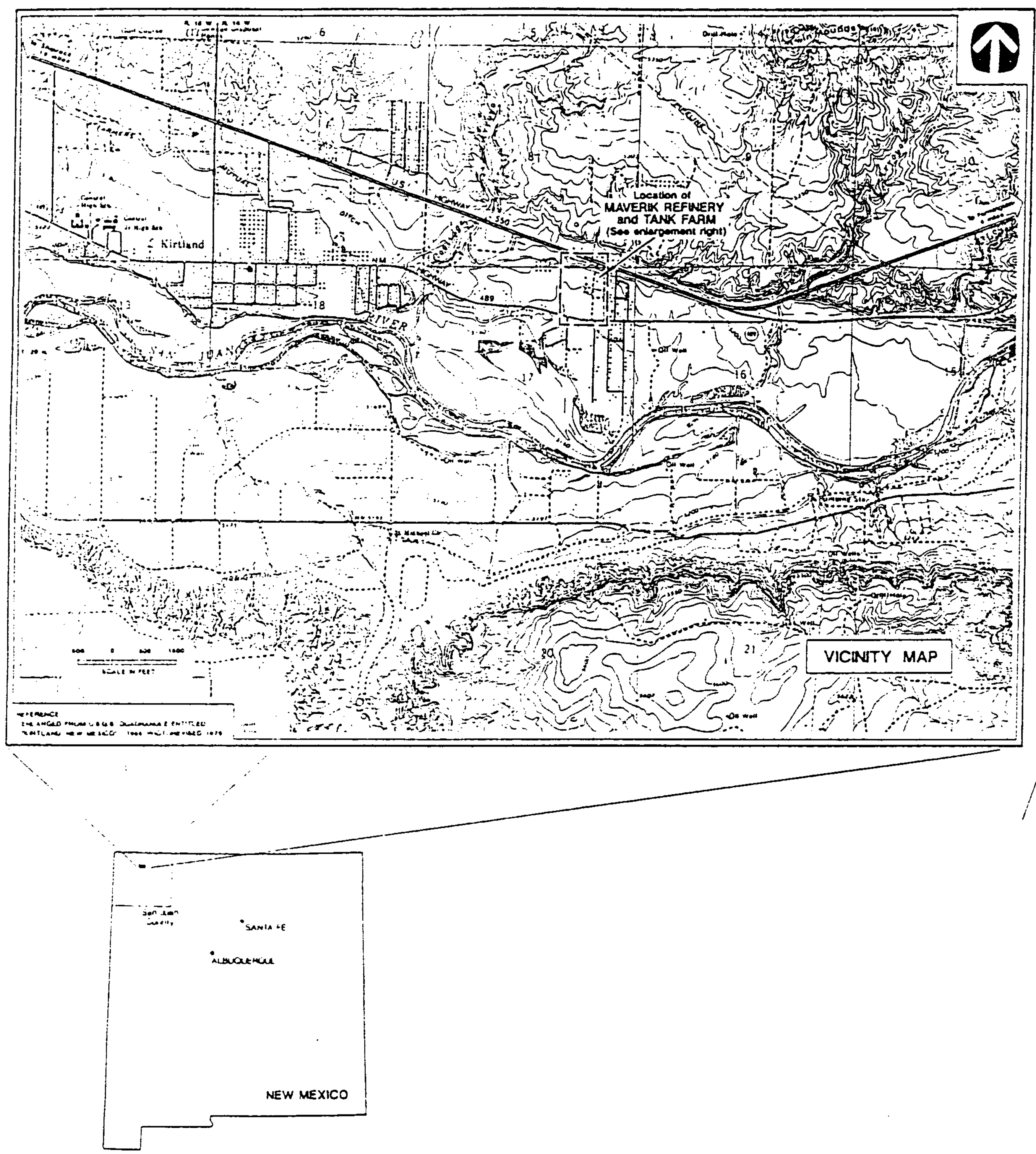
equipment was decontaminated and cleaned, all within the exclusion zone once the site restoration activities were completed.

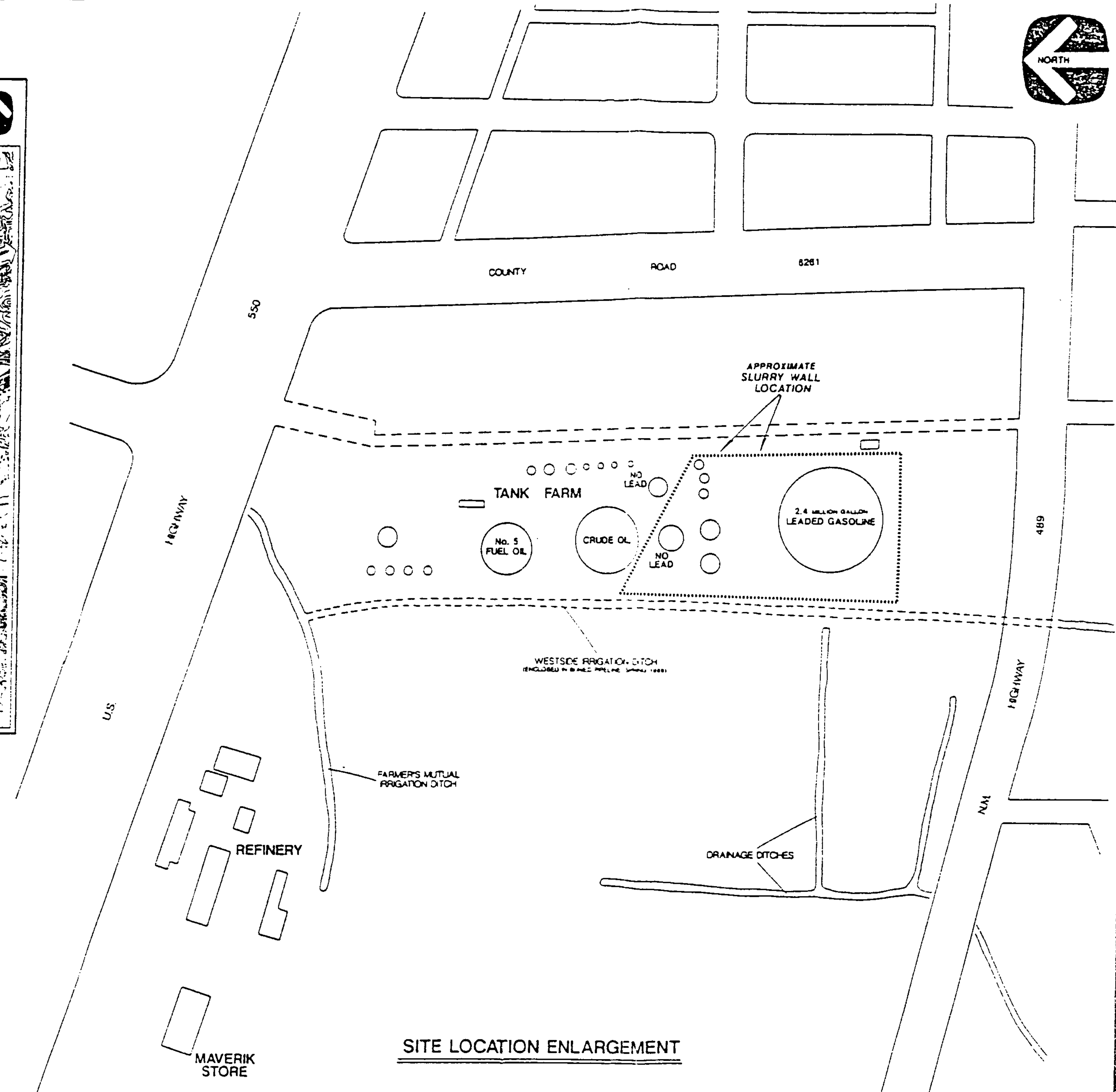
4.0 HEALTH AND SAFETY OPERATIONS SUMMARY

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

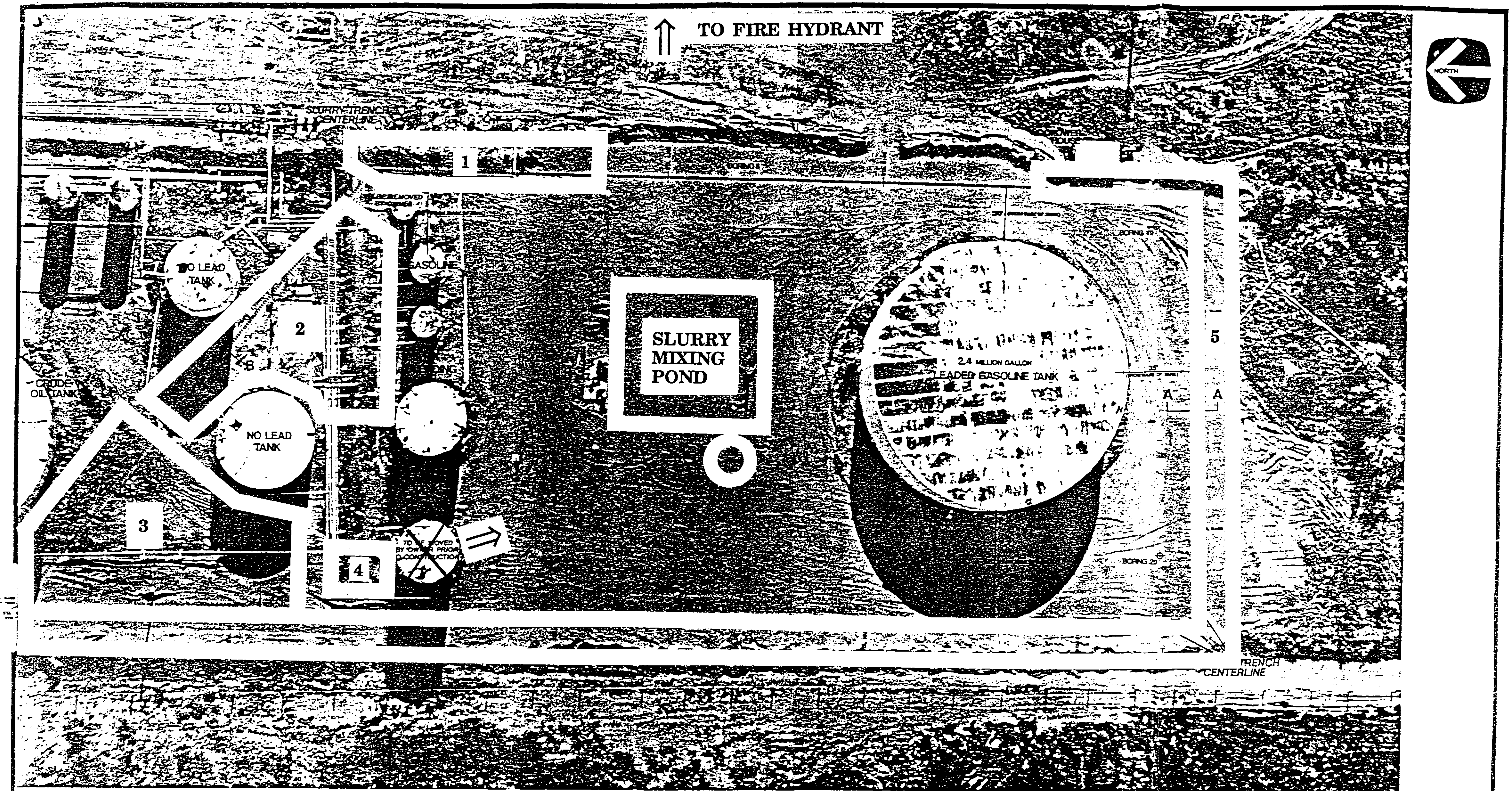
FIGURE 1

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)

