HERITAGE ENVIRONMENTAL SERVICES, INC.

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Indianapolis, IN 46251
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October 25, 1995

HARMAN-MOTIVE, INC.
Site # 1996-06-183
Site Characterization

Mr. Rick Herold
Plant Engineering Manager
Harman-Motive Inc.
1201 South Ohio St.
Martinsville IN 46151

Re: Hydrogeologic Assessment
Harman-Motive Inc.
Martinsville, Indiana

Dear Mr. Herold:

This letter transmits a copy of the assessment conducted at 1201 South Ohio Street in Martinsville. This investigation phase of work provides a summary of the soil and ground water investigations conducted by Heritage Environmental Services, Inc. (Heritage) and earlier information collected by others. It also includes a description of the proposed remediation technology.

The report describes the extent of ground water impact by various hydrocarbon and chlorinated volatile organic compounds (solvents). Numerous wells have been installed at the facility and they can be used as monitoring wells and remediation (air injection or vapor extraction) wells.

Contaminated ground water is leaving the Harman-Motive facility and has impacted areas to the west, but contaminated ground water also appears to be migrating onto the Harman property from the northeast. The potential for human exposure in the residential area west of the facility is believed to be low but follow-up activities will include a door to door survey to confirm no ground water usage in that area.

If you have any questions about this report or the nature of activities to follow, please contact us at (317) 243-7475.

Sincerely,

HERITAGE ENVIRONMENTAL SERVICES, INC.

DAO/TR

Douglas A. Opell, CPG
Senior Project Geologist

Thomas E. Roberts

Thomas E. Roberts, PE
Vice President

cc: R. Herold, Harman-Motive Inc.
M. Baugh, Harman-Motive Inc.
K. Mallin, Heritage
D. Copsey, Heritage

DAO/pjw

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HYDROGEOLOGIC ASSESSMENT REPORT

Harman-Motive, Inc.
1201 South Ohio Street
Martinsville, Indiana 46151

Prepared by:

Heritage Environmental Services, Inc.
Remediation/Engineering Group
P. O. Box 51020
Indianapolis, IN 46251

October 25, 1995

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1.0 INTRODUCTION

This report prepared by Heritage Environmental Services, Inc. (Heritage) on behalf of Harman-Motive, Inc., provides a hydrogeologic assessment for the Harman-Motive facility located in Martinsville, Indiana. The assessment was conducted in response to the discovery of subsurface volatile organic compound contamination during foundation test drilling for a building expansion/renovation. Initial investigations were conducted by ETS (Indianapolis) and those investigations involved drilling soil borings and the collection of ground water samples in the eastern portion of the Harman-Motive manufacturing building.

Heritage was retained to conduct further environmental investigations and to design and implement remedial measures at the site. The building expansion scheduling required that the investigation and installation of a remedial system be developed and installed on an expedited schedule. The remedial system was designed to accommodate the aesthetic features of the building renovation. Wells for ground water monitoring, soil vapor extraction, and subsurface air sparging have been installed inside and outside of the manufacturing building.

The results of the assessment indicate that hydrocarbon solvents and chlorinated solvents are present in the ground water at the site. It appears that there are three general source areas for the volatile organic compounds (VOCs). Chlorinated VOCs are associated with the eastern portion of the plant and data suggest that a source is present toward the northeast of the Harman property. The hydrocarbon VOCs appear to have a source area in the east portion of the plant and toward the southwest corner of the Harman-Motive building. Harman-Motive has never used chlorinated VOCs.

Ground water occurs at a depth of about 10 to 12 feet below grade at the site and subsurface geologic materials are comprised of sand. The ground water flow is toward the west-southwest.

The impact of the VOCs to the subsurface covers a large portion underlying the manufacturing building, complicating access for investigation and the application of

remediation technologies. Additionally, the off-site migration of the compounds along the western property boundary may cause further administrative problems. Off-site investigations, to date, have been confined to the City of Martinsville street right-of-ways.

Harman-Motive has determined that all nearby residents have city-supplied drinking water available, with the exception of one residence. Heritage installed a ground water monitoring well in front of the residence and no volatile organic compounds have been detected in that well. Harman-Motive will offer to connect that residence to the City of Martinsville water supply.

A remediation plan has been developed which incorporates the use of soil vapor extraction, air sparging, and *in situ* degradation of chlorinated solvents using a patented technique of bacterial cometabolism. Existing subsurface bacterial populations will be augmented via proprietary methods to optimize the *in situ* degradation of the volatile organic compounds.

1.1 Facility History

Portions of the structure that is now occupied by Harman-Motive have been the site of several different manufacturing operations since about the 1950's. Harman-Motive produces high quality automotive speakers for various domestic and foreign automobile manufacturers. Harman-Motive operates two shifts over a 5-day work week and is Martinsville's largest employer.

The facility has been used by other companies and reportedly, portions of the facility were even used as a slaughter house in the early 1950's or possibly late 1940's. A historic (Sanborn) map search was conducted but no historic maps were available for the area. Other companies and products manufactured at the site have included:

Year	Company	Product
1955	Basco Aluminum	Colored Aluminum glasses and pitchers
1960	Twigg (Altamil)	Government contract aircraft division. Boeing engine.
1973	Altamil Cabinet	Kitchen and bath cabinets
Oct. 1975	Essex (UTC)	First production Dec. 1975, automotive horn pads.
Jan. 1976	Essex (UTC)	First speakers. Chrysler 406 short line.
1977	Essex (UTC)	Cabinet speaker line, Essex, Kimball, Bose, Dukane, Peavy. Continued OEM Chrysler.
1978	UTC	Expanded automotive OEM.
1980	UTC	Design engineering moved from Ohio.
July 1981	Harman-Motive	Automotive OEM speakers.

As a part of speaker manufacturing, acetone was previously used by Harman-Motive as a glueline and paint gun flushing material. Acetone wastes resulting from those operations were managed as a supplemental fuel in the past or recycled on site. The suspected sources of the acetone contamination were eliminated by Harman-Motive in 1993. Acetone is still used as a cleaning agent.

2.0 SITE LOCATION

The mailing address for the facility is:

Harman-Motive, Inc.
1201 South Ohio Street
Martinsville, IN 46151

The facility contact is Mr. Michael Baugh, Safety and Environmental Manager at (317) 342-5551.

The facility is located on the Martinsville, Indiana 7.5-minute U.S. Geological Survey quadrangle map in the SE ¼ of Section 4 in Township 11N, Range 1E (Figure 1). The surrounding land use is mainly metropolitan with industrial and residential areas adjacent to the facility. The facility is served by the Martinsville sewer system and various other utilities.

