Revised Remedial Action Plan For The Moose Junction Lounge

Prepared for:

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October 30, 1995

EARTH BURNERS
INCORPORATED

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Office: 218-628-0454
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October 30, 1995

Chris Saari
Wisconsin Department of Natural Resources
6250 South Ranger Road, Box 125
Brule, WI 54820-0125

RE: Monthly Progress Report and Revised Remedial Action Plan for the Moose Junction Lounge LUST Investigation near Dairyland, WI. Wisconsin Unique ID# 0301.

Mr. Saari:

Earth Burners Inc. (EBI) presents this monthly progress report as required by Administrative Order No. NWD-92-023. The following actions were completed in September/October:

* Revise the Remedial Action Plan to utilize an air sparging/soil vapor extraction system.

The revised plan is contingent upon approval of both the WDNR and DILHR. If you have any questions concerning any aspect of this progress report, please call me at (218) 628-0454 during business hours.

Sincerely,

Roger W Biebl

Roger W. Biebl
Project Hydrogeologist

Enclosure

pc: John Anderson, DILHR
Dale Schultz

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1.0 INTRODUCTION

Earth Burners, Inc. (EBI) provides this change to the Remedial Action Plan (RAP) as requested by the Wisconsin Department of Natural Resources (WDNR). Concerns were expressed by the WDNR that the proposed batch flush system, formerly proposed by EBI, may require a very long time to remediate groundwater. After discussion with the WDNR, all parties agreed that air sparging/soil vapor extraction would be a more comprehensive remedial process. This revised Remedial Action Plan is an addition to the previously published Summary Report and Annual Report for the Moose Junction Lounge. The Leaking Underground Storage Tank (LUST) site is located north of the village of Dairyland, Wisconsin (see Figure 1-1). The WDNR Unique Site # is 0301. This revision will only be implemented upon approval of both the WDNR and the Department of Industry, Labor and Human Resources (DILHR).

2.0 REMEDIAL ACTION PLAN

2.1 Objectives

The objective of the RAP is to provide a remedial design which will address the groundwater contamination at this site. Groundwater at MW-1, near the former UST location, continues to decrease in contaminants after the interim action excavation. The August levels were at 0.2 ppm GRO and 0.008 ppm benzene. MW-3, the up-gradient well has generally been absent of contamination. MW-4, the down-gradient well, has been inconsistent, however, low benzene concentrations (0.006 ppm in August) may indicate groundwater contamination is increasing. Although free-product is not observed in MW-2, the water has a severe petroleum odor. August analytical results include 125 ppm GRO and 33.4 ppm benzene. Therefore, this system is designed to remediate groundwater at the MW-2 location. The Lake Superior Laboratory groundwater analytical report for August, 1995 can be viewed in Appendix A. Design criteria and estimated costs reflect EBI's professional opinion; no warranty is expressed or implied.

2.2 RAP Alternatives

EBI proposed the following RAP options as required by the DILHR to be eligible for PECFA reimbursement. EBI had considered four options in proposing this RAP which were included in the Annual Report for the Moose Junction Lounge published on December 8, 1994. The options were as follows:

- Passive Bioremediation/Long-term Groundwater Monitoring. - This option was rejected as it does not address the possible contaminant migration to the potable well located nearby on the late Margaret Dickman Estate. Estimated costs were expected to be $8,000 - 10,000 annually.

- Groundwater pump and treatment pilot system- batch flush system/air diffusion of effluent groundwater. Formerly proposed by EBI, this option could not predict a time when the remediation would be complete.

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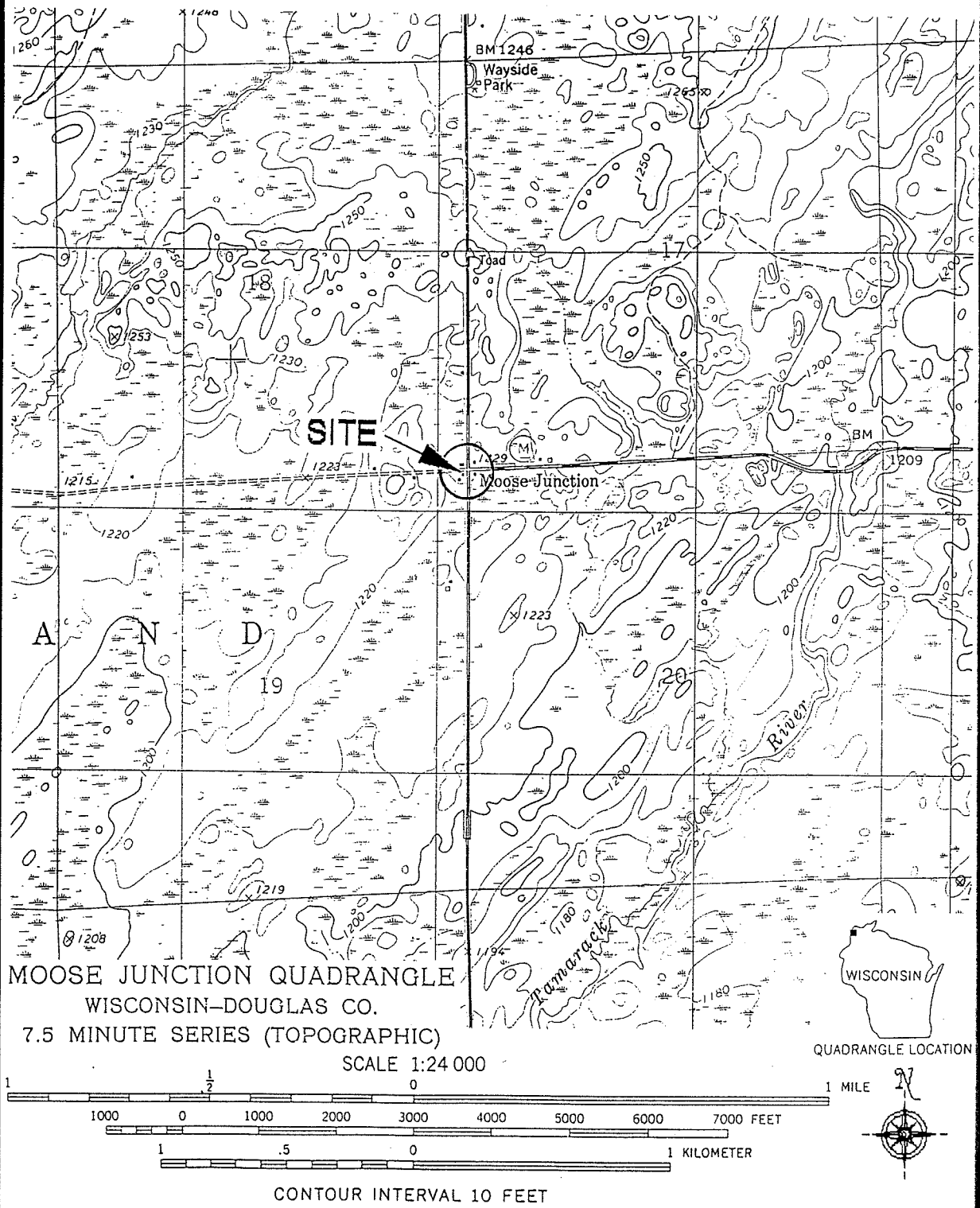

MOOSE JUNCTION LOUNGE
SITE LOCATION MAP

FIGURE 1-1

Estimated costs for groundwater treatment were expected to range between $18,000 and 28,000 which includes annual groundwater monitoring costs.