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

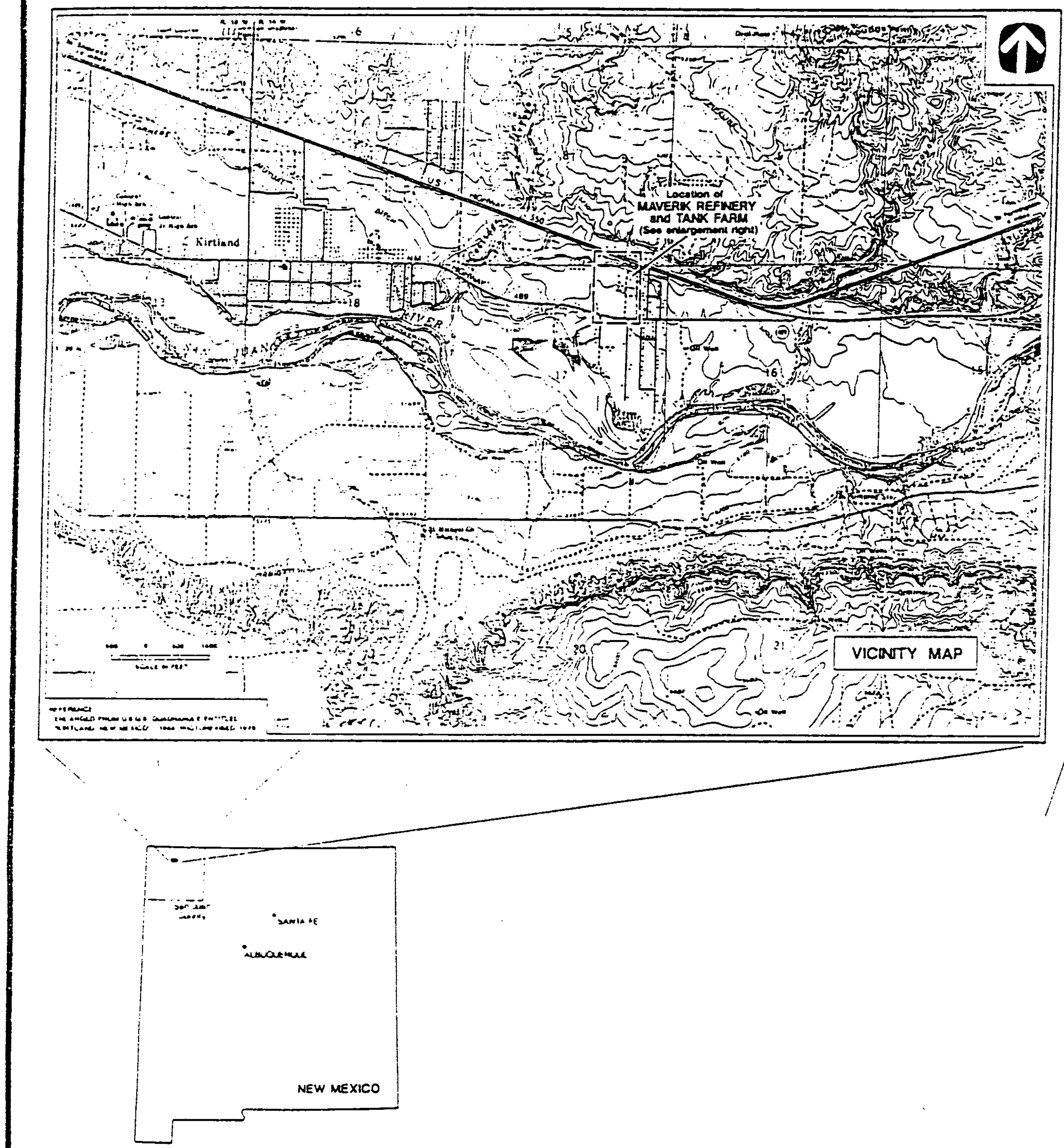
SLURRY TRENCH ALIGNMENT

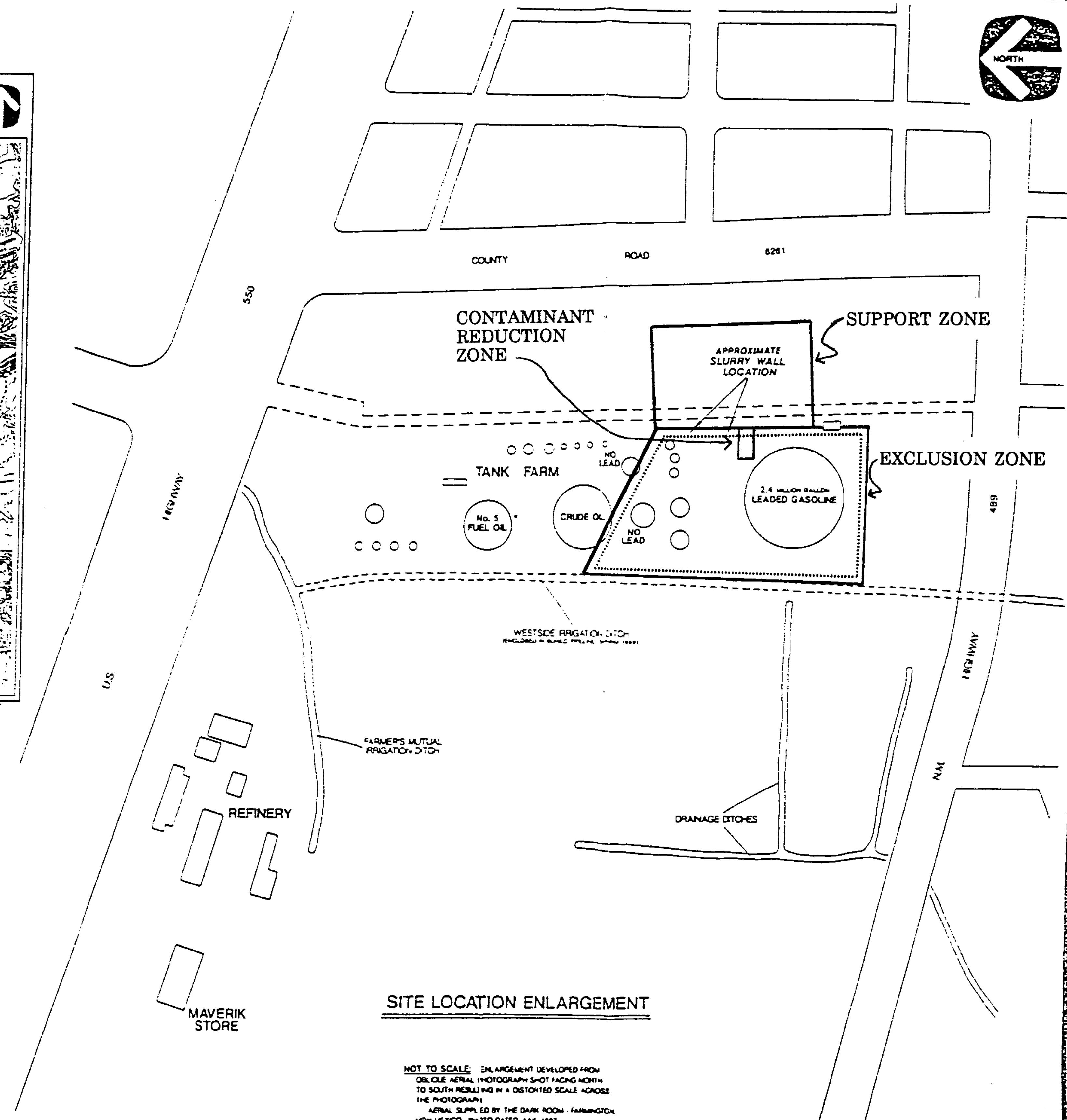
FIGURE 2

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

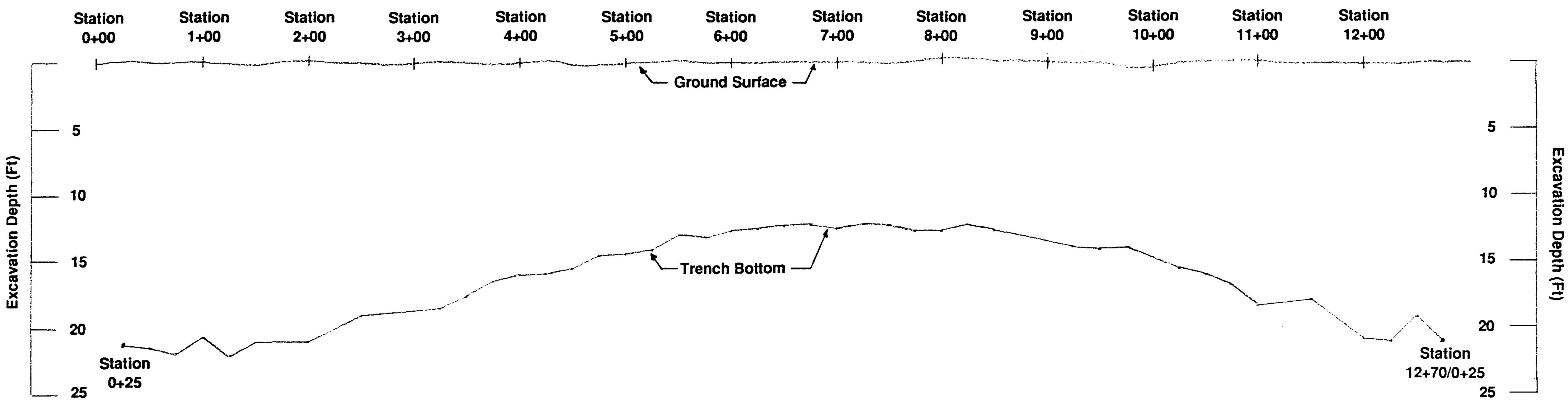
FIGURE 3 - WORK ZONE LOCATIONS

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

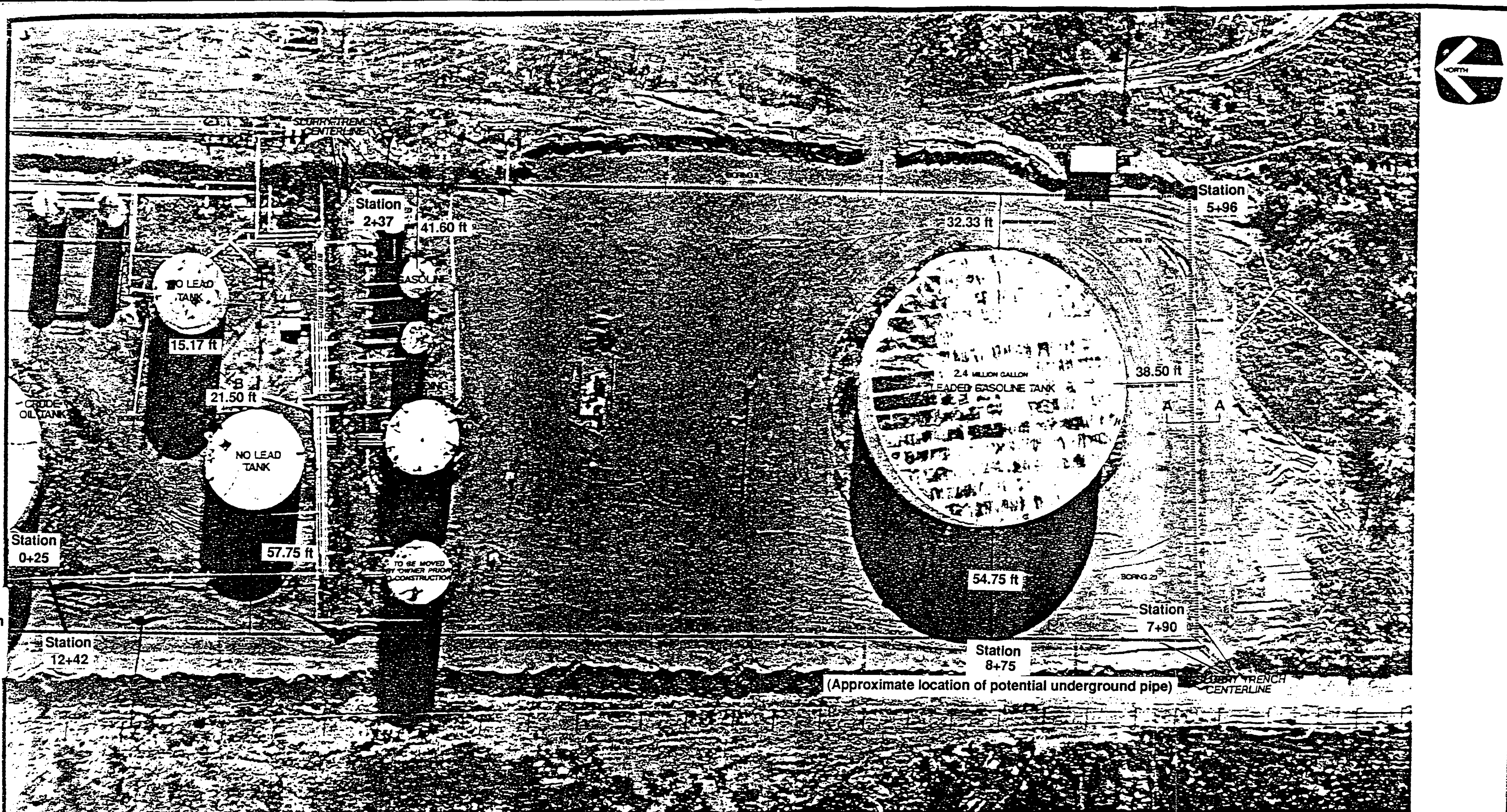
GENERAL VICINITY and SITE LOCATION MAPS

Dames & Moore
Salt Lake City, Utah

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



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



SCALE IN FEET (APPROXIMATE)

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.

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 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

ENVIROCON, INC.

BENTONITE SUBMITTAL

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

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

17880

Date 6-15-90

Purchased From Redmond C&S

Material API Bentonite

Sold To H-H

Ship To

Truck Name/Truck # Lw miller #173

80 000	Gross
31 200	Tare
48,800	Net

_____ On _____ Off

John Schmidt Driver

LARRY Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

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

17883

Date 6-16-90

Purchased From RCS

Material API Bulk

Sold To

Ship To H+H

Truck Name/Truck # C.W. miller

79 900	Gross
28 000	Tare
51,900	Net

_____ On _____ Off

Driver

JP Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

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

17893

Date 20 Jun 90

Purchased From

Material API Super Bags

Sold To

Ship To Farmington

Truck Name/Truck # High County

82 000	Gross
26 600	Tare
55400	Net

_____ On _____ Off

Bert Driver

MH Weigher

Weldon, Williams & Lick Ft. Smith, Ark.

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

INVOICE

0U1160

DATE: 6-18-90

SOLD TO	SHIP TO
	505-327-4706 ext 234 Envirio-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. Colclasure III		
	Customer: [signature]		

INV CC 755-4

INVOICE

H & H BENTONITE & MUD, INC.
P.O. Box 4147
GRAND JUNCTION, CO 81502
(303) 243-9680

DATE:

No. 000745

SOLD TO	SHIP TO

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

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

INV CC 755-4

INVOICE

DATE 6 [illegible]

SOLD TO [illegible]

SHIP TO 505 [illegible]
[illegible]
[illegible]
Farmington NM

CUST. ORDER NO.	DATE SHIPPED	SHIPPED VIA	TERMS	SALESMAN	F.O.B.	OUR ORDER NO.
15 [illegible]	6-19-9[illegible]	[illegible] #10	[illegible]	202		

[illegible]	[illegible]	DESCRIPTION		UNIT PRICE	AMOUNT
1 JM	ABE	100# [illegible]			
19	pallets				
340	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	SALESMAN	F.O.B.	OUR ORDER NO.
	6-16-90	L W Miller #165	Driver Name 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 [illegible]
GRAND JUNCTION, CO 81502
[illegible]

INVOICE

001155

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	LW Miller	T #173	JP		

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

John S[illegible]

(Ennis) INV CC 755-4

#4

H & H BENTONITE & MUD, INC.
P. O. Box #187
GRAND JUNCTION, CO 81502
(303) 243-8860

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	L W Miller Larry #171		LH31		

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

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 [signature]
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY
DRIVER [signature]

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

L. W. MILLER TRANSPORTATION, INC.

Liquid Transporter – General Transportation

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

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

DATE 6-15 19 90

ORIGIN Redmond UT COUNTY

SHIPPER NO. 001155

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.