Harman-Motive owns about 21 acres, of which 4 acres comprise the manufacturing building and an on-site warehouse. The property also includes a large multi-use fitness field to the south of the manufacturing building, and parking lots and shipping/receiving areas to the north and northeast. A residential-light industrial area is toward the east, and a residential area is toward the west of the manufacturing facility. A summer 1995 aerial photograph of the area is provided as Figure 2.

2.1 Geologic Conditions

The City of Martinsville lies within an area just beyond the maximum extent of Wisconsinan glacial ice advances some 15,000 to 20,000 years ago. Melting of the glaciers, to the north, caused erosion of the adjacent landsurface and bedrock and formed a large outwash valley, which today is associated with the White River. The glacial deposits in the outwash valley are dominated by sand and gravel. The outwash sand and gravel provides a highly abundant source of good quality ground water, although treatment for high hardness,

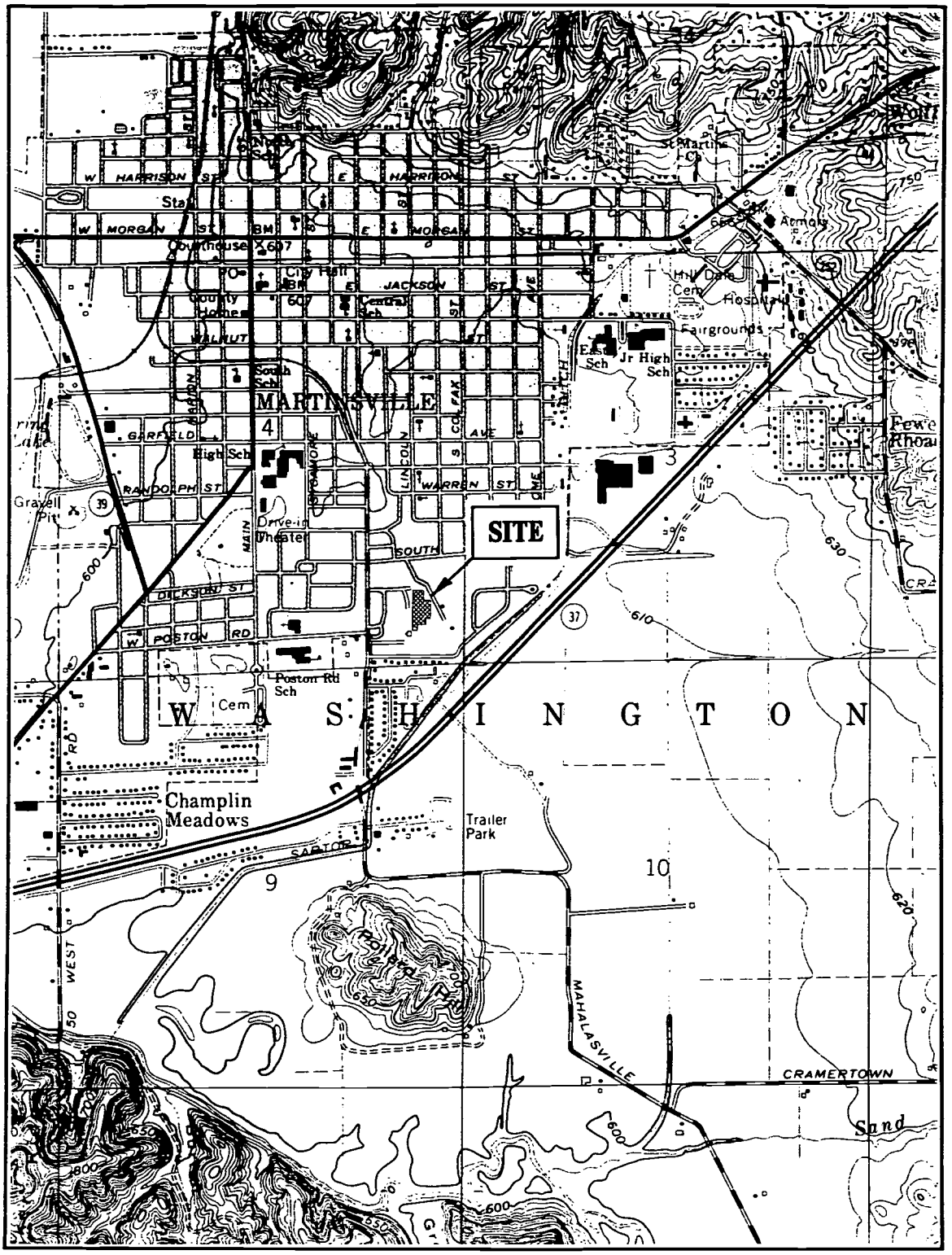


FIGURE 1

REF: USGS 7.5 MINUTE SERIES
INDIANA – MARTINSVILLE QUADRANGLE

SCALE: 1"=2000'