- Excavation of contaminated soils - This option could remove all the soil contamination in a very short time, but does not address groundwater with high levels of Gasoline Range Organics (GRO) and benzene which will continue to migrate. Estimated costs were expected at $40,000 - 60,000 not including annual groundwater monitoring costs.

- Air Sparging/Vapor Extraction System. - This option offers the most comprehensive soil and groundwater remediation plan, however it is the most expensive. Estimated costs were expected to be $60,000 - 80,000 which includes the first annual groundwater monitoring costs.

2.3 RAP Proposal

EBI proposes three phases for the Remedial Action Plan. Phase I of the RAP involves a pilot test with two air sparging wells and two horizontal vapor extraction wells. The proposed wells are located in Figure 2-1. Phase II of the RAP involves continued groundwater monitoring to determine the success of the remedial action. Phase III of the RAP would fully implement the system if the pilot tests are successful. This portion of the RAP could be used to fine tune the air sparging/vapor extraction system. A soil boring should be placed in County Road M (see SB-14 - Figure 2-1) to determine the status of soils under the road. The boring would be placed south of the southeast corner of the interim excavation. A soil sample, (B7(6'), collected to characterize the soils at that location was saturated with gasoline on June 15, 1993. If the soil boring is contaminated, an additional sparge point and two angled vapor extraction wells could be added along the south side of County Road M.

With a moderate hydraulic conductivity (2.77×10^{-5} cm/sec) near MW-2, the soils should have enough pore space to accommodate an air sparging/vapor extraction system. A grain size analysis of an archive soil sample from MW-2 indicates the sands in the vicinity have only 17 % of the grains larger than 0.75 mm which is noted in WDNR guidance as a qualifier for successful system. Most sand grains (71.4%) were between 0.20 and 0.42 mm indicating soils may respond to an air sparging system.

EBI will record groundwater levels in the monitoring wells prior to system initiation. The groundwater well level in MW-2 will be measured at least ten additional times over the 24 hour period after system start-up. The characteristics of the groundwater levels may predict the failure or success of the system. If the groundwater levels rise and stay elevated, the system has probably induced bubble flow in the aquifer and will probably strip most VOC from the soil and groundwater. If the water falls to initial levels, the sparged air has probably channelized along some preferential path which will be the only area(s) remediated. If the groundwater level falls, but stays above the initial level in MW-2, a combination of both bubble and channelized flow have occurred and the air sparging/vapor extraction will continue. Air volumes will be compared between the

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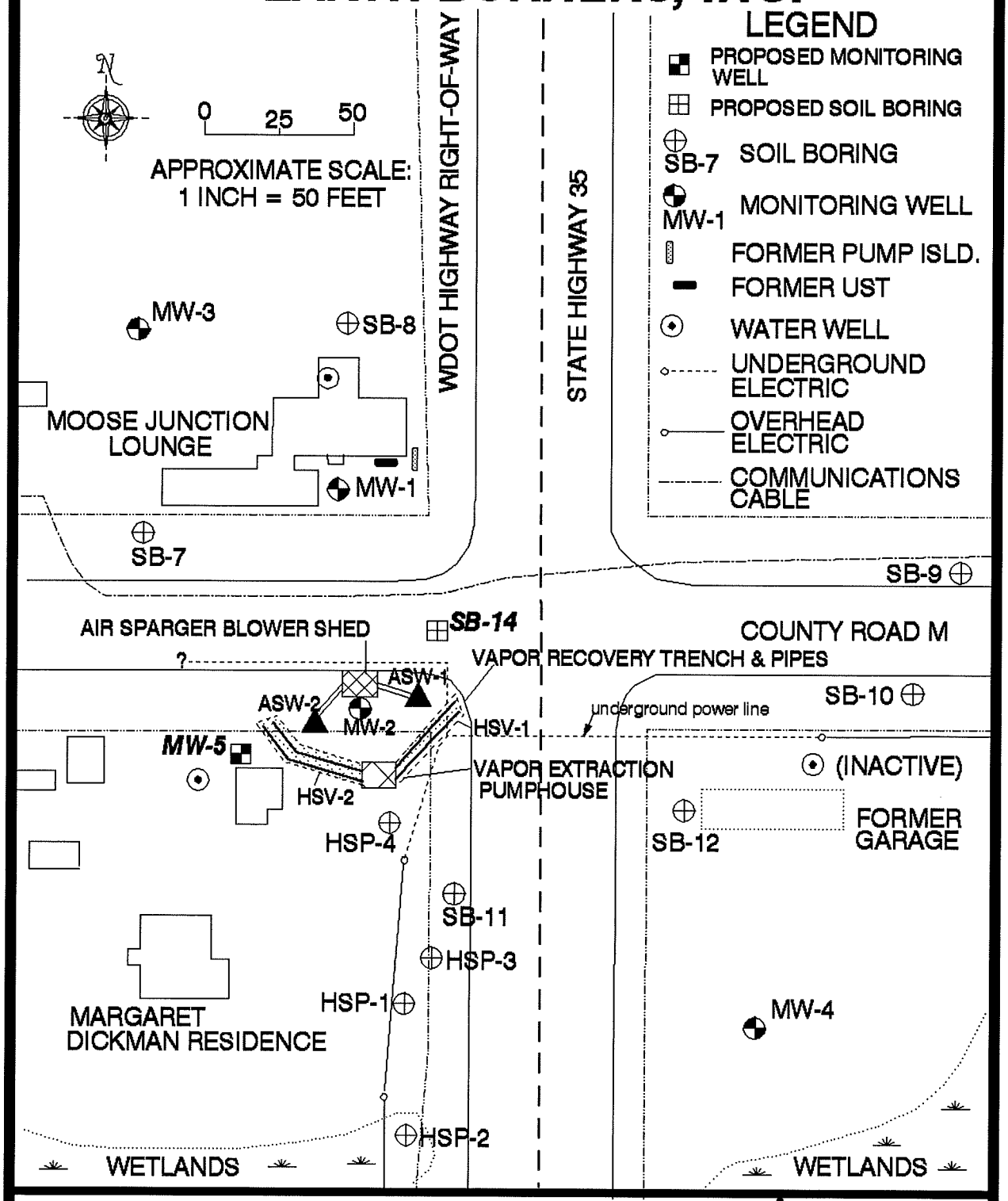

MOOSE JUNCTION LOUNGE - PROPOSED AIR SPARGING/VAPOR EXTRACTION WELL LOCATIONS

FIGURE 2-1

sparger and the extraction wells. If the extraction rate of collection is not greater than four times the sparging rate, gas migration may occur. A monitoring well placed between the system and the potable well at the late Margaret Dickman residence may determine if gas migration has occurred (see MW-5 - Figure 2-1). The well will be installed only if the WDNR requests such action. The pilot test is required to determine if the soils, below the groundwater, will release the contaminants adsorbed to them. If the pilot test is successful and a soil boring indicates contaminants have not pooled under County Road C, the pilot system could become the complete system without further additions.