CARRIER UNIT 173-P-5

ORDER NO.

CONSIGNED TO H + Enviro Con

P.O. NO.

DESTINATION Kirtland 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
T/L Bulk 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 [signature]
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY
DRIVER [signature]

NON NEGOTIABLE

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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

9722

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 REDMOND UT COUNTY

DATE 06 - 16 1990

SHIPPER NO. 1156

CARRIER UNIT 165/P16

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

DESTINATION FARMINGTON NM 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	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.
BENTONITE	51900			
2 HOURS SUNDAY				(SIGNATURE OF CONSIGNOR)
2½ HOURS MONDAY				(IF TO BE PREPAID, WRITE OR STAMP "TO BE PREPAID" ABOVE
				RECEIVED $ TO APPLY ON PRE-PAYMENT
NET 51900 #			TOTAL	AGENT OR CASHIER PER

CONSIGNEE	SHIPPER	L.W. MILLER TRANSPORTATION, INC.
BY [signature]	PER	BY
BY		DRIVER [signature]
Above Goods, Inspected and Received in Good Order		

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.

9432

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 Redmon Clay & Sand

DATE 6-18 1990

ORIGIN Redman Utah COUNTY

SHIPPER NO. 17885

CARRIER UNIT 93 P-34

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.

ORDER NO.

CONSIGNED TO H & H Bentonite

P.O. NO.

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 30,300 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 PRE-PAYMENT

______ AGENT OR CASHIER PER

CONSIGNEE
BY [signature]
BY
Above Goods, Inspected and Received in Good Order

SHIPPER
PER

L.W. MILLER TRANSPORTATION, INC.
BY [signature]
DRIVER [signature]

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. ______

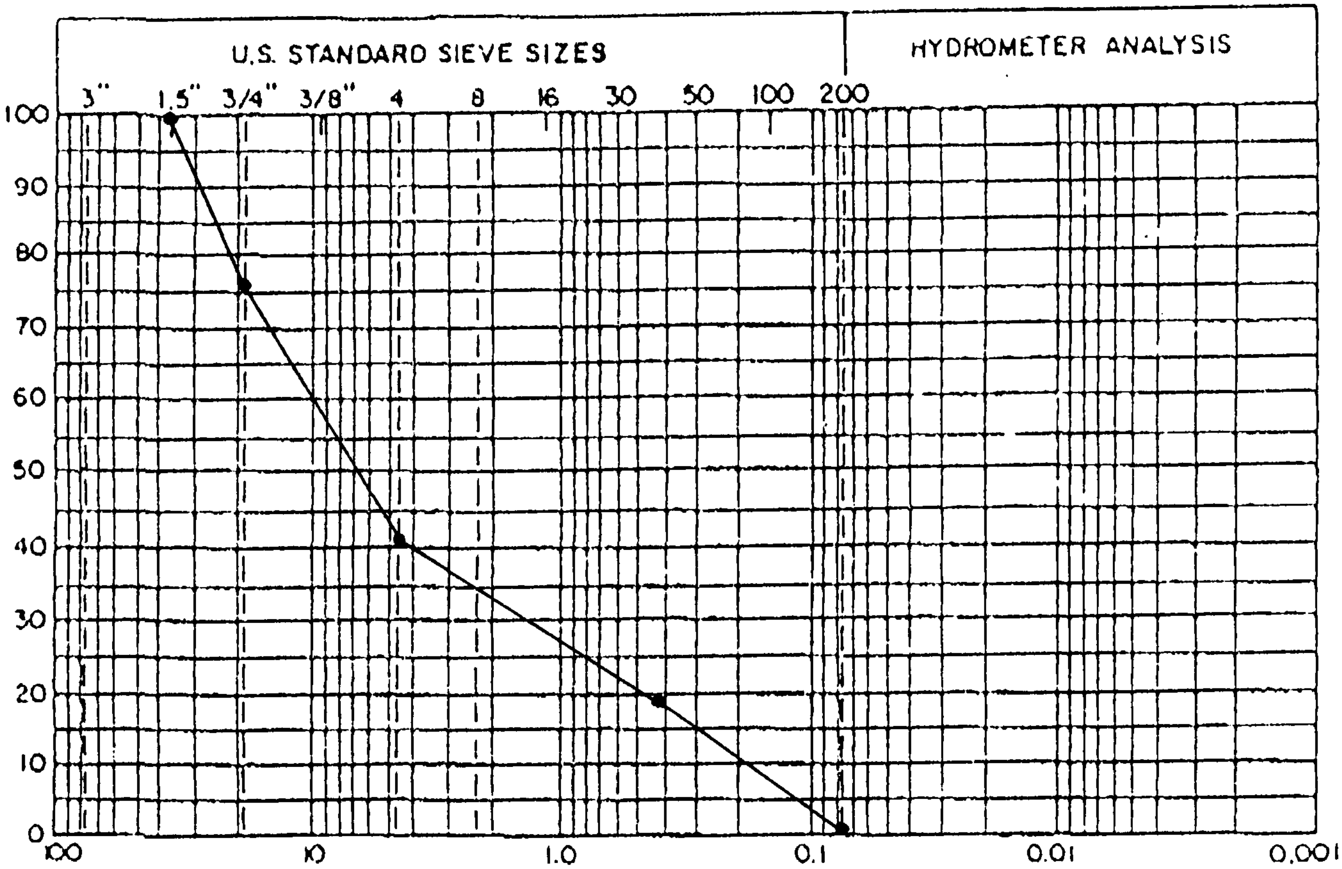
CLIENT Maverik PROJECT Caribou Refinery

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. ______

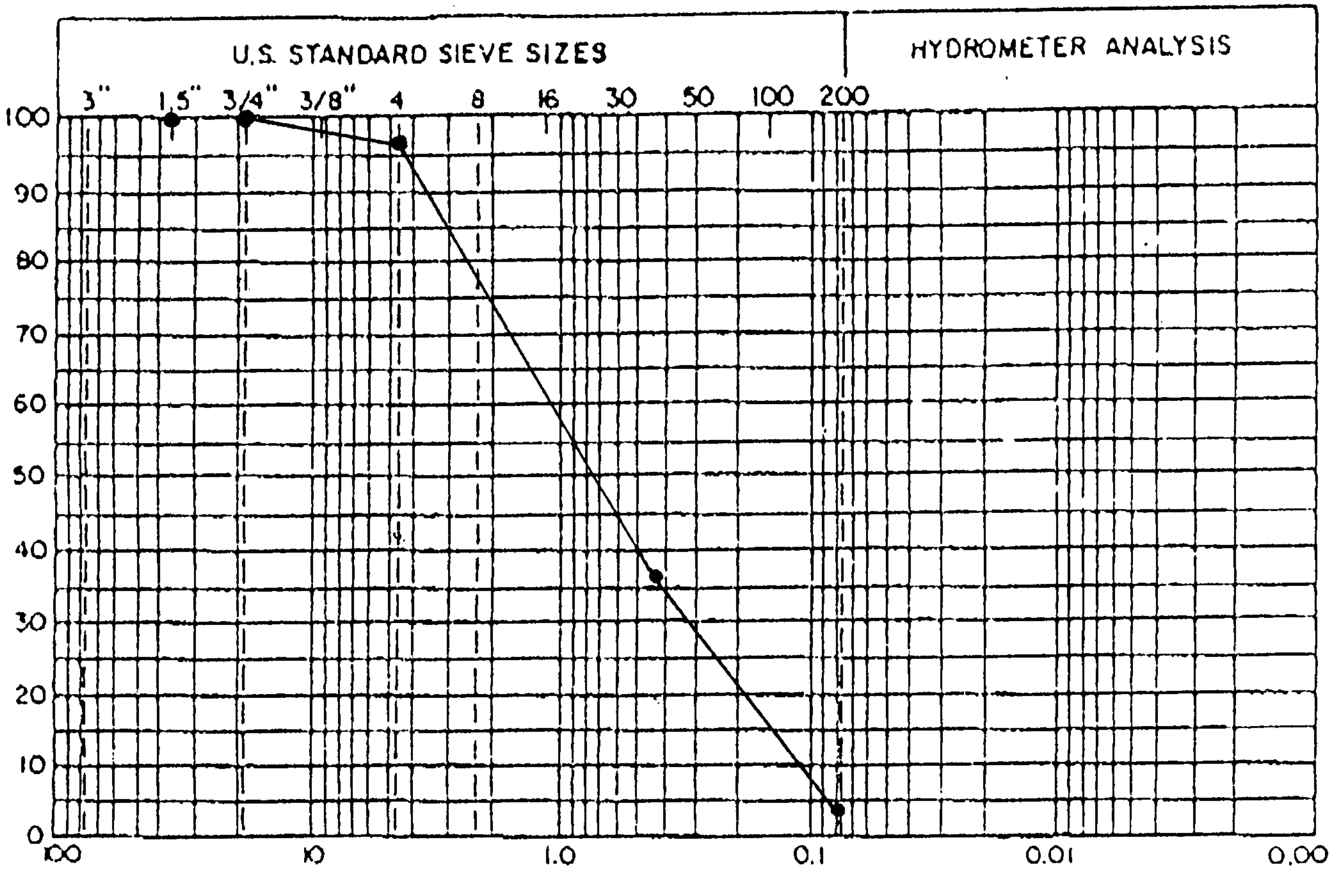
CLIENT Maverik PROJECT Caribou Refinery

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	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	100	40	.590	37	.019	
			3/8"	9.50		50	.297		.009	
5.0"	126.7		4	4.750	97	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	

ENV 06/90

FIGURE NO. ______

ENVIROCON

LAB ____________ LAB NO. ____________

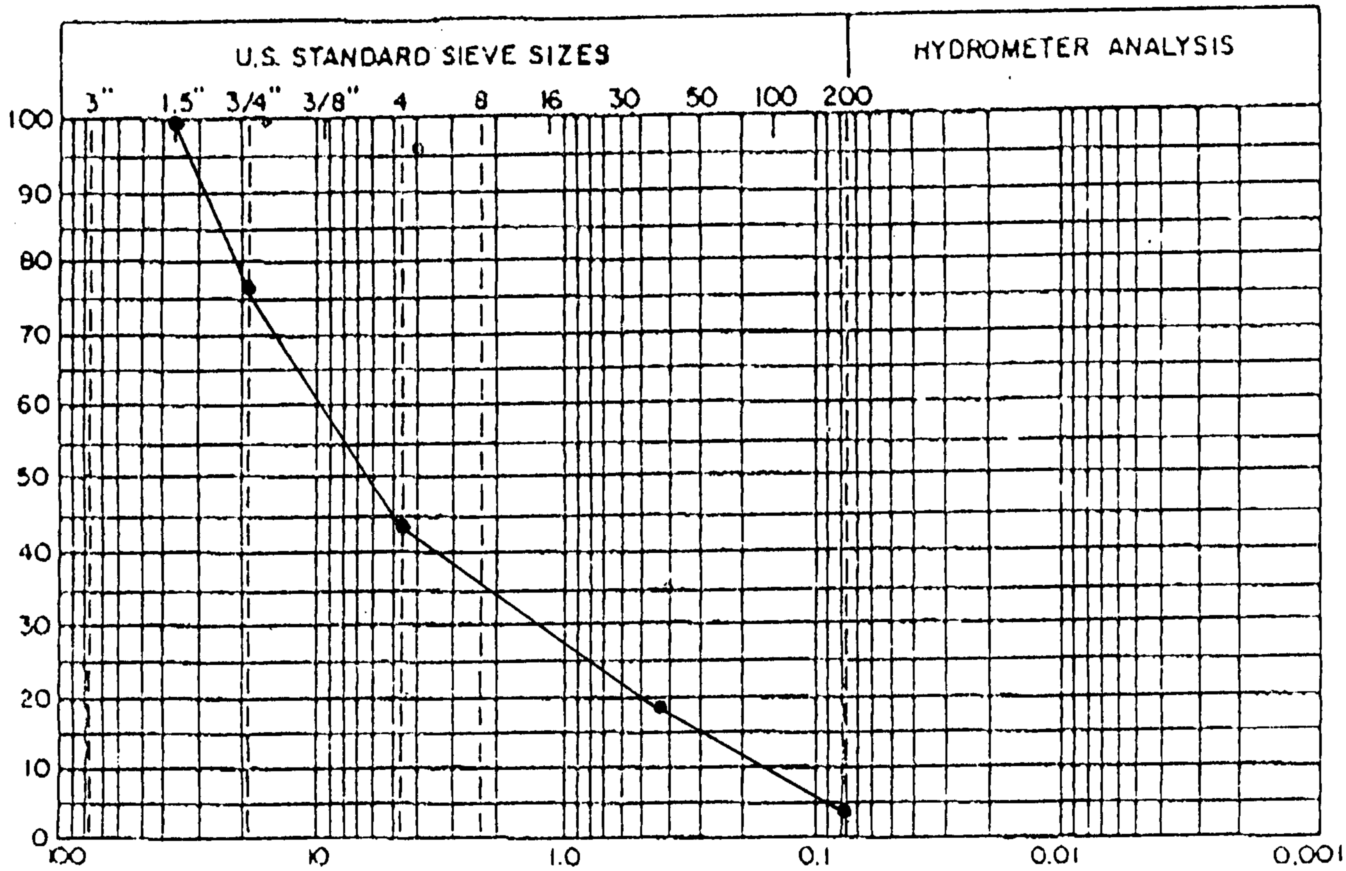
CLIENT Maverik PROJECT Caribou Refinery

FEATURE Structural Backfill PROJECT NO. 2001

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

Mixed Submittal #1

GRAIN SIZE ANALYSIS



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	77
3/8"	9.50	
4	4.750	44
8	2.380	
16	1.190	

U.S. Sieve	Particle Size mm	Percent Finer
40	.590	19
50	.297	
100	.149	
200	.074	4
—	.037	

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

Note: Material does not meet specification.