0 1000 2000

HARMAN–MOTIVE, INC.
MARTINSVILLE, INDIANA

SITE LOCATION MAP

DRAWN BY: JFH		DATE:	8-29-95
APP. BY: DAO		SCALE:	1" = 2000'
JOB NO. 80025		DWG.	B9980025

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

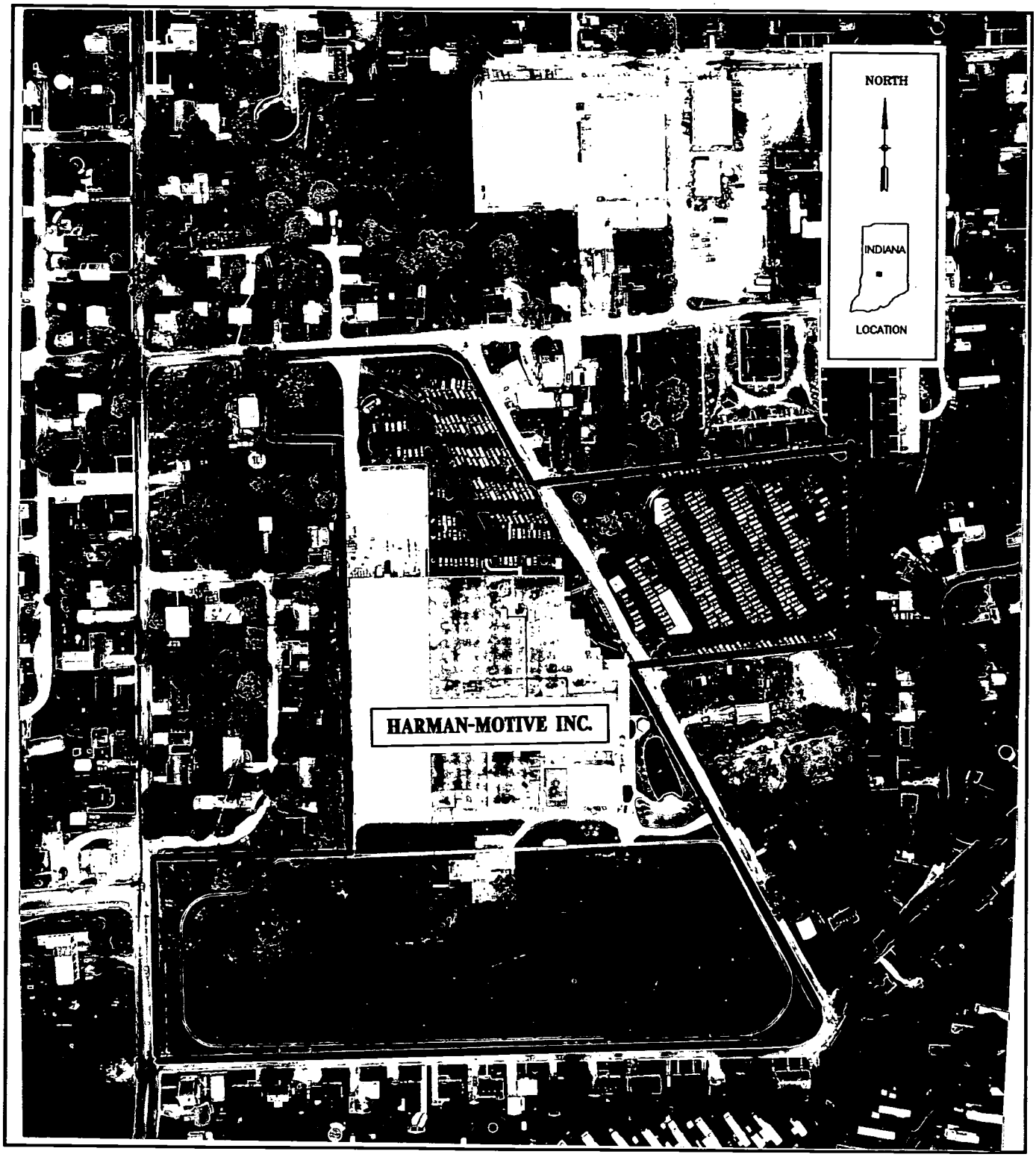


FIGURE 2

HARMAN–MOTIVE, INC. MARTINSVILLE, INDIANA	
AERIAL PHOTOGRAPH – JUNE 1995	
DRAWN BY: JFH APP. BY: DAO JOB NO. 80025	DATE: 10–26–95 SCALE: APPROX. 1" = 250' DWG. D6480025
HERITAGE ENVIRONMENTAL SERVICES, INC. INDIANAPOLIS, INDIANA	

miles northwest and hydraulically upgradient from the Harman-Motive site (Figure 3). The Harman-Motive facility is connected to the water utility and does not have any water production wells.

Harman-Motive has interviewed officials with the City of Martinsville water utility and all residences immediately downgradient from the impacted site are served by the water utility with one exception. One downgradient water well has been identified by Harman-Motive located at 1240 S. Ohio St. The water well at that address is reportedly about 20 feet deep. A ground water monitoring well (MW-20) was installed by Heritage in Ohio Street immediately upgradient from this residence and the sampling results did not disclose any VOCs.

A survey of located water well logs on file with the Indiana Department of Natural Resources, Division of Water was conducted previously by ETS. The located water well logs on file at the IDNR indicated that the nearest water well log is about 3000 feet downgradient from the site (see Figure 3;log elevation point 582). The well log for the 1240 S. Ohio St. was not in the IDNR well log file. A log for a monitoring well installed as a part of the U.S. Geological Survey (1982 study) was located in the IDNR files. The USGS well was apparently installed near the southeast corner (hydraulically upgradient) of the Harman-Motive property (see Figure 3; point #46). This well could not be located during this investigation.

Files containing significant water users in the Martinsville area revealed only the City of Martinsville well field and the Harman-Motive facility. The well at the Harman site was sealed and abandoned in 1991. The well was a 6" diameter well, 102 feet deep. The well was used by Harman-Motive for cooling water up to 1990.

As is discussed in Section 4, Harman-Motive will conduct a door to door survey at the locations immediately downgradient from the facility to determine if basements or old out-of-use water wells (pitcher pump wells) are present.

3.0 SITE INVESTIGATION

The initial investigations at the site were conducted by ETS, Inc. (Indianapolis) and subsequent investigations have been conducted by Heritage. Investigations by Heritage have also included the installation of on-site and off-site monitoring wells and pilot scale testing of proposed remedial technologies.

3.1 Borings

Harman-Motive first became aware of subsurface impacts after ETS drilled geotechnical borings for the building renovation and expansion on the eastern side of the plant. Harman-Motive requested and ETS conducted 16 GeoProbe borings in the area where soils were noted to display an odor. These GeoProbe investigations revealed concentrations of acetone, methyl ethyl ketone (MEK), methy isobutyl ketone (MIBK), tetrachloroethene or perchloroethene (PCE), and xylenes at depths from 5 to 11 feet below grade in soils and the shallow ground water. The geologic materials in these shallow borings were described as silty sands in the near surface grading to fine and medium sand with depth. Follow up work conducted by ETS included installation of three (3) shallow ground water monitoring wells at the perimeter of the site. Table 1 provides a summary of the soil and ground water sampling results from the ETS investigations and Figure 4 provides a location map of the borings/sampling points installed by ETS and Heritage.

Heritage has drilled a total of 39 soil borings at the site and all but one of the borings were followed by installation of a monitoring well or a well for remediation purposes (Figure 4). In addition, a total of 6 shallow (less than 8 feet) borings were drilled and will be used as soil vapor extraction wells. Heritage borings were logged by a Heritage geologist or engineer and samples were field screened using a PID or OVA meter. Boring logs are in Appendix 1. The Heritage borings were installed using standard hollow-stem auger techniques with split spoon sampling at selected intervals. All drilling augers were decontaminated between borings using a hot water pressure washer and all sampling equipment used for collection of samples for laboratory analysis

Table 1
Harman-Motive, Inc.
Martinsville, IN
ETS Soil and Groundwater Results (4/95)