The air sparging/vapor extraction system estimated horizontal zone of influence is shown in Figure 2-2. The estimated vertical zone of influence is shown in Figure 2-3. During the air sparging pilot test, the wells will inject ambient air at an increasing pressure in pounds per square inch (psi). During each psi setting, the volume of air in standard cubic feet per minute (scfm) will be measured to determine the optimum performance without approaching the maximum of 9.5 psi. The base of the sparging wells should be placed at the bedrock level which is expected to vary from the level shown in the air sparging well diagram (see Figure 2-4). VOC vapors will be collected by horizontal extraction wells installed approximately three to four feet below grade (just above the seasonal high groundwater level). A typical horizontal well can be seen in Figure 2-5 with a cross section of the trench in Figure 2-6. Petroleum contaminated vapors will be monitored by EBI to ensure the rates do not exceed those listed in Attachment 1 of the WDNR "Guidance for Design and Operation of Soil Venting Systems". Pilot venting systems are not controlled by the state air emissions if run for less than eight hours. During the initial tests, air sampling will be completed with a 680 HVM Flame Ionization Detector (FID). If the pilot test is expected to run longer than eight hours or if VOC emission rates exceed 9 pounds per hour, the exhaust vapors may be remediated through a carbon filtration unit. When petroleum VOC concentrations have dropped below 5.7 pounds per hour (the rate an air pollution control permit is not required), the vapors will be vented to the ambient air in a low traffic area.

If results from the pilot tests indicate the air sparging/vapor extraction is ineffective and analytical samples from MW-2 indicate groundwater remediation has not improved significantly, another remedial design will probably be required. EBI proposes the following contingency:

If petroleum vapors cannot be retrieved in an economical manner, the RAP design could be changed to previously proposed pilot test groundwater pump and treatment system.

2.4 System Design

The system components will consist of :

- Regenerative blower to supply air to the two air sparge points
- Regenerative air pump to supply a vacuum for the two horizontal vapor extraction wells.

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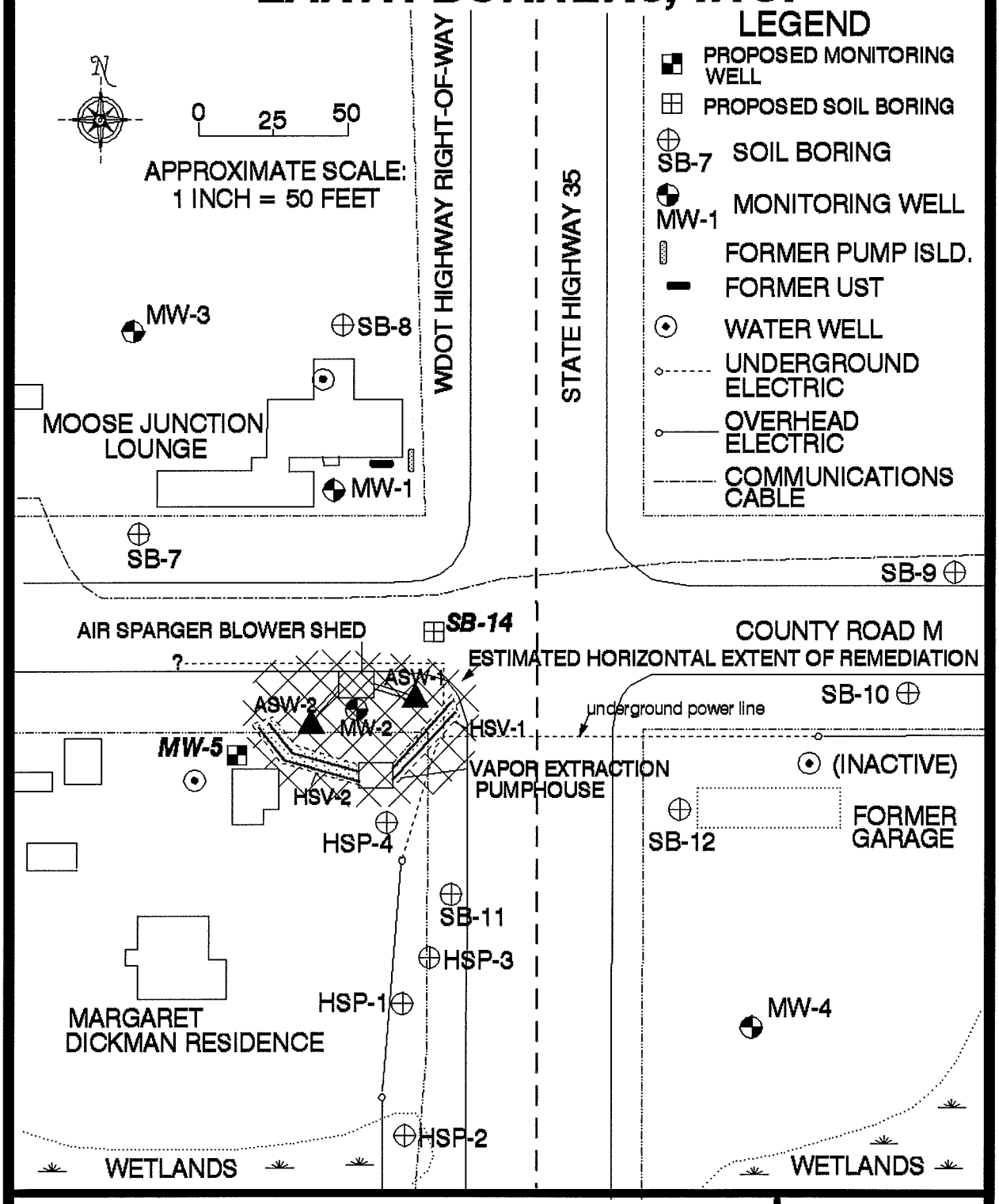