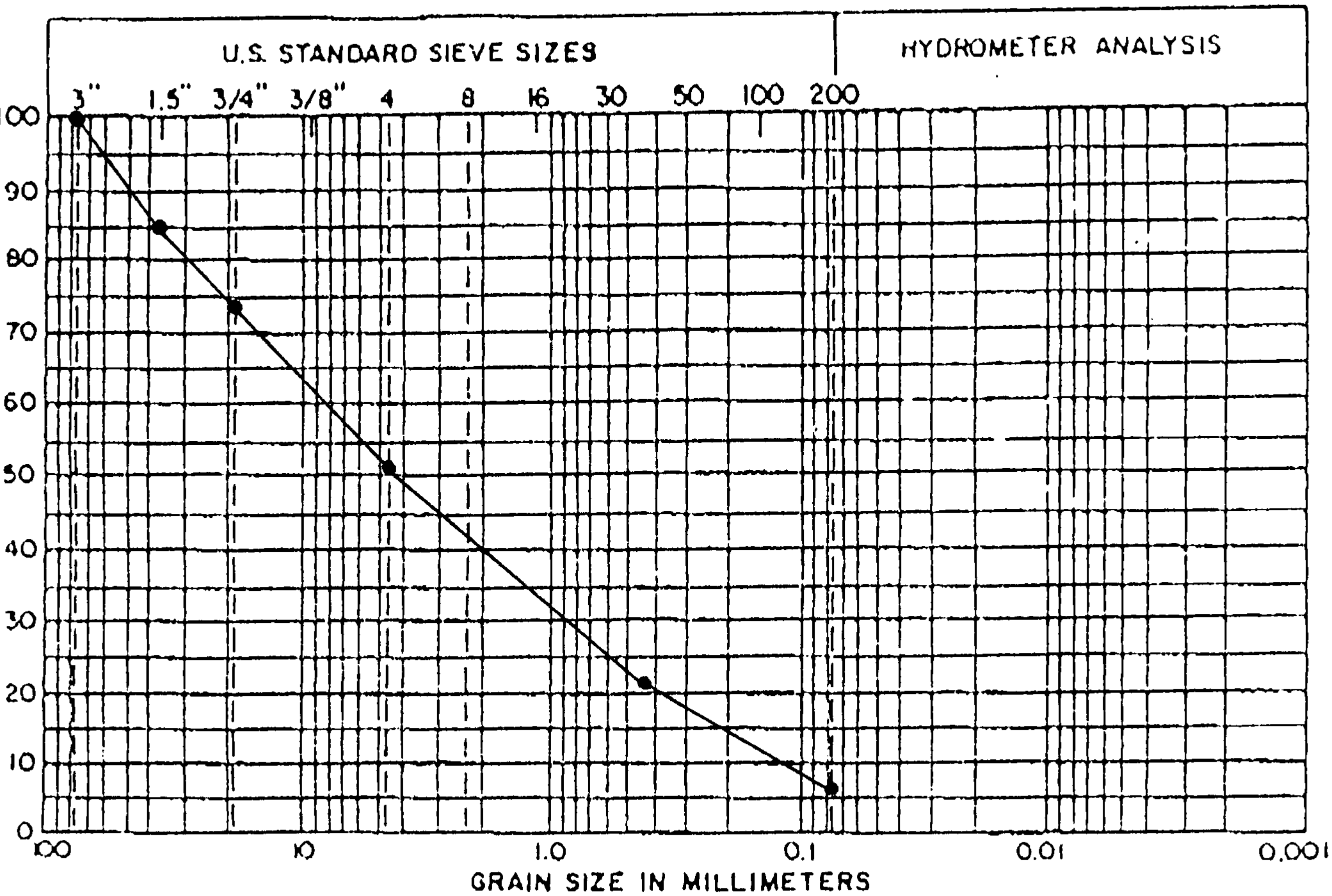
ENV 06/90 FIGURE NO. ____________

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



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"	128.7	
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.

FIGURE NO. ____

ENV 06/90

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

Property	Test Method	Dura-Flex Typical Values* 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)

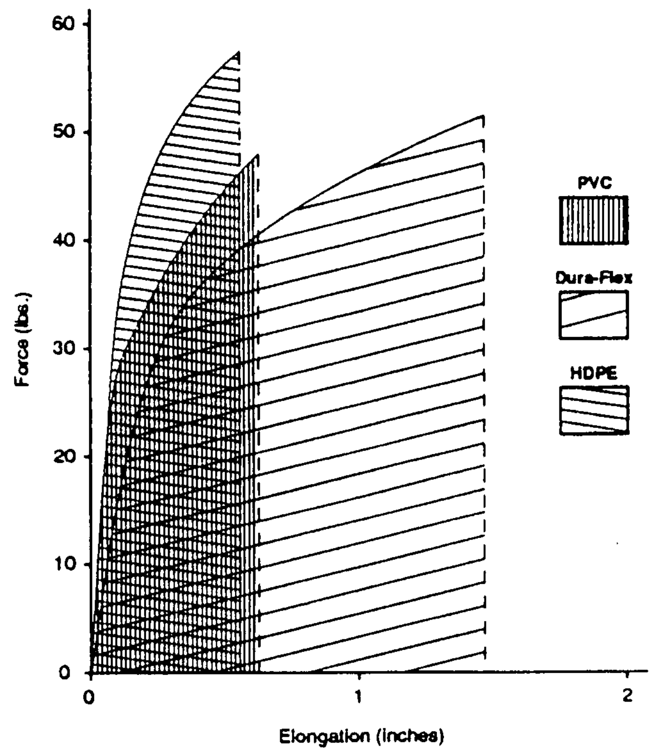


Figure 2

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/m^2.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.

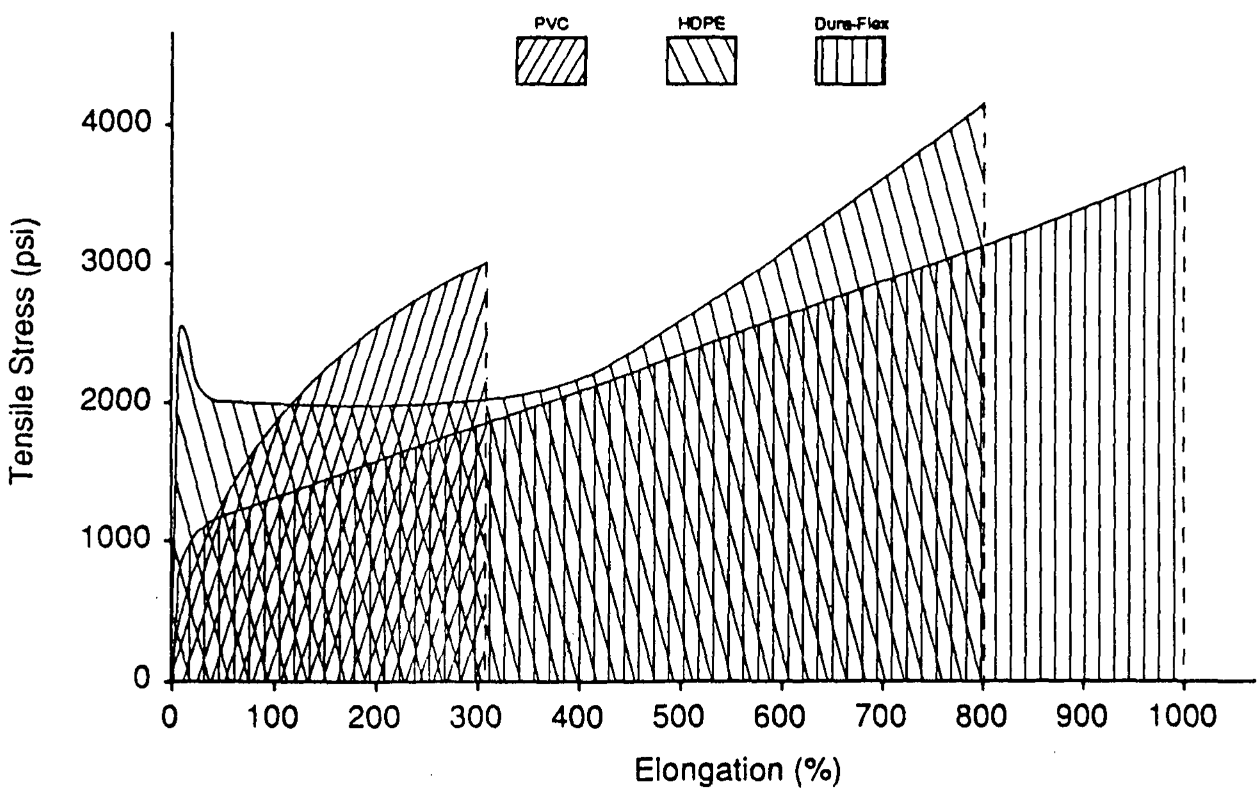


Figure 1. Stress-Strain Diagram for PVC, HDPE, and Dura-Flex

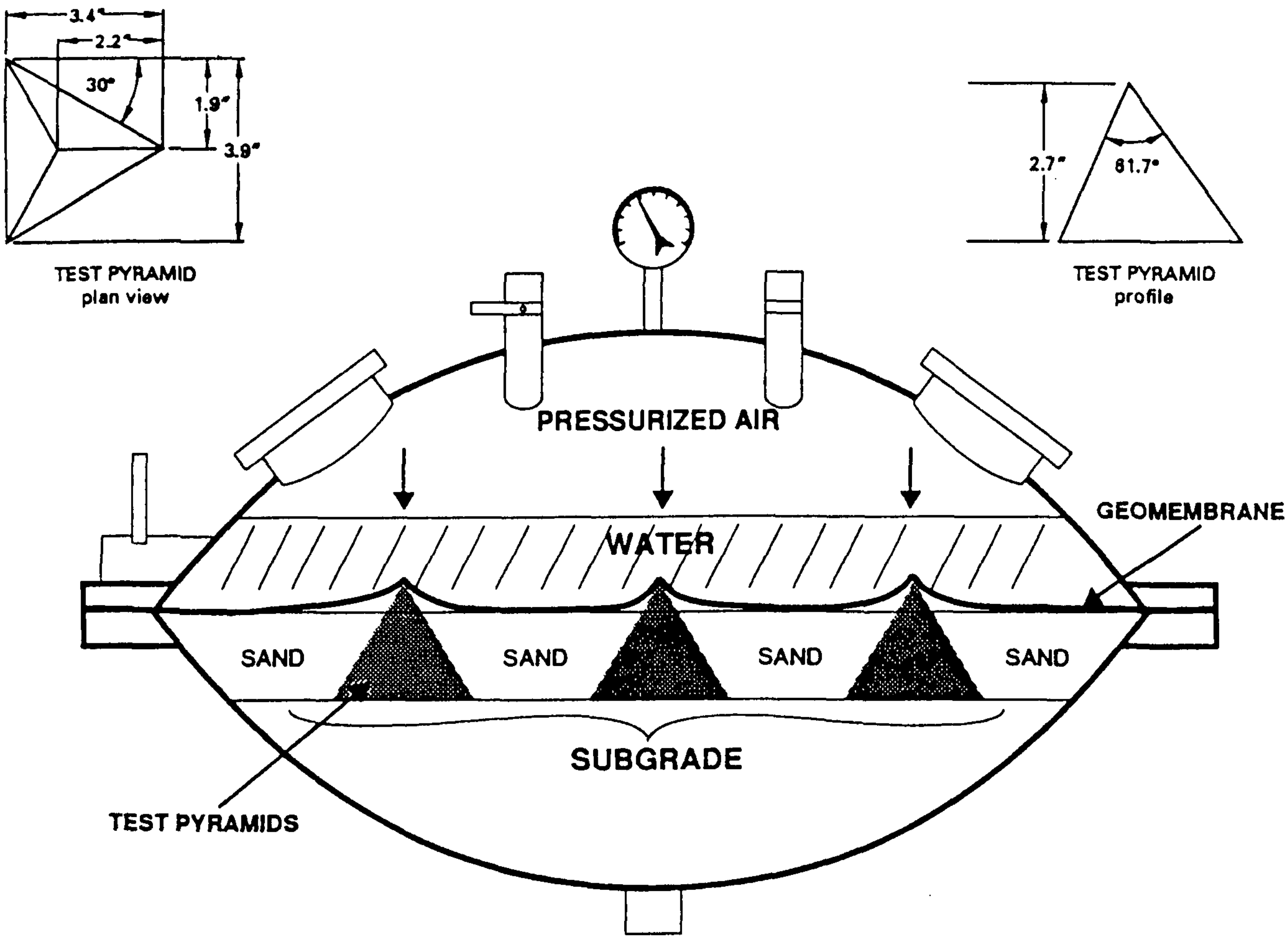


Figure 3. Hydrostatic Pressure Test Vessel

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:

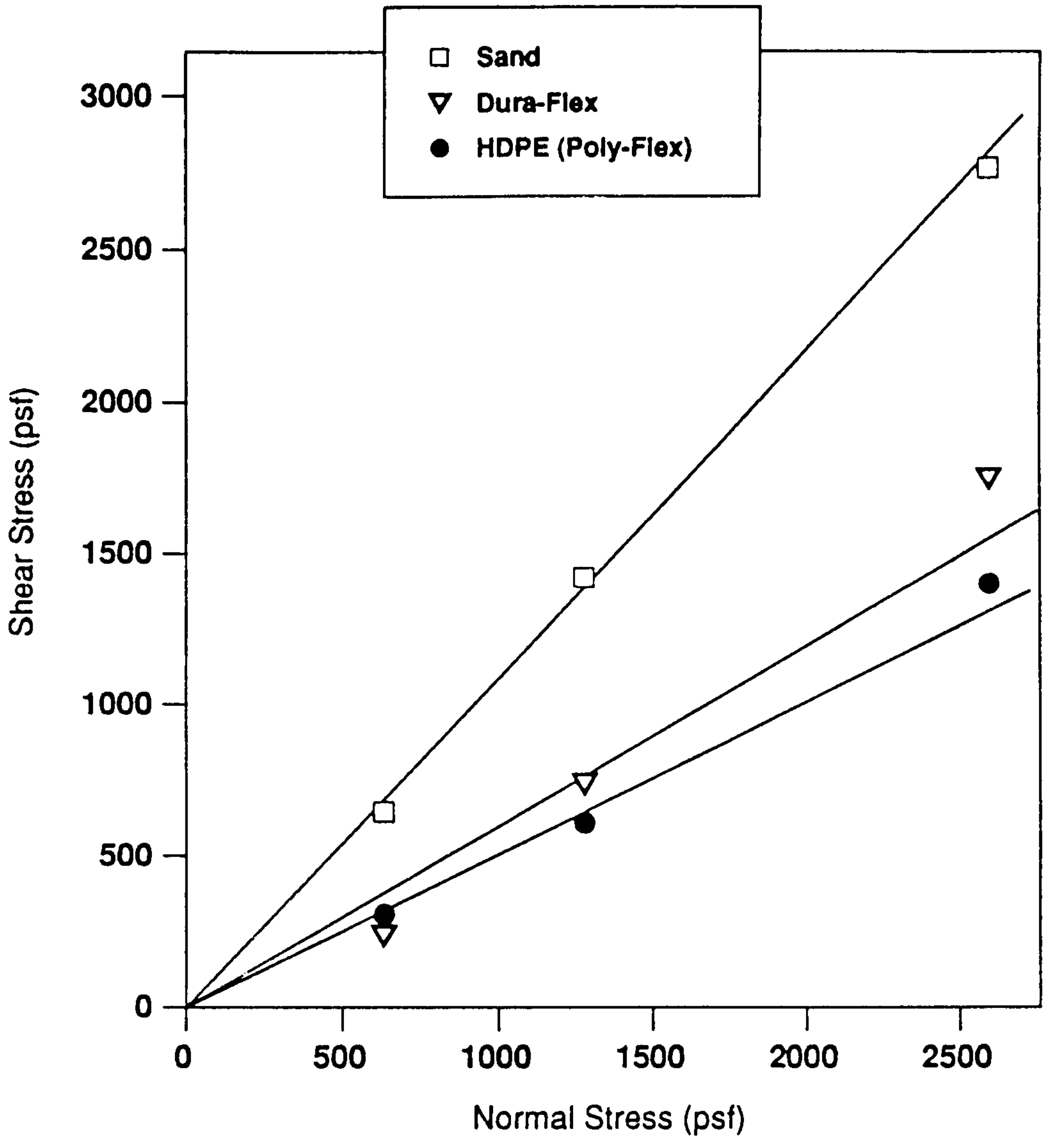
Geomembrane (GM): Poly-America 30 mil Dura-Flex Geomembrane
Geonet (GN): Tensar DN 4 Geonet with and without Typar 3401 Geotextile
Ottawa Sand: Standard #40 Sieve Test Sand (Particulately spherical)
Concrete Sand: Approximately #40 Sieve (Particulately angular)

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

$$E_\phi = \text{Efficiency} = \left(\frac{\tan \delta}{\tan \phi} \right) 100$$

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.**

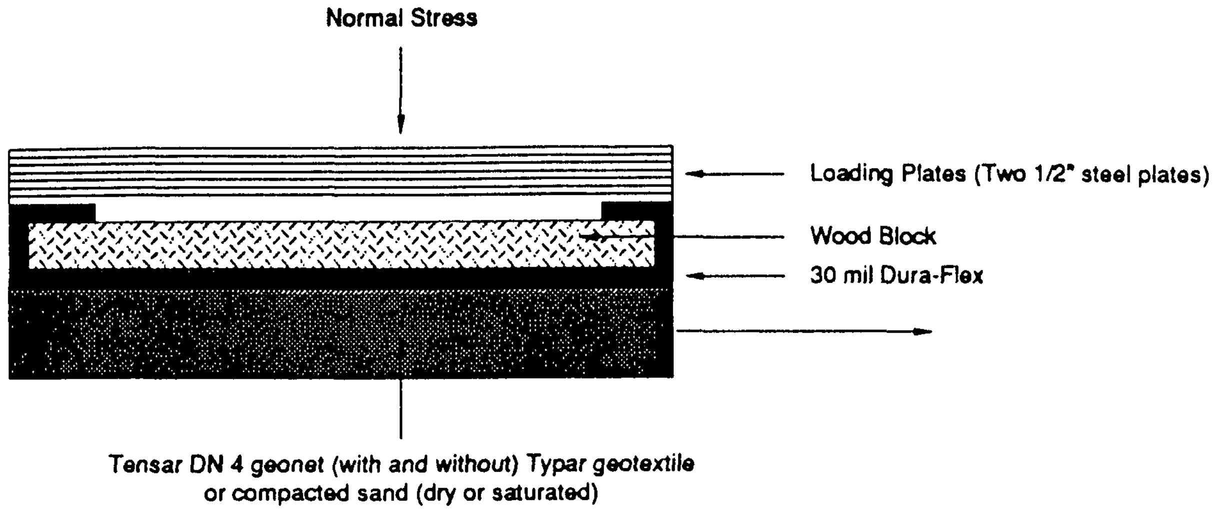


Figure 5. Test cross-section for determining the friction angle between 30 mil Dura-Flex and various interface materials

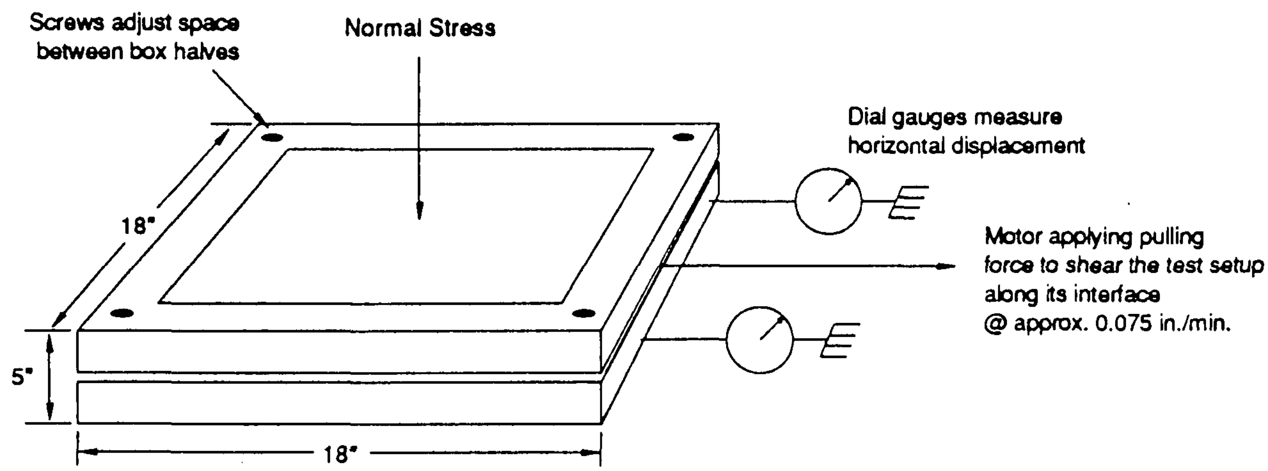


Figure 6. Test setup of GRI's 18" x 18" direct shear box

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_{ϕ} = $(\tan\delta/\tan\phi)100$
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%

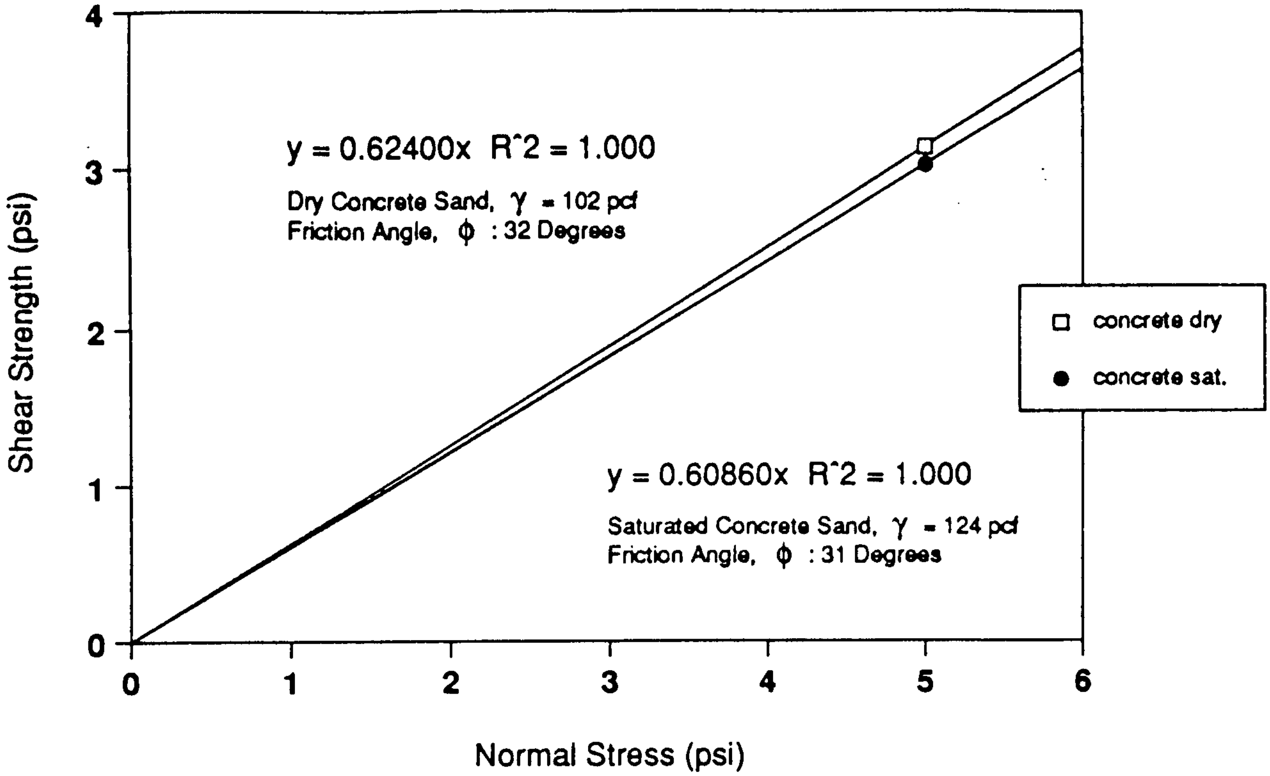


Fig. 7 - Curves for Obtaining Friction Angles of Concrete Sand (Dry and Saturated)

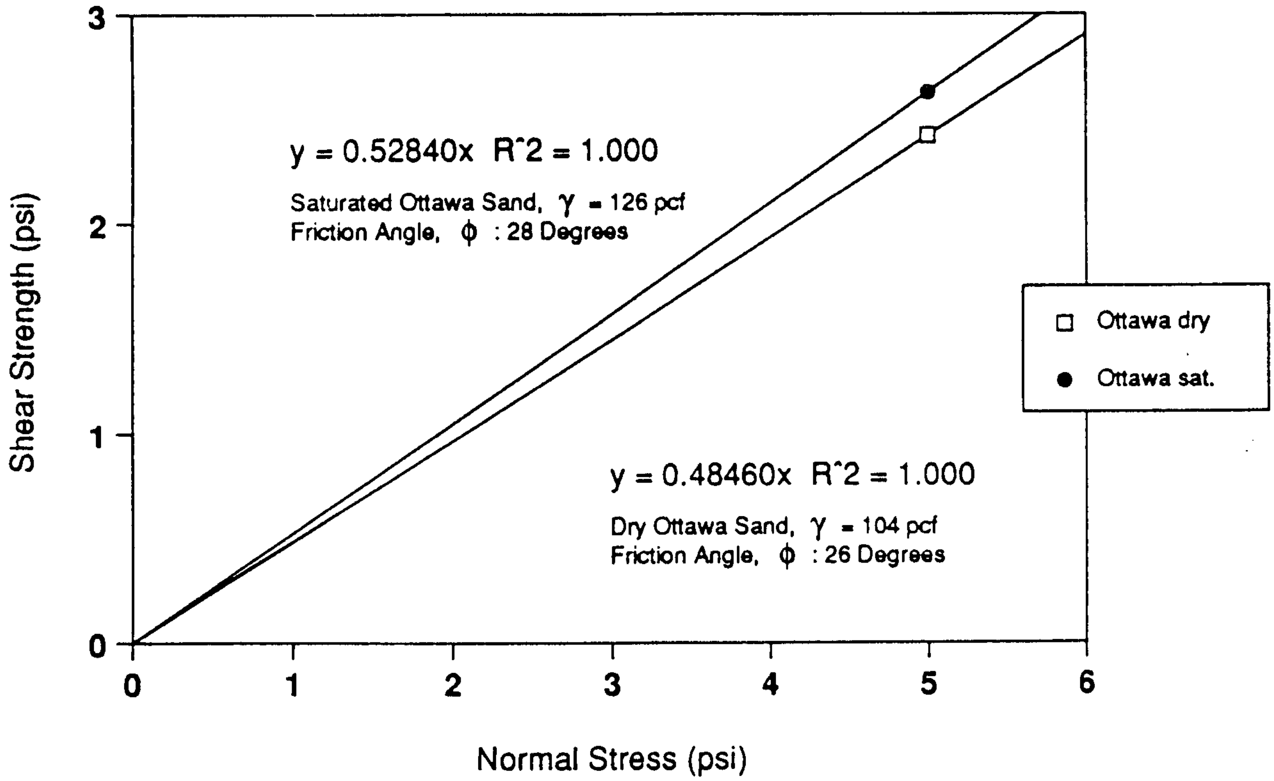


Fig. 8 - Curves for Obtaining Friction Angles of Ottawa Sand (Dry and Saturated)