Analyte/Boring Identification	GP-1 03/30/95	GP-2 03/30/95	GP-3 (soil) 03/30/95	GP-4 03/30/95	GP-5 03/30/95	GP-6 03/30/95	GP-7 03/30/95	GP-8 03/30/95	GP-9 03/30/95
Acetone	<10	N/A	670	890	N/A	15,000	<10	N/A	N/A
Ethylbenzene	<2.0	N/A	<5.0	<2.0	N/A	2.1	<2.0	N/A	N/A
Methyl Ethyl Ketone	<10	N/A	24	<10	N/A	180	<10	N/A	N/A
Methyl Isobutyl Ketone (MIBK)	<10	N/A	<10	<10	N/A	12	<10	N/A	N/A
Toluene	<2.0	N/A	<5.0	6.7	N/A	44	<2.0	N/A	N/A
Total Xylenes	<2.0	N/A	15	<2.0	N/A	5.6	<2.0	N/A	N/A
Chloromethane	<2.0	N/A	<5.0	<2.0	N/A	<2.0	<2.0	N/A	N/A
1,1-Dichloroethane	<2.0	N/A	<5.0	<2.0	N/A	<2.0	<2.0	N/A	N/A
1,1-Dichloroethene	<2.0	N/A	<5.0	<2.0	N/A	<2.0	<2.0	N/A	N/A
1,2-Dichloroethene (Cis and Trans)	<2.0	N/A	<5.0	<2.0	N/A	<2.0	200	N/A	N/A
Tetrachloroethene	52	N/A	<5.0	97	N/A	67	210	N/A	N/A
1,1,1-Trichloroethane	<2.0	N/A	<5.0	<2.0	N/A	<2.0	<2.0	N/A	N/A
Trichloroethene	<2.0	N/A	<5.0	2.3	N/A	<2.0	46	N/A	N/A
Vinyl Chloride	<2.0	N/A	<5.0	<2.0	N/A	<2.0	11	N/A	N/A
Non Chlorinated Volatile Organics	0	0	709	896.7	0	15,243.7	0	0	0
Chlorinated Volatile Organics	52	0	0	99.3	0	67.0	467	0	0
Total Volatile Organics	52	0	709	996	0	15,310.7	467	0	0

N/A - Not Analyzed

All concentrations reported as micrograms per liter (ug/L)

Soil Samples GP-3 and I-2 are reported as ug/kg.

Table 1
Harman-Motive, Inc.
Martinsville, IN
ETS Groundwater Results (5/95)

Analyte/Boring Identification	I-1 05/08/95	I-2 (soil) 05/08/95	I-3 05/08/95	I-4 05/08/95	I-5 05/08/95	I-6 05/08/95	I-7 05/08/95
Acetone	510	3,600,000	1,200	8,900,000	3,600,000	N/A	N/A
Benzene	<10	<50	2.2	<40	<40	N/A	N/A
Ethylbenzene	26	<50	3.3	66	150	N/A	N/A
Methyl Ethyl Ketone	<50	18000	<10	11000	350	N/A	N/A
Methyl Isobutyl Ketone (MIBK)	<50	140	<10	2400	<200	N/A	N/A
Toluene	<10	<50	<2.0	170	96	N/A	N/A
Total Xylenes	<10	<50	9.4	260	560	N/A	N/A
Chloromethane	<10	<50	<2.0	<40	<40	N/A	N/A
1,1-Dichloroethane	<10	<50	<2.0	<40	<40	N/A	N/A
1,1-Dichloroethene	19	<50	<2.0	<40	<40	N/A	N/A
1,2-Dichloroethene (Cis and Trans)	2600	<50	<2.0	<40	<40	N/A	N/A
Tetrachloroethene	<10	<50	6.1	<40	<40	N/A	N/A
1,1,1-Trichloroethane	<10	<50	<2.0	<40	<40	N/A	N/A
Trichloroethene	<10	<50	<2.0	<40	<40	N/A	N/A
Vinyl Chloride	3000	<50	<2.0	<40	<40	N/A	N/A
Non Chlorinated Volatile Organics	536	3,618,140	1,214.9	8,913,896	3,601,156	0.0	0.0
Chlorinated Volatile Organics	5,619	0	6.1	0	0	0.0	0.0
Total Volatile Organics	6,155	3,618,140	1,221.0	8,913,896	3,601,156	0.0	0.0

N/A - Not Analyzed

All concentrations reported as micrograms per liter (ug/L)

Soil Samples GP-3 and I-2 are reported as ug/kg.

were washed with detergent and water followed by a distilled water rinse. Soil residues from drilling were contained in roll-off boxes at the site and later disposed at Adams Center Landfill as a non-hazardous material. Decontamination fluids and well purge waters were discharged to the City of Martinsville sanitary sewer under Harman-Motive's permit with the City.

In addition to the wells installed by ETS and Heritage, one well installed on the City right-of-way was sampled. That well, identified in this report as off-site railroad well, is believed to have been installed as a part of investigations at the Twigg Corp., located hydraulically upgradient (northeast) from the Harman-Motive facility. Ground water from that well displayed a variety of chlorinated VOCs.

3.2 Wells

Three (3) ground water monitoring wells were installed by ETS and a total of 38 ground water monitoring wells were installed by Heritage. A total of 6 shallow soil vapor extraction wells have also been installed by Heritage. One well (MW-6) installed during the initial Heritage investigations was destroyed during building construction activity and was replaced later with well MW-6R. All wells were installed using hollow stem auger techniques and well logs were maintained by a Heritage geologist (Appendix 1). The monitoring wells are set at depths of about 20 feet and 40 feet below grade and deep air sparging wells are set to about 54 to 70 feet below grade. All wells monitor the same sand outwash deposit. The only confining layer present appears to be at or very near the base of the outwash. The confining layer has not been penetrated by investigation borings/wells. Table 2 summarizes the depth information, screened interval and horizontal control coordinates for all wells installed at the site.