MOOSE JUNCTION LOUNGE
ESTIMATED HORIZONTAL EXTENT OF REMEDIATION

FIGURE 2-2

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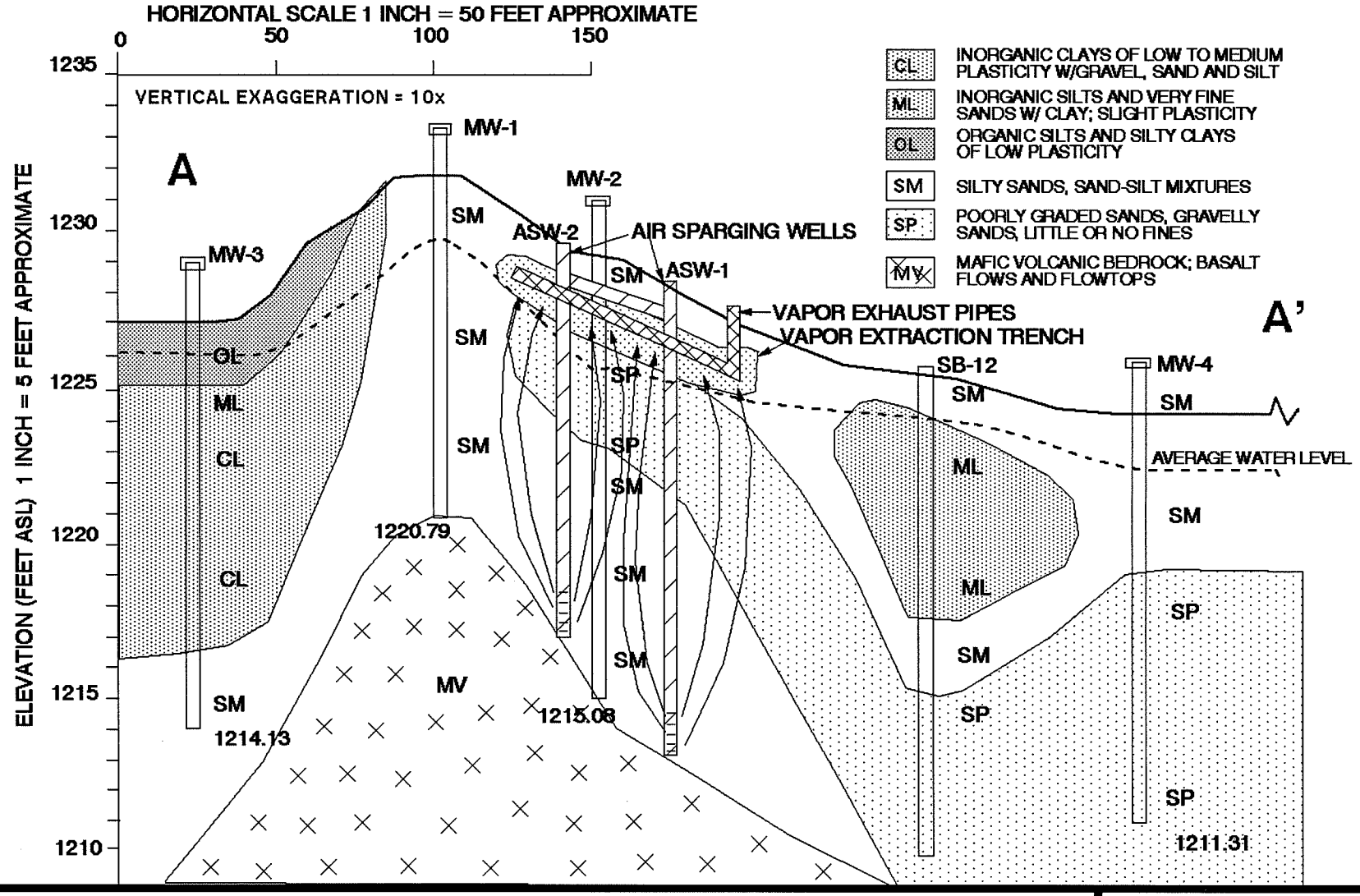


MOOSE JUNCTION LOUNGE - ESTIMATED VERTICAL EXTENT OF SOIL/GROUNDWATER REMEDIATION

FIGURE 2-3

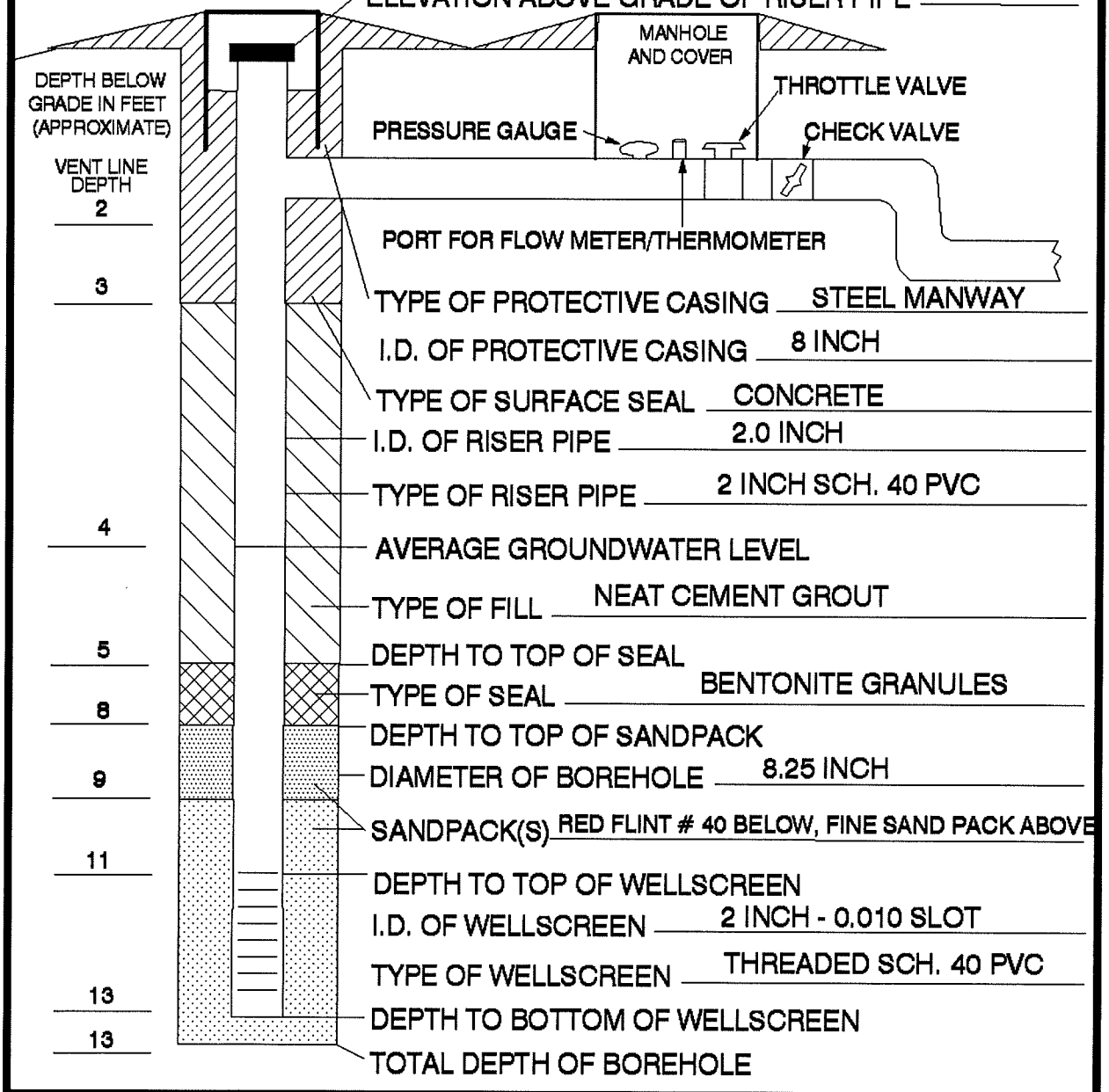
EARTH BURNERS, INC.

UNIQUE WELL # _____ AIR SPARGING WELL # ASW-1/ASW-2

SITE MOOSE JUNCTION LOUNGE CONTRACTOR UNDETERMINED

DATE UNDETERMINED DRILLER UNDETERMINED

PROJECT # R424, WDNR # 0301 SITE ENGINEER LES CONWAY P.E.