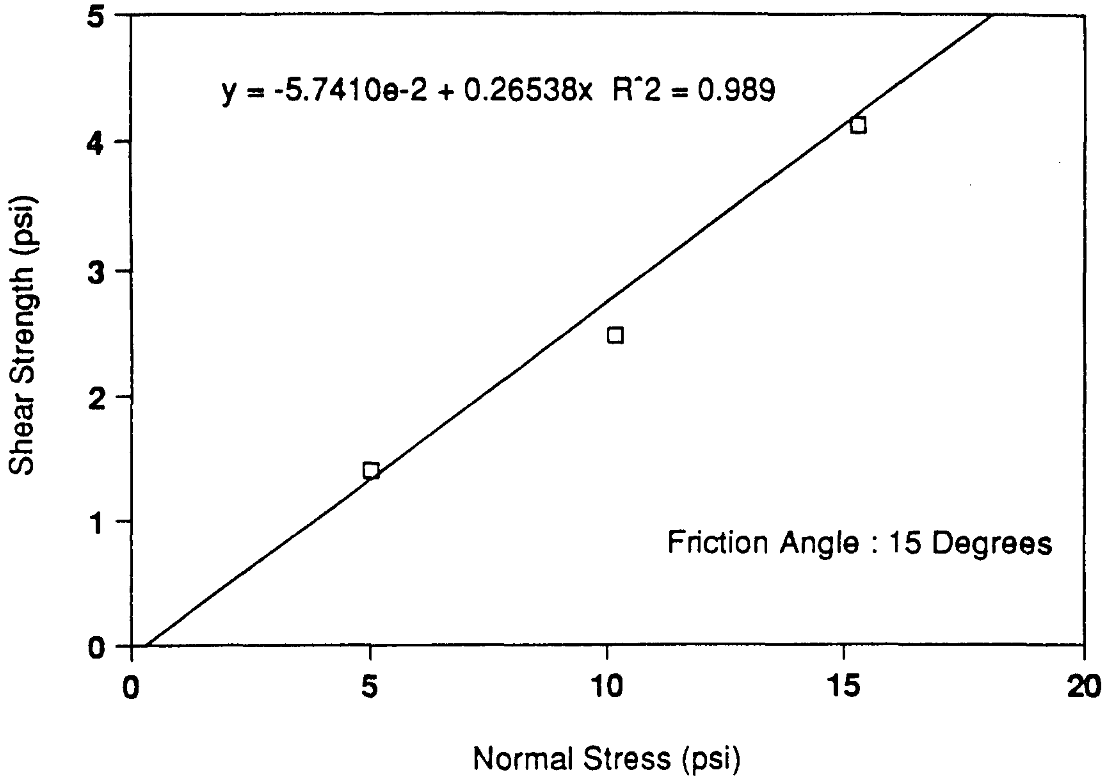


Fig. 9 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Tensar DN 4 Geonet

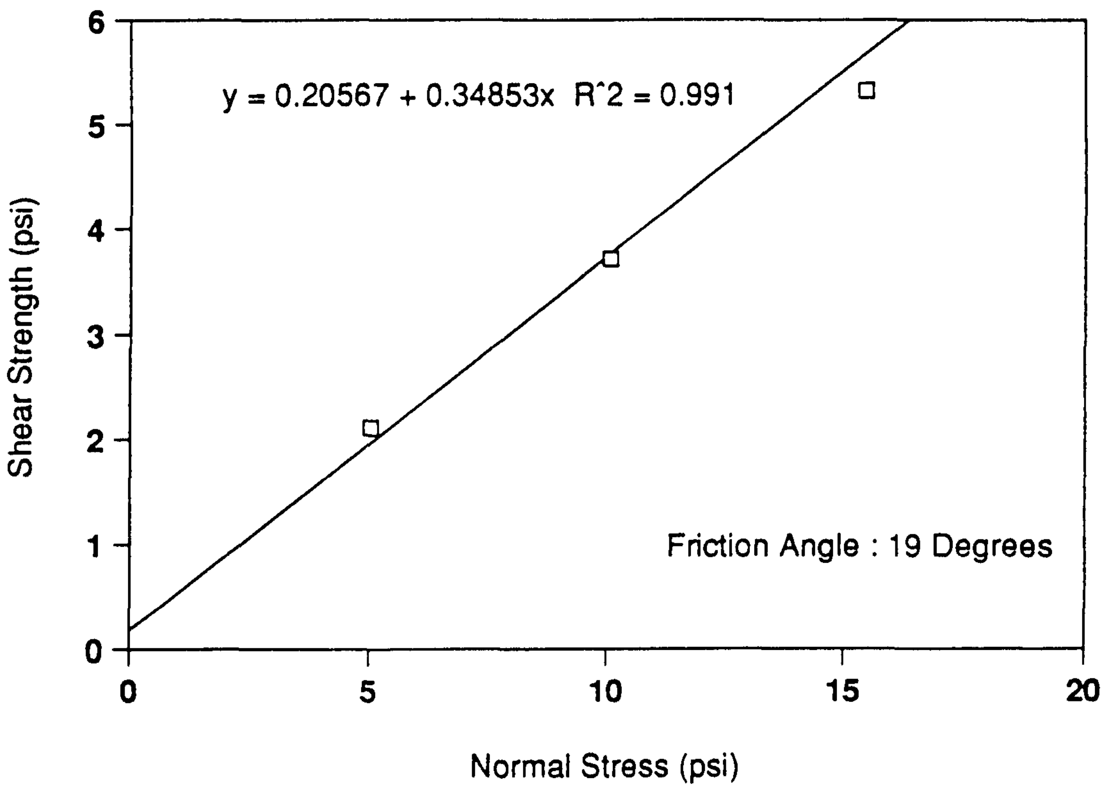


Fig. 10 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Typar 3401 Geotextile on Tensar DN 4 Geonet

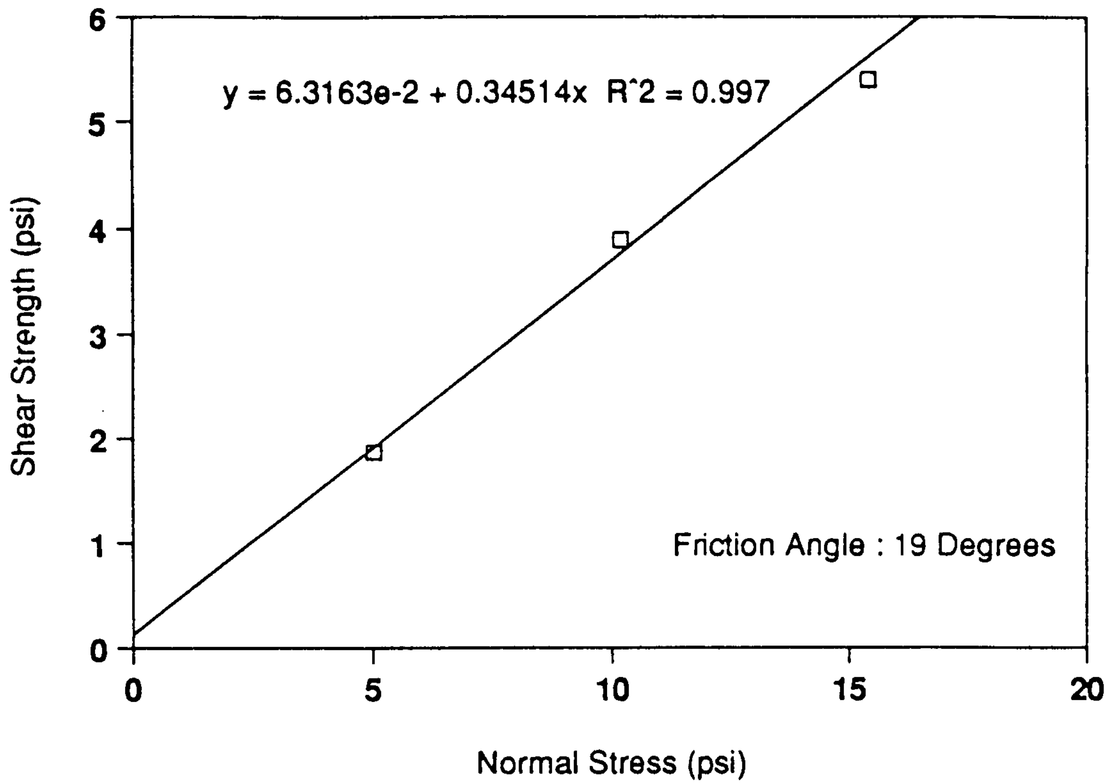


Fig. 11 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Dry Ottawa Sand

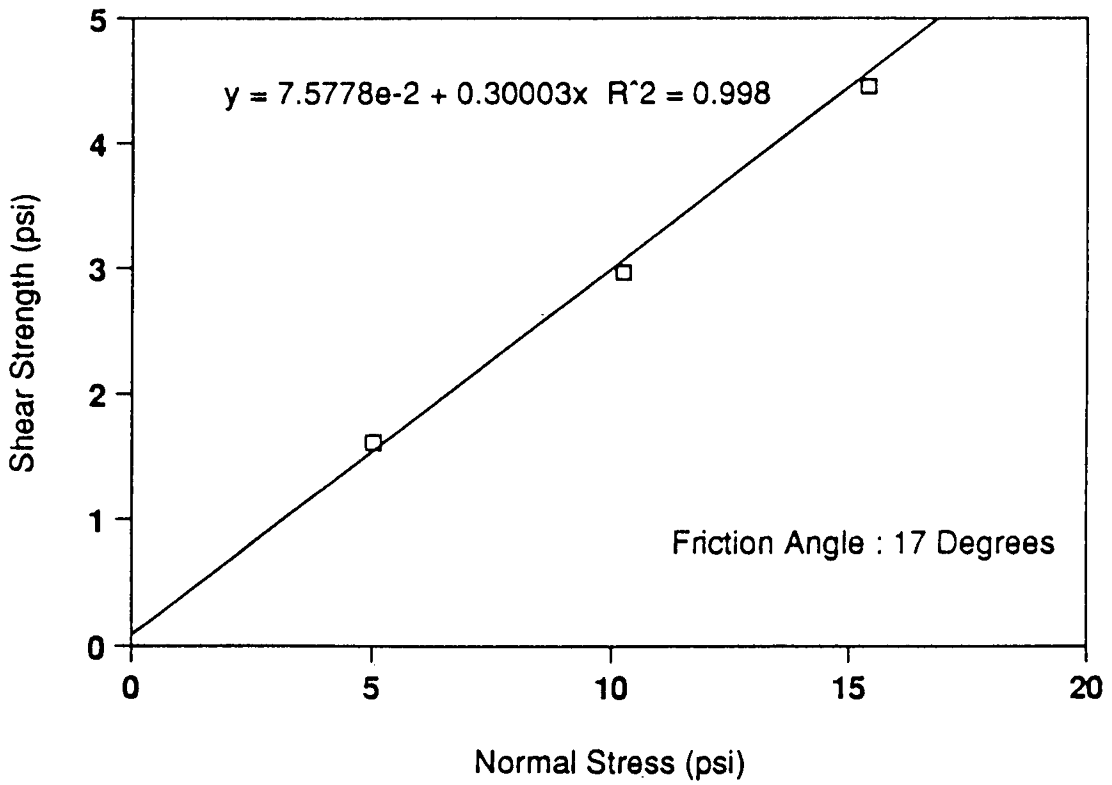


Fig. 12 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Saturated Ottawa Sand