Table 2
Harman-Motive, Inc.
Martinsville, IN
Summary Well Data

WELL DESIGNATION	X COORD.	Y COORD.	ELEVATION		Top of Screened Interval		Total Depth (Bottom of Screen)	
			Ground	Riser	Depth*	Elev.	Depth*	Elev.
ETS-MW-1	5791.59	5854.28	603.38	603.10	10.21	592.89	20.21	582.89
ETS-MW-2	5818.25	4963.61	602.26	601.99	9.74	592.25	19.74	582.25
ETS-MW-3	5037.48	4991.77	602.16	601.93	9.61	592.32	19.61	582.32
MW-2	5752.59	5524.45	604.73	604.47	7.67	596.80	17.67	586.80
MW-3	5723.49	5563.60	605.06	604.82	8.77	596.05	18.77	586.05
MW-5	5788.44	5480.33	604.88	604.75	7.47	597.28	17.47	587.28
MW-6	5852.69	5505.42			6.80		16.80	
MW-6R	5875.83	5515.28	603.50	603.29	7.22	596.07	17.22	586.07
MW-7	5854.95	5423.28	603.74	603.43	5.07	598.36	15.07	588.36
MW-8	5934.81	5415.36	603.75	603.52	5.92	597.60	15.92	587.60
MW-9	5348.70	5635.11	603.53	602.97	9.90	593.07	19.90	583.07
MW-10	5344.66	5517.62	603.56	603.05	9.73	593.32	19.73	583.32
MW-13	5578.18	5562.21	604.62	604.11	6.97	597.14	16.97	587.14
MW-15	5810.77	5318.82	602.38	601.60	8.12	593.48	18.12	583.48
MW-16	5799.34	5630.99	604.71	604.40	7.89	596.51	17.89	586.51
MW-17	5340.55	5419.25	603.21	602.80	7.04	595.76	17.04	585.76
MW-18	5350.93	5734.00	603.97	603.69	8.11	595.58	18.11	585.58
MW-19	5350.20	5832.73	604.29	603.86	7.10	596.76	17.10	586.76
MW-20	4996.24	5689.52	603.78	603.48	7.17	596.31	17.17	586.31
MW-21	5002.35	5850.44	604.04	603.76	7.95	595.81	17.95	585.81
MW-22	5215.27	5563.55	602.56	602.24	7.39	594.85	17.39	584.85
MW-23	5218.50	5713.62	602.82	602.19	7.11	595.08	17.11	585.08
MW-24	5356.62	5934.57	603.66	603.40	6.90	596.50	16.90	586.50
MW-25	5353.62	6041.15	603.96	603.60	7.95	595.65	17.95	585.65
MW-26	4990.79	5452.78	603.45	603.03	7.81	595.22	17.81	585.22
MW-27	5208.31	5413.76	603.37	602.00	7.94	594.06	17.94	584.06
MW-28	5338.24	5257.14	601.54	601.09	6.77	594.32	16.77	584.32
MW-29	5536.99	5318.51	602.30	601.94	6.86	595.08	16.86	585.08
MW-30	5815.08	5219.60	602.95	602.52	6.61	595.91	16.61	585.91
MW-31	5594.88	6106.19	605.07	604.67	7.90	596.77	17.90	586.77
MW-32	5792.34	5719.64	604.04	603.70	7.85	595.85	17.85	585.85
MW-33	5035.22	5278.23	602.91	602.34	7.74	594.60	17.74	584.60
RR Well	5562.97	6232.48	604.62	604.35	14.74	589.61	24.74	579.61
DMW-7	5854.58	5427.39	603.79	603.53	29.95	573.58	39.95	563.58
DMW-8	5933.21	5419.44	603.84	603.42	29.75	573.67	39.75	563.67
DMW-9	5343.33	5635.58	603.00	602.16	29.70	572.46	39.70	562.46
DMW-10	5339.06	5517.76	602.97	602.79	29.09	573.70	39.09	563.70
DMW-13	5573.64	5562.62	604.65	604.42	29.27	575.15	39.27	565.15
DMW-18	5346.78	5734.36	603.84	603.30	29.43	573.87	39.43	563.87
AS-1**	5753.52	5510.74	604.76	604.06	70.25	533.81	75.25	528.81
AS-2	5681.79	5538.37	604.56	604.32	53.93	550.39	63.93	540.39
AS-3**	5733.52	5561.78	605.08	604.83	58.80	546.03	63.80	541.03
AS-6**	5874.47	5511.75			59.50		64.50	
SVE-1	5778.90	5504.64	604.84	604.62			8.00	596.62
SVE-2							4.00	
SVE-7	5774.48	5450.15		603.95			7.00	596.95
SVE-8	5770.17	5568.28	605.10	605.72			7.00	598.72
SVE-9	5733.23	5480.98	604.90	605.52			7.00	598.52
SVE-10	5711.58	5603.73	605.13	605.73			7.00	598.73
SB-14	5481.12	5682.29	604.63				12.00	