AIR SPARGING WELL LOG

FIGURE 2-4

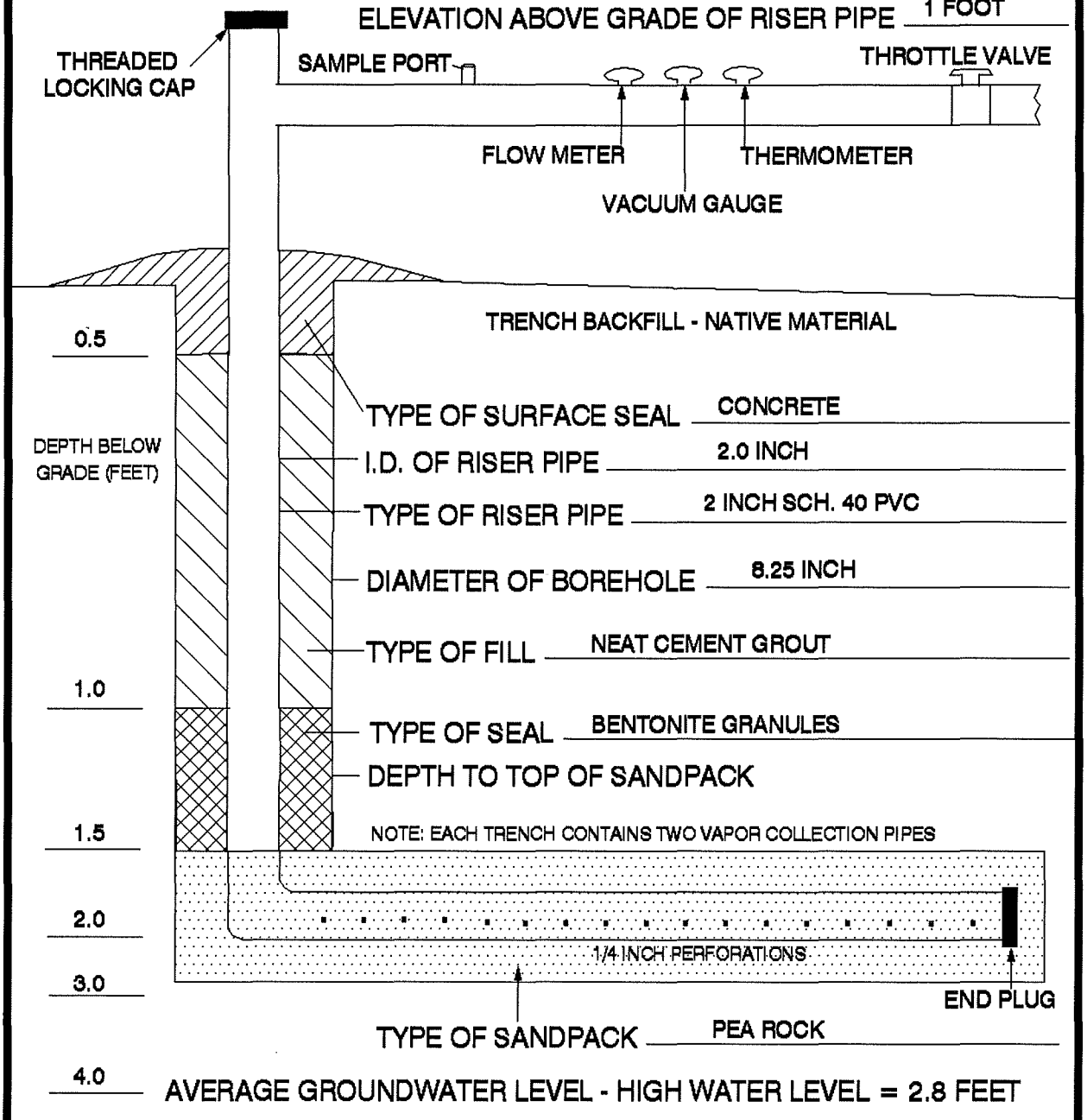
EARTH BURNERS, INC.

UNIQUE WELL # _____ AIR EXTRACTION WELL HSV-1, HSV-2

SITE MOOSE JUNCTION LOUNGE CONTRACTOR UNDETERMINED

DATE NA DRILLER UNDETERMINED

PROJECT # R424, WDNR # 301 SITE ENGINEER LES CONWAY



HORIZONTAL VAPOR EXTRACTION WELL LOG | FIGURE 2-5

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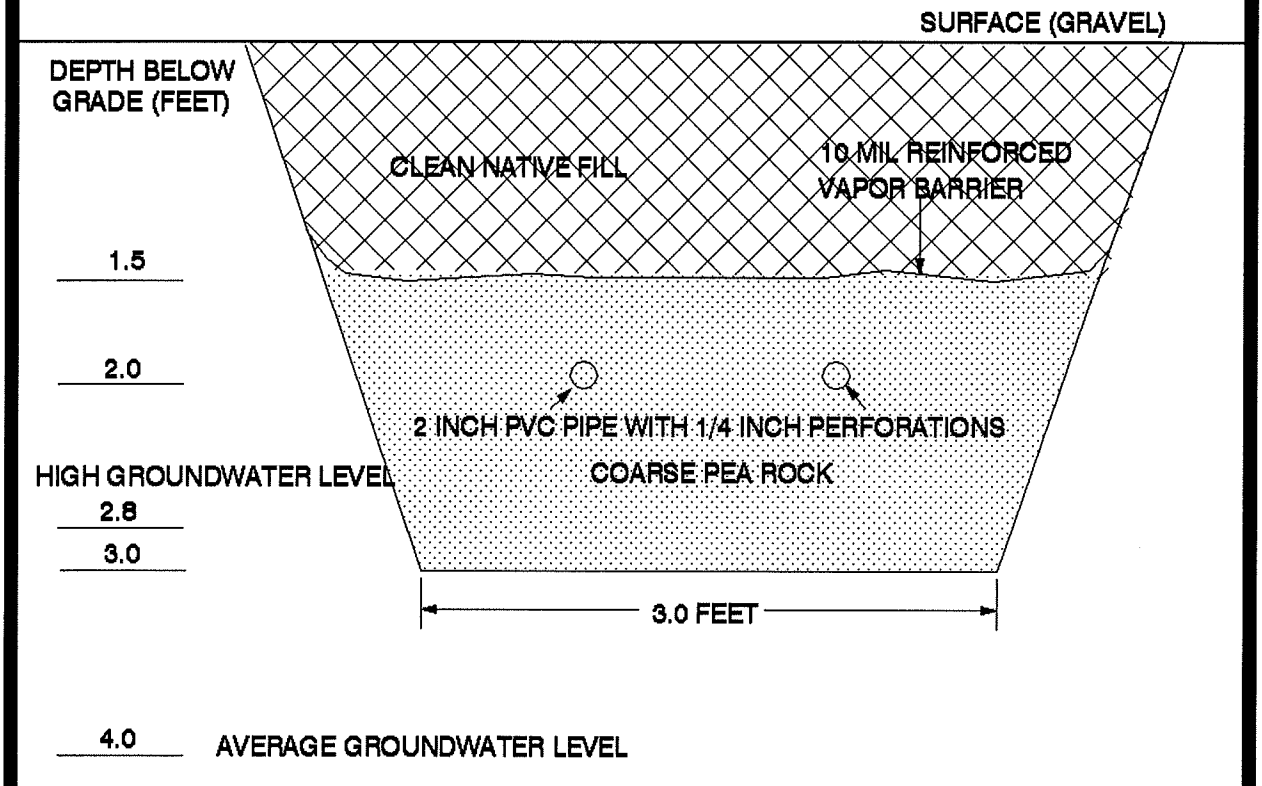

MOOSE JUNCTION LOUNGE
TRENCH DIAGRAM FOR VAPOR EXTRACTION

FIGURE 2-6

- Two air sparge wells outfitted with a tee connection with a pressure gauge, throttle valve, check valve, and ports for an air flow meter and thermometer.

- Two lateral vapor extraction wells outfitted with a sample port, flow meter port, thermometer port, valve and threaded locking cap.

- Threaded two inch PVC piping used for both the air sparging and the vapor extraction wells.

- A water trap is recommended because of the rise in water level caused by the pressurization and vacuum of the shallow groundwater level may cause it to rise into the vapor extraction trenches. The trenches cannot be made shallower without causing a preferential path to the surface beyond the collection system.