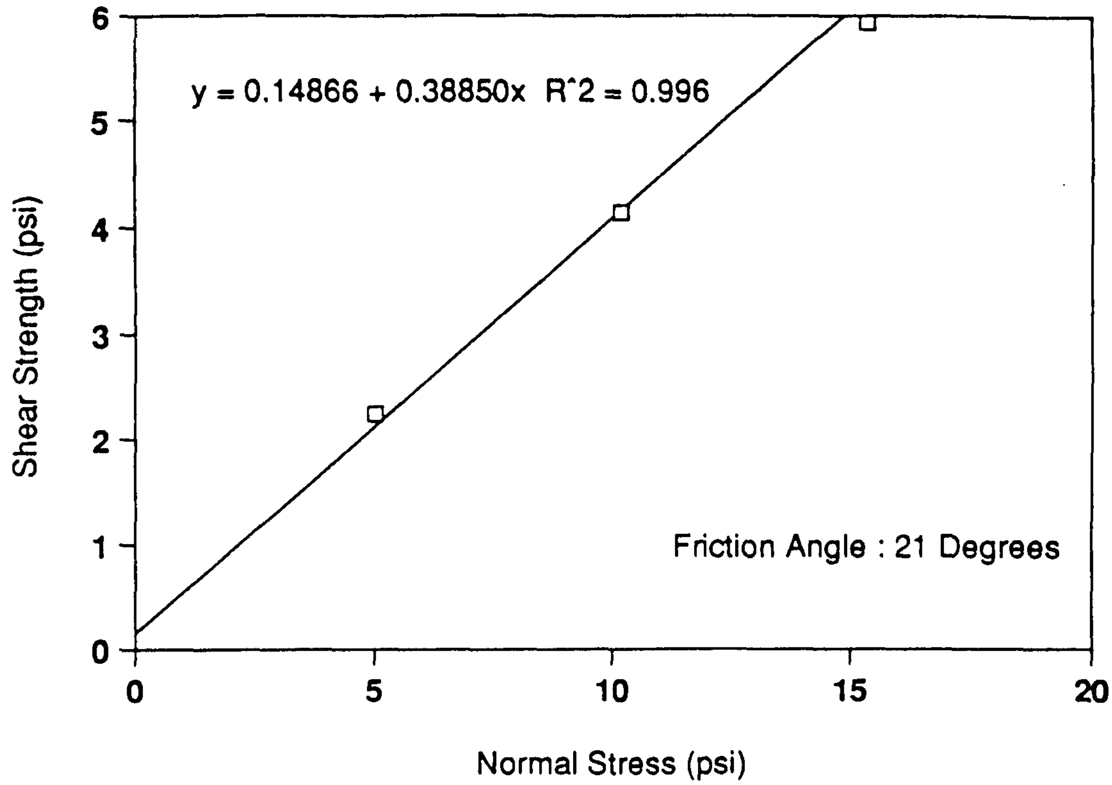


Fig. 13 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Dry Concrete Sand

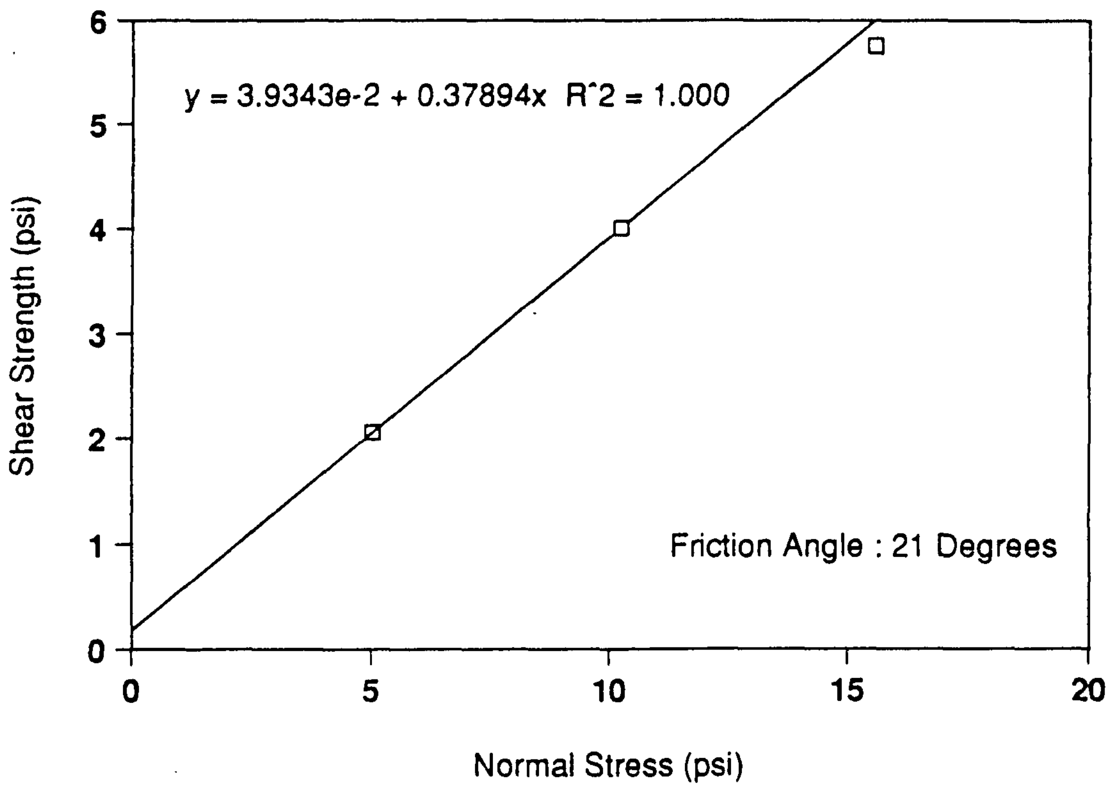
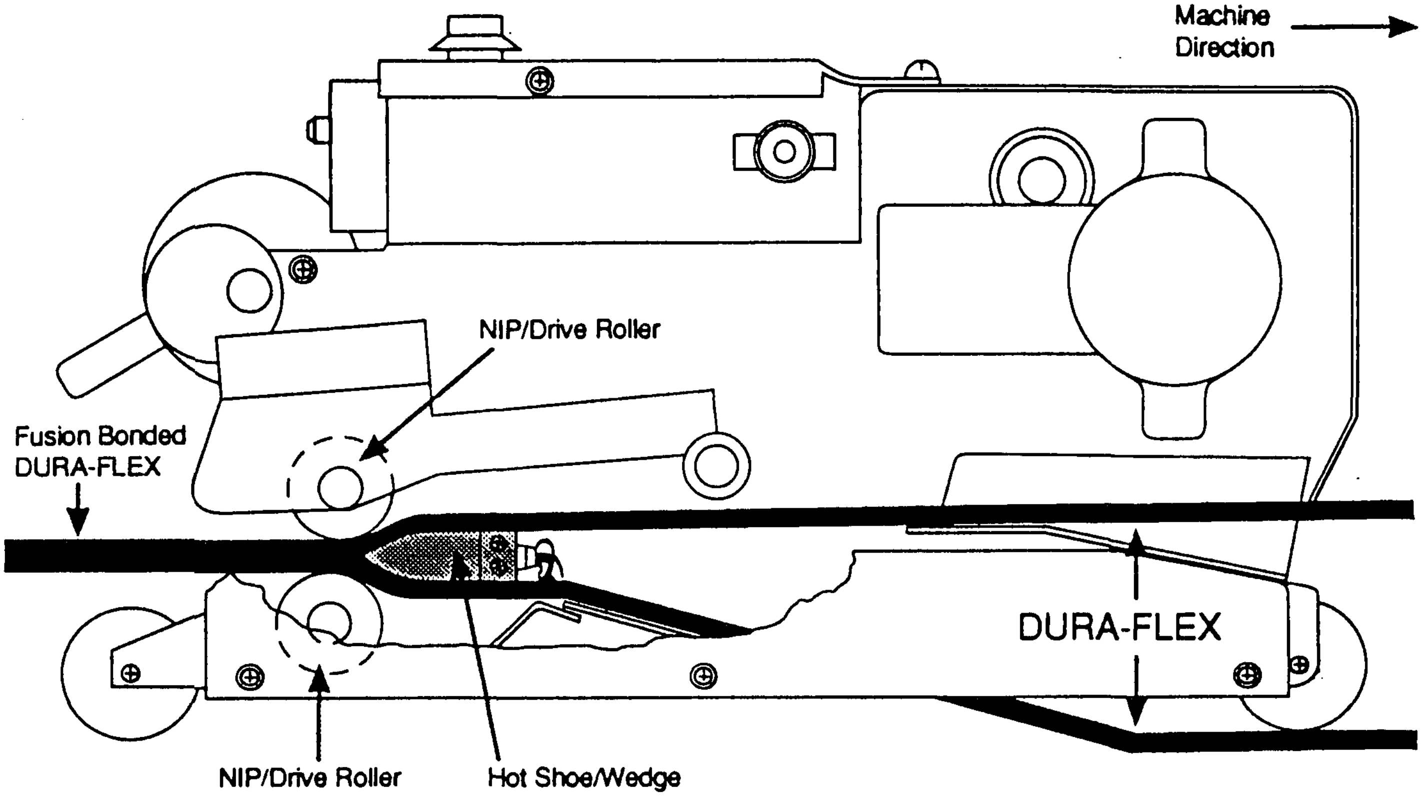
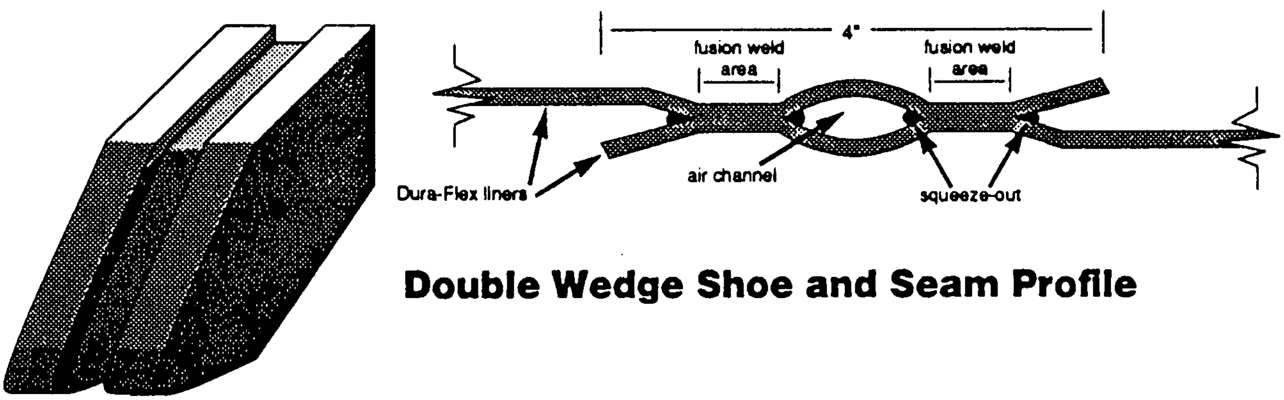


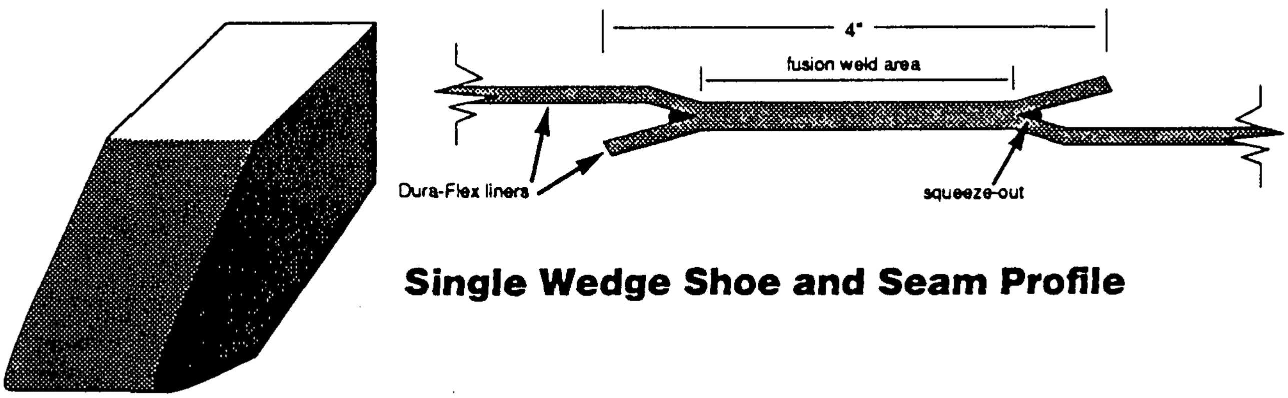
Fig. 14 - Curves for Obtaining Friction Angles Between 30 mil Dura-Flex and Saturated Concrete Sand

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
sec-Butyl Alcohol	EG	EE
tert-Butyl Alcohol	EG	EE
Butyric Acid	NN	FN
Calcium Hydroxide, Conc.	EE	EE
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

CHEMICAL	LDPE	HDPE
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.

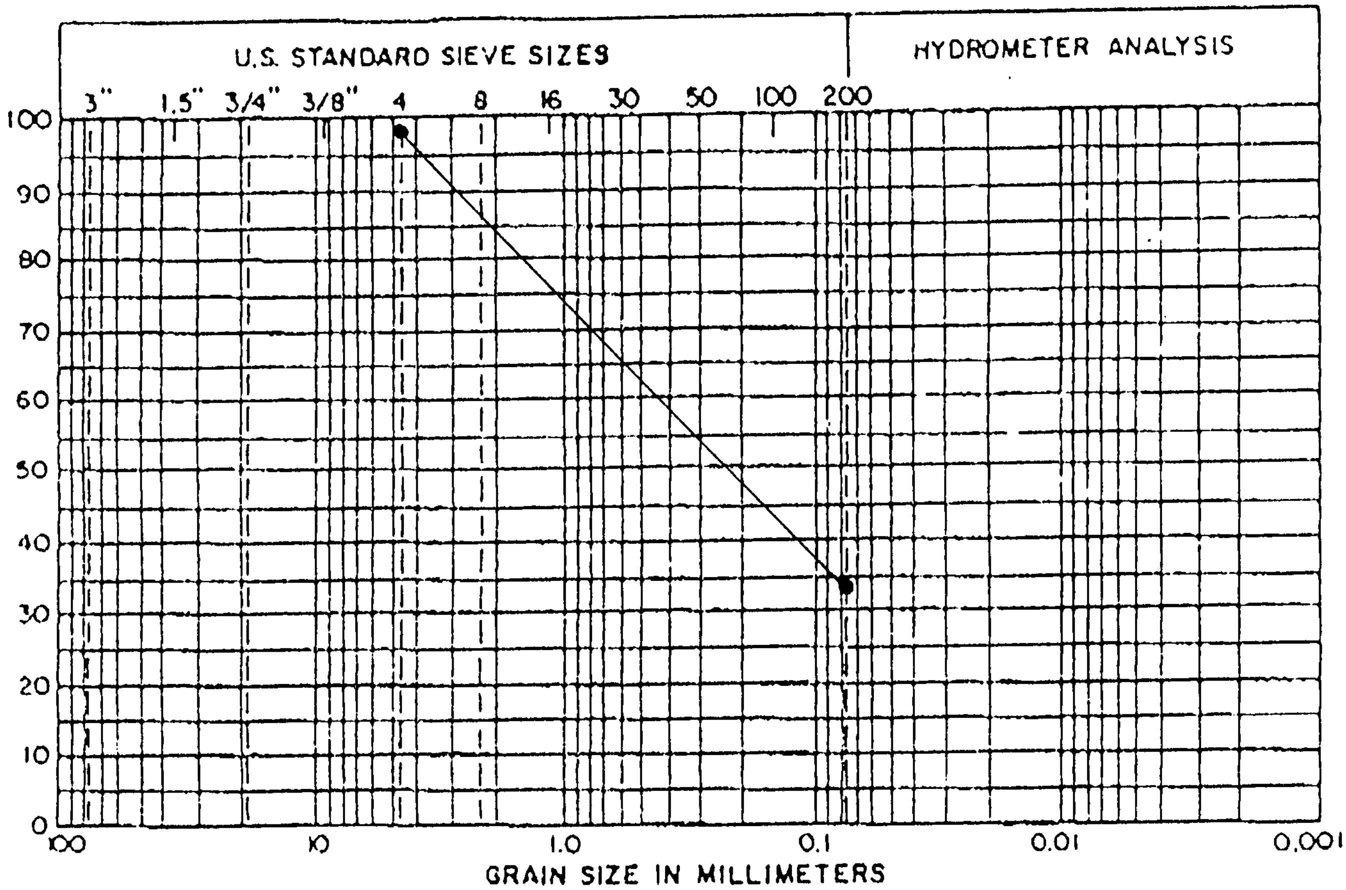
APPENDIX B

- **MATERIAL TEST DATA**

ENVIROCON

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



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	97.6	100	.149		.005	
3.0"	76.0		8	2.380		200	.074	34.4	.002	
1.5"	38.0		16	1.190		—	.037		001	