All measurements are in feet

* - Measured from top of riser

** - Screened Interval is 5 feet in length (All other process monitoring wells are 10 feet in length).

X, Y and Elevation coordinates surveyed by Bledsoe and Tapp Surveyors

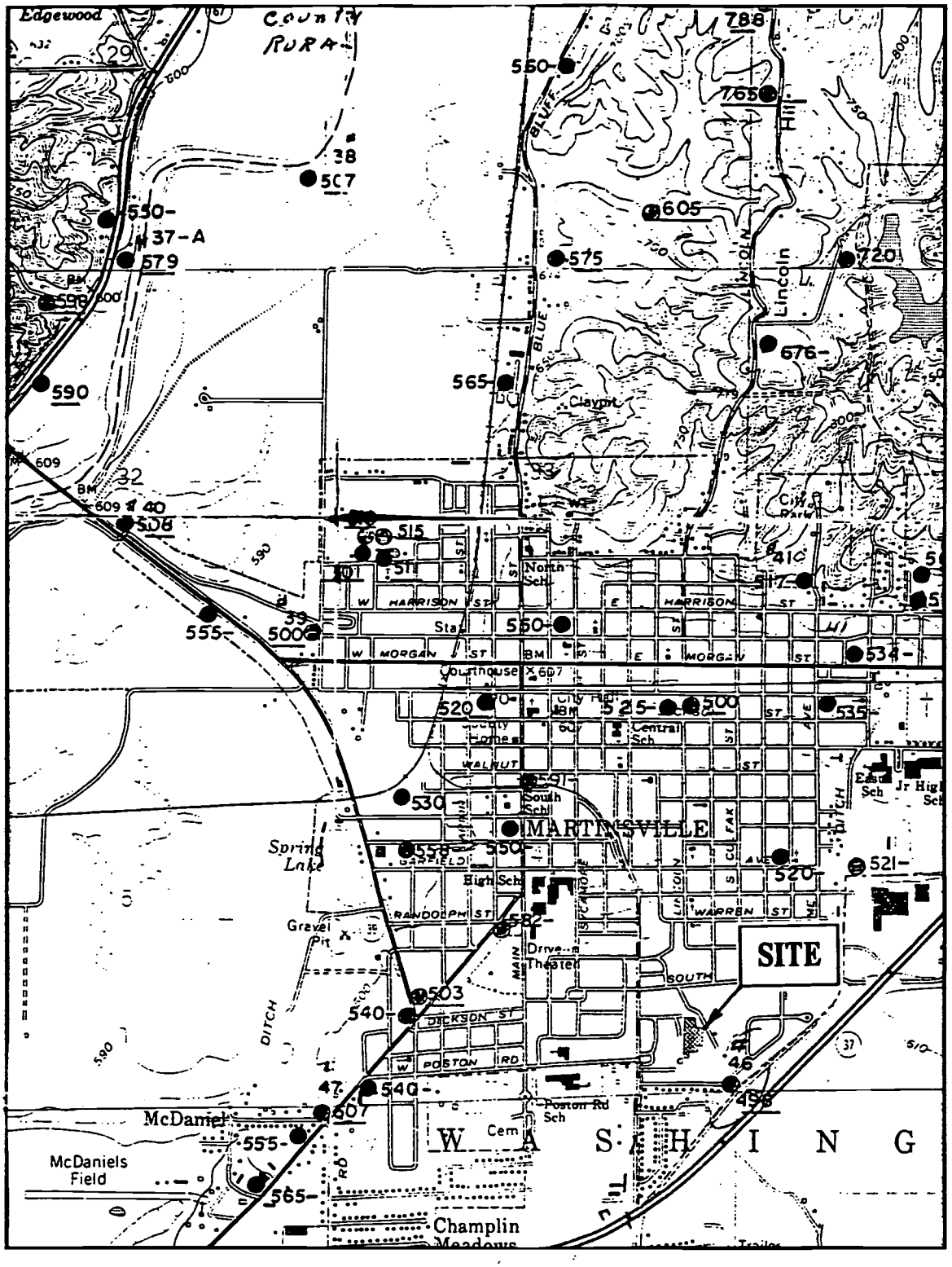


FIGURE 3

REF: USGS 7.5 MINUTE SERIES
INDIANA – MARTINSVILLE QUADRANGLE

SCALE: 1"=2000'

0 1000 2000

HARMAN–MOTIVE, INC.
MARTINSVILLE, INDIANA

IDNR WATER WELL LOCATIONS

DRAWN BY: JFH		DATE:	8-30-95
APP. BY: DAO	HERITAGE	SCALE:	1" = 2000'
JOB NO. 80025		DWG.	C0580025

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

dissolved iron and manganese is sometimes necessary. The water quality is also impacted by agricultural activities and sometimes locally displays elevated concentrations of nitrates (Bailey & Imbrigiotta, 1982). The Mississippian age bedrock strata (Borden Group), which underlie the outwash sand and gravel in the Martinsville area consist mainly of siltstones, shale and limestones and are not good sources of water supply.

The outwash valley in the general Martinsville region is up to 4 miles wide and the sand and gravel deposits can be up to 120 feet thick. Thin clay lenses are present only locally within this region and tend to occur near the base of the outwash (Bailey & Imbrigiotta, 1982). The hydraulic characteristics of the outwash deposits at the Harman-Motive facility are mapped as sand with a hydraulic conductivity of 40 feet/day (Bailey & Imbrigiotta, 1982). The sand outwash is about 70 feet thick under the site.

The geologic materials encountered by the borings drilled for this investigation are consistent with the literature information and data provided on Indiana Department of Natural Resources (IDNR) water well logs for the region. The subsurface geologic materials encountered are mainly fine to medium sand with minor amounts of coarser materials. A clay layer was encountered in two (2) of the Heritage borings at depths of approximately 72 and 74 feet below grade (see Appendix 1; logs for "AS" borings). A U.S. Geological Survey boring drilled previously at the southeast corner of the property for the 1982 study mentioned above encountered "hardpan" at a depth of 70 to 72 feet below grade.

2.2 Ground Water Use

Martinsville is served by a public water utility owned and operated by the City of Martinsville. The water supply wells for the public utility are located 1.25

All wells installed by Heritage and the three (3) ETS wells were surveyed for horizontal and vertical control by a licensed land surveyor (Bledsoe and Tapp; Bloomington, IN). Additionally, the one monitoring well identified as off-site RR well was surveyed.

The wells were designated with a prefix according to the intended function, *e.g.*, "MW" designates a monitoring well (approximately 20' depth); "DMW" a deep monitoring well; (approximate 40' depth); "AS" an air sparging well; "SVE" a soil vapor extraction well (approximate 4 to 8 feet depth). Some of the wells can actually have a dual function, *i.e.*, an air sparging well can also be used for a monitoring well.

An additional note regarding the construction of the wells is important. The subsurface area requiring intense remediation efforts underlies the constructed cafeteria in the eastern portion of the plant. These wells are installed within the closets and spaces between wall studs in the new building so that they would not be obtrusive. This installation was conducted by Heritage in conjunction with other building construction activities during the summer months of 1995.

3.2.1 *Ground Water Flow*

Ground water occurs in the water table outwash aquifer at depths from about 10 to 12 feet below grade. Based on the regional and site-specific information the ground water flow direction is toward the west/southwest. Potentiometric surface maps are presented as Figures 5, 6 and 7. It is noted that these potentiometric maps deviate slightly from an earlier map constructed by ETS using the three (3) ETS perimeter wells.


EAST SOUTH STREET
PARKING LOT
PARKING LOT
MW-21
592.21
MW-19
592.97
ETS-MW-1
594.06
MW-20
592.14
MW-23
592.55
MW-18
592.91
OHIO STREET
CLORA STREET
MW-9
592.83
MW-16
594.05
MW-22
592.49
MW-13
593.42
MW-3
593.81
MW-10
592.82
MW-2
593.88
MW-6R
594.17
MW-17
592.77
MW-5
594.10
HARMAN DRIVE
MW-15
593.98
TRACK
BRICK BUILDING
GRASS FIELD
ETS-MW-3
591.97
ETS-MW-2
593.64
PRATHER STREET
RESIDENTIAL
594
593.75
593.5
593.25
593.0
592.75
592.5
592.25
592
NORTH
KEY
MONITORING WELL
GROUND WATER FLOW DIRECTION
SCALE 1" = 150'
0 1/2" 1"
0 75' 150'
REVISIONS
HERITAGE
HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA
HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA
SHALLOW WELL POTENTIOMETRIC SURFACE MAP - AUG 30, 1995
DRAWN BY JFH
DATE OCT 24, 1995
PROJ. NO. 80025
DWG. NO. D4880025
APPROVED BY KM
SCALE 1" = 150'

FIGURE 5

EAST SOUTH STREET

OHIO STREET

OHIO STREET

PARKING LOT

PARKING LOT

HARMAN DRIVE

TRACK

BRICK BUILDING

GRASS FIELD

PRATHER STREET

MW-19
592.81

ETS-MW-1
593.88

MW-15
593.76

ETS-MW-3
591.81

ETS-MW-2
593.44

593.75

593.50

593.25

593.00

592.75

592.50

592.25

592.00

NORTH

KEY

MONITORING WELL

GROUNDWATER FLOW DIRECTION

FIGURE 6

SCALE: 1" = 150'

0 1/2" 1"

0 75' 150'

REVISIONS

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA

POTENTIOMETRIC SURFACE MAP - SEPT 5, 1995

DRAWN BY JFH	DATE OCT 26, 1995	PROJ. NO. 80025	DWG. NO. C5380025
APPROVED BY KM	SCALE 1" = 150'		