- If required by air emission standards, a carbon filter/air stripping system could be used to eliminate explosive or toxic vapors. Methyl Tertiary Butyl Ether (MTBE), which may be present in the groundwater, may shorten the remedial life span of the carbon filters.

The air pumps from the air sparging and the vapor extraction units will utilize non-sparking electric motors. Temperature will be initially monitored for the first 24 hours to ensure the operating temperatures do not exceed 140 degrees Fahrenheit, at which PVC pipe begins to deteriorate.

The maximum psi the air sparging well can be operated is determined by the weight of the soil above the screen level of the shallowest sparge well. Using the following parameters, the maximum psi is calculated as 9.5.

Maximum psi = (length of soil) * (soil particle density) * (1 - soil porosity) * (soil weight per ft^3) then: Maximum psi = (11') * (2.7) * (1- 0.3) * (62.4 lbs/ft^3) = 9.5

This pressure will not be approached as fracturing of the aquifer may result. The pilot test will start at 3.0 psi and increase in 1.0 psi increments after flow and contaminant rates have stabilized. An optimum flow rate with the greatest concentration removal will be calculated from the data. Stratification of glacial soils causes the ratio of the horizontal conductivity to the vertical permeability to vary from 3 to 10. Determining a theoretical flow rate with this variance may be unrealistic. If an airflow rate of 0.5 scfm cannot be maintained at 7.5 psi, then air sparging is probably not the correct remedial method for this site.

Sand, which most resembles the native grain size, will be used as well packs of sparging units. Because most of the sand passed the 40 sieve and was retained on the 80 sieve, 45/55 red flint sand will be used in conjunction with a 0.010 slot screen for the air sparging wells. The fine sand above the well pack will consist of # 80 fine sand.

The introduction of oxygen to the aquifer will probably enhance biodegradation of any remaining contaminants, which could be either trapped in stagnation zones between sparge points, or are strongly adsorbed to the surface of small grains within the soils. As the concentrations of contaminants recede, the likelihood of bioremediation assisting the process becomes magnified. The WDNR project manager and the project hydrogeologist will be notified if any deviations occur from the RAP. The monitoirng wells will be tested for dissolved oxygen twice before start-up of the pilot system to set a baseline. The wells will again be checked during the pilot test. An increase of oxygen in the site monitoring wells could determine the area of possible remediation.

If the system is deemed successful, EBI proposes a soil boring should be installed in the middle of County Road M between the former UST location and MW-2. After the interim excavation, sidewall samples collected to characterize the soils which could not be excavated without removing the road, indicated very high concentrations may be under the road at that location. If the soil boring is contaminated above 100 ppm GRO, an angled sparge well and two angled vapor extraction wells could be installed and outfitted to the proposed system.

2.5 SCHEDULE/MONITORING

The groundwater monitoring interval will be accelerated if VOC concentrations from the vapor extraction emissions drop excessively. Analytical results from MW-2 will determine the success of the system. If the system air monitoring shows a steady, but slow decline in VOC, the groundwater monitoring will continue quarterly. The contamination declination rate may help determine the length of time the system will need to operate. The next groundwater sampling events are scheduled for November of 1995. If the system is approved by both the WDNR and DILHR, installation of the air sparging/vapor extraction system could be accomplished in the late fall of 1995. Because the remedial system rate and the volume of contaminants are unknown, a remedial schedule cannot be predicted at this time. Table 8-1 shows an estimated schedule concerning groundwater sampling and remediation.

2.6 PERMITS

Access agreements will be needed to install the air sparging/vapor extraction on or within five feet of the Wisconsin Department of Transportation (WisDOT) property. An access agreement with the late Margaret Dickman estate has been gained for remedial activities. However, some pine trees along the north side of the estate (which may be on WisDOT right-of-way) may need to be removed to install the system. Additionally, an underground electrical power cable is near the proposed system. If the power line is located in contaminated soils which require remedial measures, it may need to be removed before system installation. Because of the high concentration of petroleum contaminants in the proposed area, it is expected that an air quality control permit will be required.

2.7 SITE CLOSURE

After groundwater monitoring indicates air sparging/vapor extraction has reduced

contaminant levels under the WDNR Enforcement Standards for four consecutive groundwater sampling events, site closure will be requested. If granted, the site will be properly abandoned by removing and/or sealing monitoring, air sparging, and vapor extraction wells. The wells will be sealed according to Chapter NR 141, the WDNR groundwater monitoring well requirements. The monitoring well casings will either be removed or cut two feet below grade and the boring sealed with neat cement grout. A report will be sent to the WDNR and, if all requirements are met, a site closure should be granted.

3.0 ESTIMATED COSTS

The following are estimated costs for the air sparging/vapor extraction pilot system. It is possible the area of concern may be addressed by the pilot system. Design additions to this system may include an angled vapor extraction well under the roadway(s) (Douglas County Road M and State Highway 35). The following costs are based on pilot system start-up, annual maintenance, and power costs. Additional costs to install additional sparge/vapor extraction points are estimated.

SCHEDULE OF COSTS

CONTRACTOR SERVICES

-Clean sand fill	13 c.y. @ $10	$ 130
-Pea rock	13 c.y. @ $20	260
-Trench and tamp backfill	52 c.y. @ $10	520
-20 Mil poly vapor barrier	One roll	640
-Sheds to house pump units, 2 Ea.,	constructed	4,500
-Install two sparging wells	@ $700	1,400
-Threaded PVC pipe	200 feet @ $20	4,000
-Monitoring well manholes (installed)	2 Ea.	800
-Install vapor extraction piping	40 hr @ $35/hr	1,400
-Flow meter/pressure gauge/valves	(installed)	2,000
-Regenerative blower for air sparger		3,000
-Regenerative blower for vapor extraction		2,500
-Exhaust silencer, air filtration and water catch tank		1,500
-Electrical connections and panel for both pump units		3,300
-Heat tape (installed)	as needed	200
-Supply electrical power	hook-up	5,500
-Bumper posts (installed)	3 @ $100 Ea.	300
-Fence along road	50 ft @ $30/ft.	1,500
-Mobilization	12 @ $100	1,200
-Electrical power (est.)		600
-System start-up		2,000
-Annual maintenance (est.)		2,400
	SUB TOTAL	$39,950

PROFESSIONAL SERVICES

-Remedial Workplan	1,320
-Health and safety plan additions	440
-Coordination with contractor/regulator	660
-Soil boring supervision/soil sample collection	880
-Sparging well installation supervision	880
-Horizontal extraction well installation supervision	880
-Groundwater sample collection (quarterly sampling, one year)	1,720
-Dissolved Oxygen sample collection	880
-Well development	220
-Surveying/field mapping	330
-Soil extraction pilot test analysis	440
-Air sparging test analysis	440
-Gain access agreements and applicable permits	660
-Data reduction/performance evaluation	440
-Treatability Report	2,420
-Annual report/progress reports	2,200
-System Engineering	4,400
-System start-up and monitoring	2,640
-Project Management	1,650
SUB TOTAL	$23,500

EXPENSES

-Per Diem	$ ---
-Diagnostic Equipment	900
-Field Supplies	1,200
-Vehicle Mileage	600
-Material & Supplies	600
SUB TOTAL	$3,300
SYSTEM TOTAL	$66,750

ADDITIONAL EXPENSES

Contingency based on soil boring results:	
One angled sparge well and two angled vapor extraction wells.	$18,300
Remove and reimburse for trees (estimated)	500
Electrical power line location change if required	5,000+
Installation of MW-5 if required	1,200
ADDITIONAL TOTAL	$25,000+

+ This cost is estimated by Head of The Lakes Electrical Co-Op, it could be substantially higher depending on the amount of power line which requires relocation.