Moisture = 23.5%

ENV 06/90

FIGURE NO. ______

ENVIROCON

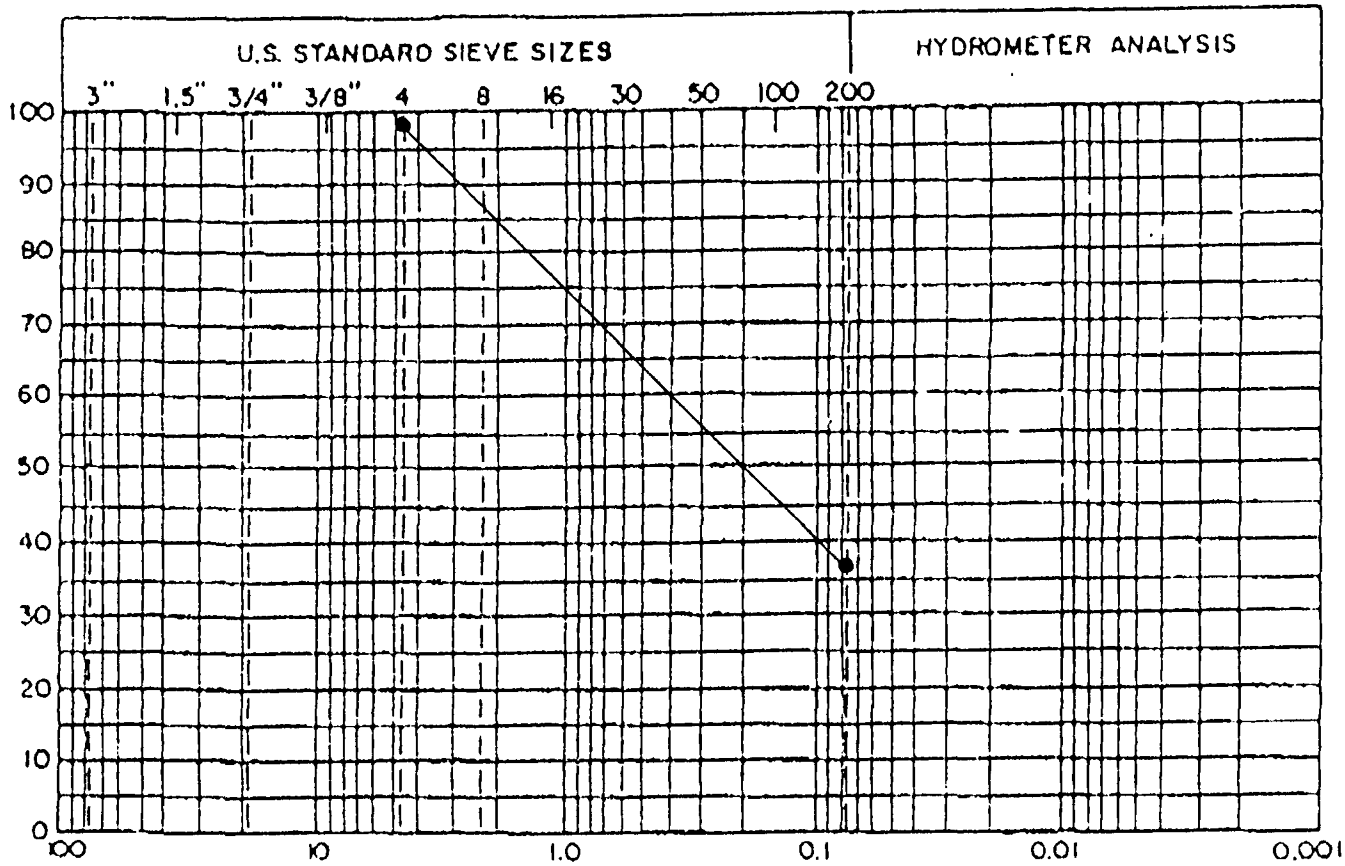
LAB ______ LAB NO. ______

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

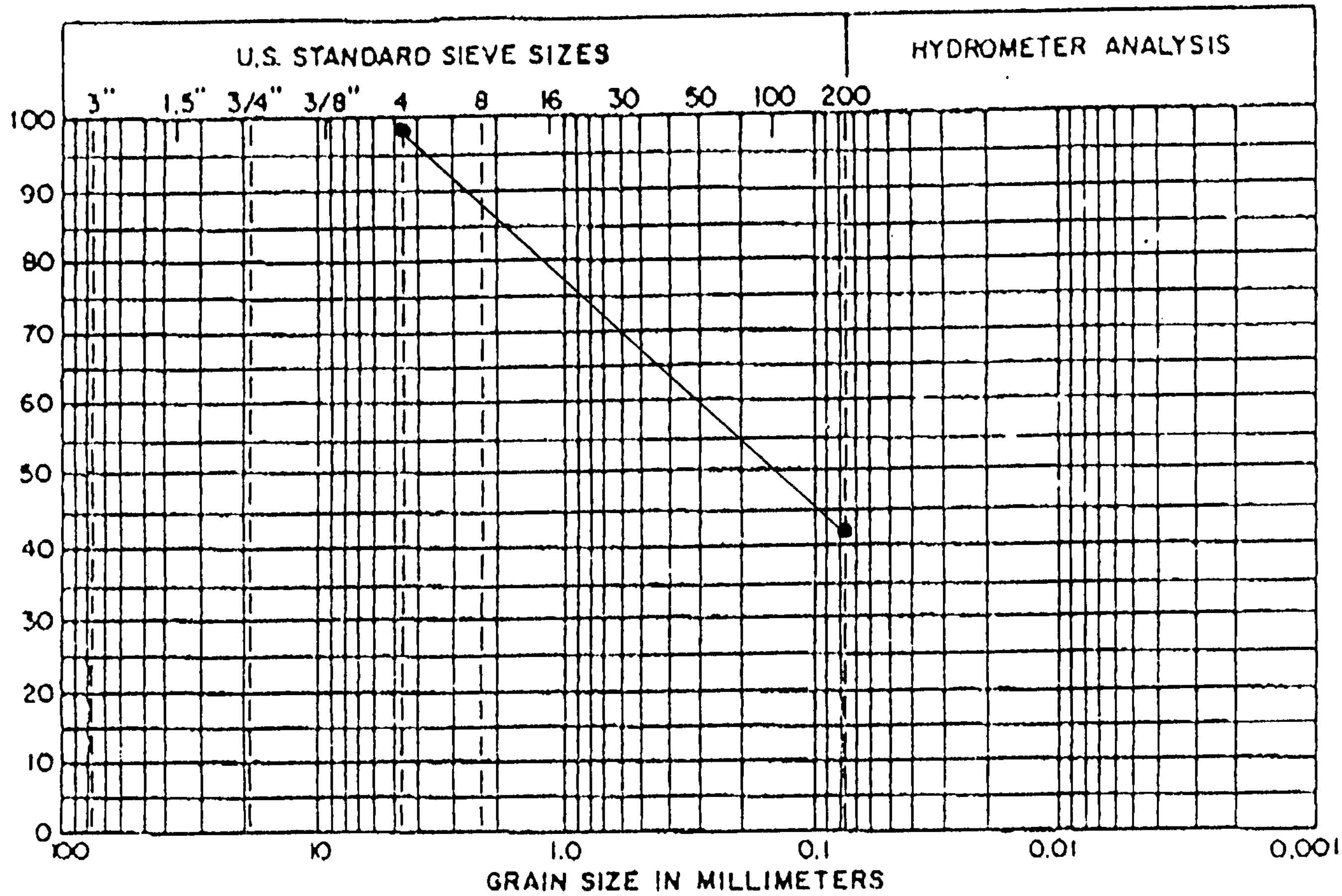
LAB ______ LAB NO. ______

CLIENT Maverik PROJECT Caribou Refinery

FEATURE Trench Sample PROJECT NO. 2001

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

GRAIN SIZE ANALYSIS



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	97.8	100	.149		.005	
3.0"	76.0		8	2.380		200	.074	42.9	.002	
1.5"	38.0		16	1.190		—	.037		001	

Moisture = 33.7%

ENV 06/90

FIGURE NO. ______

ENVIROCON

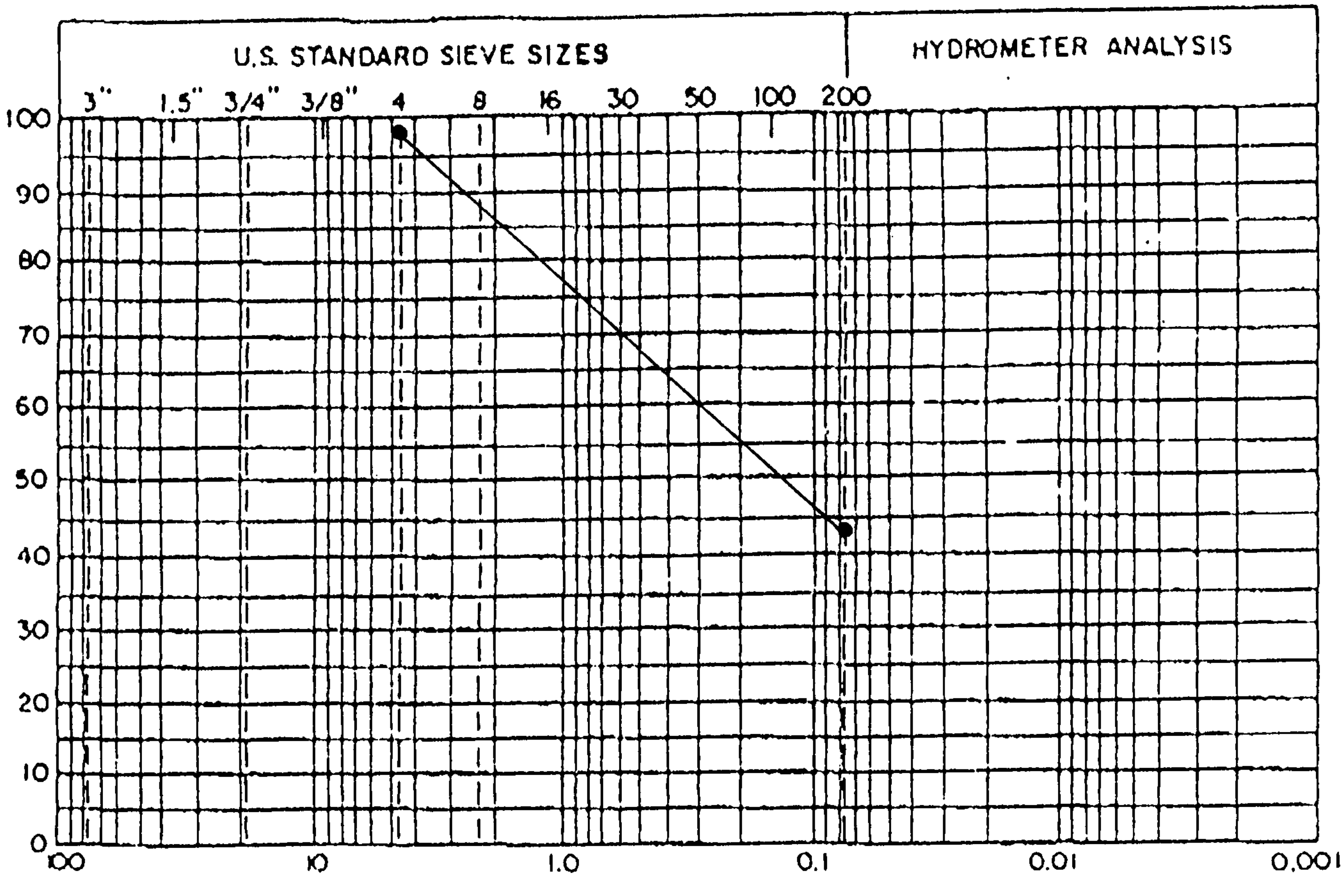
LAB ______ LAB NO. ______

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...............(406) 543-7271 Ext.2676

(Dana Headapohl, MD)

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-lb. 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 n o t 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-producingctivities 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.

<u>Heat Stress Monitoring</u>

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 visible, a water mist will be applied. If the mist is not effective in reducing dust generation, personnel will don respirators (half-face).

Record Keeping

To assure HASP implementation, many site activities will be documented. These will include maintenance of HAST at the site; employee HASP sign-off; safety briefings; site sign-in log; emergency medical data sheets; health and safety log notes (which include instrument calibration records, sampling data, monitoring results, and incident reports) chemical safety data sheets; and other records identified in the HASP.

All medical and exposure records will be maintained in Occupational Health Service, St. Patrick Hospital. No medical information will be kept at the work site.

Access to Medical Records will be provided consistent with state and federal regulations.

All occupational injuries and illnesses will be recorded and reported in compliance with state and federal regulations. Copies of the OSHA 101 and 200 forms will be kept on the work site.

Emergency Evacuation Procedures

In the event of a site emergency, all workers at the site will be notified by the SSO to stop work immediately and offer assistance. Those not needed for immediate assistance will decontaminate per normal procedures and leave the site to an up-wind area.