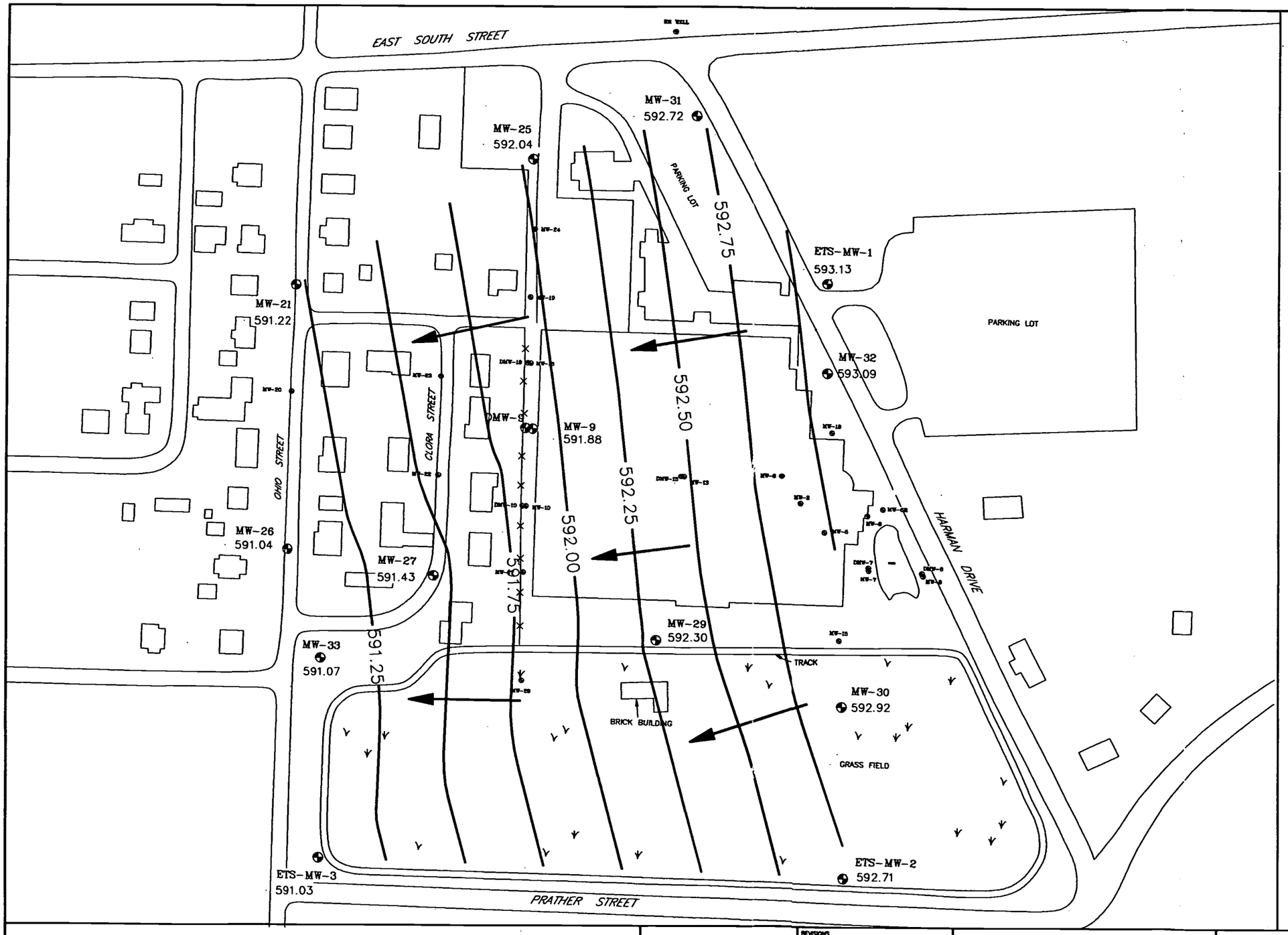

EAST SOUTH STREET
MW-31
592.72
MW-25
592.04
PARKING LOT
592.75
ETS-MW-1
593.13
MW-21
591.22
PARKING LOT
MW-32
593.09
OHIO STREET
CLORA STREET
DMW-9
MW-9
591.88
592.50
592.25
592.00
591.75
591.25
HARMAN DRIVE
MW-26
591.04
MW-27
591.43
MW-29
592.30
MW-33
591.07
TRACK
MW-30
592.92
BRICK BUILDING
GRASS FIELD
ETS-MW-2
592.71
ETS-MW-3
591.03
PRATHER STREET
NORTH
KEY
MONITORING WELL
GROUND WATER FLOW DIRECTION
SCALE 1" = 150'
0 1/2" 1"
0 75' 150'
REVISIONS
HERITAGE
HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA
HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA
SHALLOW WELL POTENTIOMETRIC SURFACE MAP
OCT 9, 1995
DRAWN BY JFH
DATE OCT 26, 1995
PROJ. NO. 80025
DWG. NO. D6280026
APPROVED BY TM
SCALE 1" = 150'

FIGURE 7

A deviation from the regional flow pattern is present near a landscaped pond located at the east end of the facility. Based on the data collected and observations of Harman-Motive staff, it appears that ground water is mounded locally around this pond and flow is likely somewhat radial from the pond. Harman-Motive is planning to place a liner in the pond, thereby eliminating the mounding effect.

Ground water velocity is estimated at 0.66 ft/day (243 ft/yr). This velocity is calculated from the average hydraulic gradient of 0.005 ft/ft, estimated hydraulic conductivity of 40 ft/day (Bailey and Imbrigotta, 1982) and an estimated porosity of 30%.

Based on the data collected there are no significant vertical gradients between the deep, intermediate and shallow wells at the site, *i.e.*, there is no significant vertical flow at the site.

3.2.2 *Ground Water Quality*

The ground water underlying the facility has been impacted by VOCs. The lateral extent of ground water impact covers a significant area. The vertical extent of contamination appears to range down to the approximate base of the sand unit at the maximum extent of contamination. Table 3 provides a summary of the analytical data for all wells installed by Heritage. All wells were sampled and analyzed using SW846-8240A/8260A and SW846-8021 methods during June through October 1995.

Wells were sampled using a polytetrafluoroethene (PTFE) bailer and dedicated polypropylene twine. All wells were purged of at least three (3) well volumes prior to sampling and field parameters including pH, specific conductance, dissolved oxygen and temperature were taken. The bailer was decontaminated between each well using a soap and water rinse followed by a triple rinse of laboratory grade organic-free water. Trip blanks and QA/QC blanks collected throughout the

sampling effort indicated that all trip, equipment and field blanks were clean with respect to VOCs. Data validation on 20% of the data indicate that all data is of good quality, using EPA data validation guidelines.