Table 8-1 Anticipated schedule for soil/groundwater remediation and sampling activities at the Moose Junction Lounge LUST site.

Work schedule
Week # Activity

1. After workplan approval by both the WDNR and DILHR, an air emissions permit will requested. EBI will arrange subcontractors and procure supplies. Ensure site access permits are current and complete dissolved oxygen baseline.

3. Install air sparging/vapor extraction wells. Electrical power lines will be moved if necessary.

4. Install regeneration pumps, electrical panel, connect electrical system to power source, build sheds, remove trees, and coordinate activities with the WDNR.

6. Pilot test system start-up, monitor system, set optimum rates.

7. Determine if system will remediate soils and groundwater, write treatability report.

8. First groundwater sampling after system (all wells)

12. Install additional air sparging/vapor extraction components, if required

14. Start complete remedial system.

16. Second groundwater sampling (MW-2 only)

18. Third groundwater sampling event (MW-2 only)

20. Fourth groundwater sampling, (all wells); examine groundwater data to determine remedial results.

24. If the groundwater analytics indicate remediation is complete, the system will be shut-down.

32. Fifth groundwater sampling; evaluate groundwater data, either restart system or plan system removal.

44. Sixth groundwater sampling event.

56. Seventh groundwater sampling event.

70. Eighth groundwater sampling, if analytical results are below WDNR enforcement standards for one year, site closure will be requested.

4.0 STANDARD OF CARE

The conclusions contained in this report represent our professional opinion. These opinions were arrived at in accordance with currently accepted environmental practices. No warranty is implied or intended.

Prepared By:

Roger W. Biebl

Roger W. Biebl
Project Hydrogeologist

Reviewed By:

Les Conway

Les Conway PE
Consulting Engineer

APPENDIX A
Groundwater Analytical Results - August, 1995

LAKE SUPERIOR LABORATORIES

728 GARFIELD AVENUE ■ DULUTH, MINNESOTA 55802
MN (218) 722-1911 ■ FAX (218) 722-3295

A DIVISION OF TWIN PORTS TESTING, INC.

Date: 09/14/95

Client: Earth Burners Inc.
500 Leisure Street
P.O. Box 16083
Duluth, MN 55816

Attn: Jim Warren

Phone: (218) 628-0454

Fax: (218) 628-0455

Chain of Custody #: 12916

Project: Moose Junction Lounge

Project ID: 9308

LAB ID #	SAMPLE ID
3724-95LS	MW-2
3725-95LS	MW-4
3726-95LS	MW-1
3727-95LS	MW-3

REVISED

Signature Timothy A. Buck

Linda Thiry, Director
Tim Buck, Lab Manager

Wis. Certification Number: 816057440

Minn. Certification Number: 027-137-307

This cover page is the first of _____ pages

Quality Assurance / Quality Control Report

Client: Earth Burners Inc.

Chain Of Custody #: 12916

Project: Moose Junction Lounge

Project ID: 9308

QC Parameter	Blank	Soil Blank	Duplicate	Spike	Spike Duplicate	Soil Spike	Soil Spike Duplicate
GRO	Pass	NA	NA	Pass	Pass	NA	NA
BTEX/PVOC	Pass	NA	NA	Pass	Pass	NA	NA

Remarks REVISED REPORT

Client
Earth Burners Inc.
500 Leisure Street
P.O. Box 16083
Duluth, MN 55816

Project: Moose Junction Lounge
Project ID: 9308

Collected By: Wayne Orrey
Delivered By: Wayne Orrey

Analysis	Date Analyzed	MDL	Chem. Lab ID: 3724-95LS	3725-95LS	3726-95LS
			Sample Type: Water	Water	Water
			Collected: 08/07/95	08/07/95	08/07/95
			Received: 08/08/95	08/08/95	08/08/95
			Reported: 08/16/95	08/16/95	08/16/95
			Sample Description: MW-2	MW-4	MW-1
MTBE	08/11/95	0.00500 mg/l	ND	ND	ND
Benzene	08/11/95	0.00500 mg/l	33.4 mg/l	0.00583 mg/l	0.00841 mg/l
Toluene	08/11/95	0.00500 mg/l	34.3 mg/l	0.00546 mg/l	ND
Ethylbenzene	08/11/95	0.00500 mg/l	1.95 mg/l	ND	ND
Total Xylene	08/11/95	0.00500 mg/l	12.1 mg/l	ND	ND
1,3,5 Trimethylbenzene	08/11/95	0.00500 mg/l	<1.00 mg/l	ND	ND
1,2,4 Trimethylbenzene	08/11/95	0.00500 mg/l	1.82 mg/l	ND	ND
Gasoline Range Organics	08/11/95	0.100 mg/l	125 mg/l	ND	0.201 mg/l

Remarks

REVISED REPORT

3724-95LS Elevated detection limit due to dilution effect.

MDL ⇒ Method Detection Limit
ND ⇒ Not Detected at or above MDL

LABORATORY ANALYSIS REPORT

Client
Earth Burners Inc.
500 Leisure Street
P.O. Box 16083
Duluth, MN 55816

Project: Moose Junction Lounge
Project ID: 9308

Collected By: Wayne Orrey
Delivered By: Wayne Orrey

Chem. Lab ID	3727-95LS		
Sample Type	Water		
Collected	08/07/95		
Received	08/08/95		
Reported	08/16/95		
Sample Description	MW-3		

Analysis	Date Analyzed	MDL			
MTBE	08/11/95	0.00500 mg/l	ND		
Benzene	08/11/95	0.00500 mg/l	0.0559 mg/l		
Toluene	08/11/95	0.00500 mg/l	ND		
Ethylbenzene	08/11/95	0.00500 mg/l	ND		
Total Xylene	08/11/95	0.00500 mg/l	ND		
1,3,5 Trimethylbenzene	08/11/95	0.00500 mg/l	ND		
1,2,4 Trimethylbenzene	08/11/95	0.00500 mg/l	ND		
Gasoline Range Organics	08/11/95	0.100 mg/l	0.107 mg/l		

Remarks

REVISED REPORT

MDL ⇒ Method Detection Limit
ND ⇒ Not Detected at or above MDL

SERIAL NUMBER

№ 12916

LAKE SUPERIOR LABORATORIES

728 GARFIELD AVENUE • DULUTH, MINNESOTA 55802
MN (218) 722-1911 • FAX (218) 722-3295

A DIVISION OF TWIN PORTS TESTING, INC.

LABORATORY REQUEST AND CHAIN OF CUSTODY RECORD

Project Name/No. Moose Junction Lounge P.O. # _____

Client EARth Burners Report To Earth Burners

Address _____

Bill To EARth Burners

Phone (218) 625-0454

Remarks

Sampler Signature Wayne Orrey

Sampler (Print) Wayne Orrey

Sample No./Location	Date	Time	Matrix: Air	Matrix: Liquid	Matrix: Solid	Number Of Containers	Preservative	Analyses: GRO/PVOC	LSL No.
mw 3	8-7	2:22		X		3		3	3724
mw 4	8 7	2:50		X		3		3	3725
mw 1	8 7	3:30		X		3		3	3726
mw 2	8 7	4:10		X		3		3	3727

Relinquished By	Date/Time	Received By	Relinquished By	Date/Time	Received By
Wayne Orrey	8-8-	Cindy			
Relinquished By	Date/Time	Received By	Relinquished By	Date/Time	Received By
		Lange 8-8-95			

Turnaround Time: 24 Hour Rush X 2-5 Day _____ 2 Week _____

APPENDIX B
Grain Size Analysis

WORK SHEET FOR SIEVE ANALYSIS OF GRANULAR MATERIAL

MINNESOTA DEPARTMENT OF TRANSPORTATION PIT:

S.P. NO. Moose Junction Lowmyer	DATE: 10/18/95	TEST NO. MW-2 Archive Sample
CLASS: Fine to medium Sand (SP)	STATION:	LAYER:
TOTAL WT. OF SAMPLE LBS.	TEST MADE BY Roger Bub)	

COARSE SIEVES:	(1) INDIV. WEIGHTS	(2) SIEVE SIZE	(3) CUMULATIVE WTS. PASSING	(4) TOTAL % PASSING	GRADATION REQUIREMENTS
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. ____" Sieve					
*Pass. ____" Sieve, Ret. Bottom					
Check Total –		– Shall check Total Wt. Within 0.2 Pounds			

*Enter necessary sieve sizes for class of material to be tested.
Column (1) Enter weights of material between each set of sieves individually.
Column (2) Enter the passing sieve size.
Column (3) Add columns (1) from bottom up to get cumulative weights passing each sieve.
Column (4) Divide columns (3) by check total of sample to get total % passing.

FINE SIEVES:

(A) Take two samples identical in condition and damp weight from "passing _____ material".
(B) Dry one sample and record weight 148.0
(C) Wash and dry other sample and record weight _____
(D) Loss in washing (B-C) (Enter below) _____

Grain Size (mm) (Approx)

	(5) INDIV. WEIGHTS	(6) SIEVE SIZE	(7) CUM. WTS. PASSING	(8) CUM. % PASSING	(9) ~~% PASSING~~ OF TOTAL PASS	GRADATION 2% ~~REQUIREMENTS~~
*Pass. # 10 Sieve, Ret. # 20	10.2	10	147.0	100	1.68	6.9
*Pass. # 20 Sieve, Ret. # 40	11.5	20	136.8	93	0.84	7.8
*Pass. # 40 Sieve, Ret. # 80	105.0	40	125.3	85	0.42	71.4
*Pass. # 80 Sieve, Ret. # 100	5.3	80	20.3	14	0.20	3.6
*Pass. # 100 Sieve, Ret. # 200	11.1	100	15.0	10	0.15	7.6
*Pass. # 200 Sieve, Ret. Bottom	3.9	200	3.9	3	0.07	2.7
Loss By Washing –						
Check Total –	147.0	– Shall check (B) within 5 grams.				
Percent Passing # 200 Sieve Divided By Percent Passing 1" Sieve (if specified)						

Column (5) Enter weights of material between each set of sieves and loss by washing. (DO NOT OVERLOAD SIEVES)
Column (6) Enter passing sieve size.
Column (7) Add column (5) from bottom up to get cumulative weights passing each sieve. Be sure to add loss by washing to weight of material passing #200 sieve by dry sieving to get first entry at bottom of column (7).
Column (8) Divide column (7) by check total dry weight of fine sample (Column 5) to get cumulative % passing.
Column (9) Multiply column (8) by % passing final sieve from column (4) to get "Percent Passing" based on total sample.

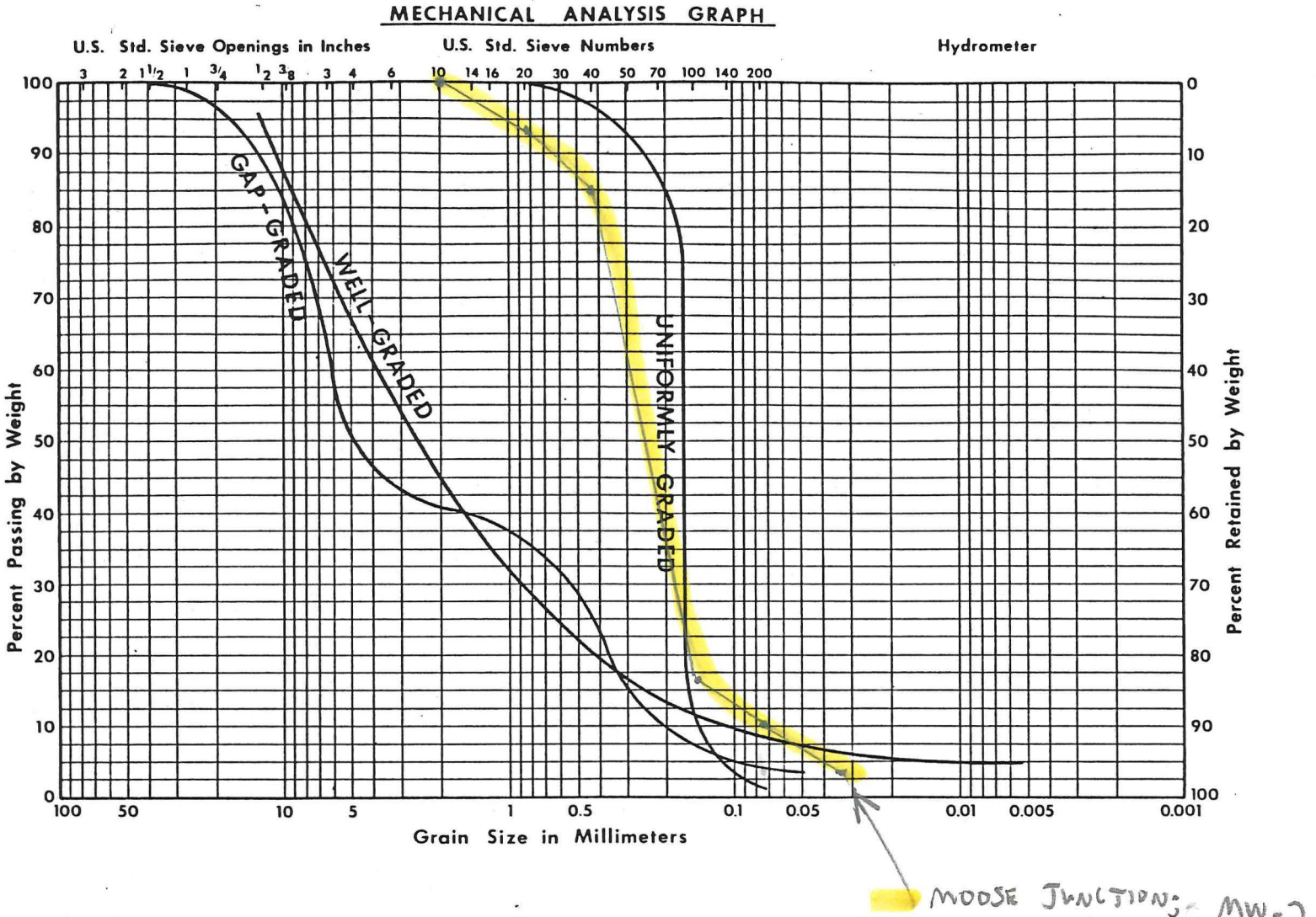

Fig 5-1. Grain size distributions showing one well-graded and two poorly-graded (uniformly-graded and gap-graded) soils.