Table 3 provides a summary of the VOCs detected in the wells at the site and Figures 8 through 10 provide a isoconcentration plots of total VOCs, hydrocarbon VOCs and chlorinated VOCs dissolved in ground water.

Trends in the ground water quality reflect that both hydrocarbon VOCs, mainly acetone, and chlorinated VOCs are distributed throughout a large portion of the plant area, but different source areas are apparent. The eastern portion of the plant seems to be a source area for both chlorinated and hydrocarbon VOCs, off-site toward the northeast (Twigg Corp.) could be a source for chlorinated VOCs, and the southwest corner of the present Harman building structure seems to be a source of hydrocarbon VOCs (see Figures 8 through 10).

Table 3
Harman-Motive, Inc.
Martinsville, IN
Heritage Ground Water Results

Well Identification	AS-1	AS-2	AS-6	MW-2	MW-3	MW-5	MW-6	MW-6 (dup)	MW-6R	MW-7	DMW-7
Laboratory ID number	A346381	A348081	A350733	A346568	A346384	A346567	A346569	A346570	A350730	A346571	A346572
Total Well Depth (ft.)	75	65	65	18	19	17.5	17	17	17	15.5	40
Parameter/Well Identification	06/28/95	07/18/95	08/14/95	06/29/95	06/28/95	06/29/95	06/29/95	06/29/95	08/14/95	06/29/95	06/29/95
Acetone	1,500	7,600	<20	6,600,000	250	57	1,500	350	<20	<20	<20
Methyl Ethyl Ketone	<10	81	<10	150,000	<10	<10	100	28	<10	<10	<10
Toluene	5	15	<5	<5,000	5	<5	<5	<5	<5	<5	<5
Chloromethane	<10	<10	<10	<10,000	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<5	<5	<5	<5,000	<5	<5	7	8	<5	<5	<5
1,1-Dichloroethene	<5	<5	<5	<5,000	<5	<5	13	13	<5	<5	<5
1,2-Dichloroethene (Cis and Trans)	<5	<5	<5	<5,000	<5	<5	9,400	11,000	<5	<5	<5
Tetrachloroethene	<5	<5	<5	<5,000	150	300	22,000	22,000	7	14	67
1,1,1-Trichloroethane	<5	<5	<5	<5,000	41	<5	<5	<5	<5	<5	<5
Trichloroethene	<5	<5	<5	<5,000	6	<5	3,100	4,200	5	<5	5
Vinyl Chloride	<10	<10	<10	<10,000	<10	<10	1,100	910	<10	<10	<10
Non Chlorinated Volatile Organics	1,505	7,696	0	6,750,000	255	57	1,600	378	0	0	0
Chlorinated Volatile Organics	0	0	0	0	197	300	35,620	38,131	12	14	72
Total Volatile Organics	1,505	7,696	0	6,750,000	452	357	37,220	38,509	12	14	72

AS = Air Sparging Well (~65')
MW = Monitoring Well (~20')
DMW = Deep Monitoring Well (~40')
NS - No Standard
All concentrations reported as micrograms per liter (ug/L)
* cis-isomer only
Dates indicate time sampled

Table 3 (cont.)
Harman-Motive, Inc.
Martinsville, IN
Heritage Ground Water Results

Well Identification	MW-8	DMW-8	MW-9	DMW-9	MW-10	DMW-10	MW-13	DMW-13	MW-15	MW-16	MW-17
Laboratory ID number	A346573	A346574	A346722	A346723	A346725	A346724	A348080	A348079	A350612	A350613	A350727
Total Well Depth (ft.)	16	40	21	41	20.5	39.5	17.5	39.5	18	18	17.5
Parameter/Well Identification	06/29/95	06/30/95	06/30/95	06/30/95	06/30/95	06/30/95	07/18/95	07/18/95	08/11/95	08/11/95	08/14/95
Acetone	35	30	<200	<20	21	<20	300	160	<20	<20	16,000
Methyl Ethyl Ketone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	5,400
Toluene	<5	<5	<5	<5	<5	<5	8	6	<5	<5	<5
Chloromethane	<10	<10	340	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<5	<5	<50	<5	<5	<5	<5	<5	<5	<5	<5
1,1-Dichloroethene	<5	<5	<50	5	14	<5	<5	<5	<5	<5	<5
1,2-Dichloroethene (Cis and Trans)	<5	<5	960	<5	<5	<5	79	<5	<5	<5	<5
Tetrachloroethene	6	<5	470	<5	8	<5	4,000	150	98	620	<250
1,1,1-Trichloroethane	<5	5	150	25	<5	<5	32	<5	<5	24	<250
Trichloroethene	<5	<5	94	<5	<5	<5	70	<5	<5	<5	<5
Vinyl Chloride	<10	<10	<100	<10	10	<10	57	<10	<10	<10	<10
Non Chlorinated Volatile Organics	35	30	0	0	21	0	308	166	0	0	21,400
Chlorinated Volatile Organics	6	5	2,014	30	32	0	4,238	150	98	644	0
Total Volatile Organics	41	35	2,014	30	53	0	4,546	316	98	644	21,400

AS = Air Sparging Well (~65')
MW = Monitoring Well (~20')
DMW = Deep Monitoring Well (~40')
NS - No Standard
All concentrations reported as micrograms per liter (ug/L)
* cis-isomer only
Dates indicate time sampled

Table 3 (cont.)
Harman-Motive, Inc.
Martinsville, IN
Heritage Ground Water Results

Well Identification	DMW-18	MW-18	MW-19	W-19 (dup	MW-19	MW-20	MW-21	MW-22	MW-23	MW-24	MW-25
Laboratory ID number	A350726	A350728	A350614	A350615	A354193	A350617	A350618	A350619	A350620	A354183	A354181
Total Well Depth (ft.)	39.5	18	17.5	17.5	17.5	17.5	18	17.5	17.5	17	18
Parameter/Well Identification	08/14/95	08/14/95	08/11/95	08/11/95	08/11/95	08/11/95	08/11/95	08/11/95	08/11/95	09/14/95	09/14/95
Acetone	<20	<20	<20	<20	<25	<20	<20	<20	<20	<20	<20
Methyl Ethyl Ketone	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10	<10
Toluene	<5	<5	<5	<5	<1	<5	<5	<5	<5	<5	<5
Chloromethane	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<5	<5	<5	<5	<1	<5	<5	<5	<5	<5	<5
1,1-Dichloroethene	<5	<5	<5	<5	<1	<5	<5	<5	<5	<5	<5
1,2-Dichloroethene (Cis and Trans)	<5	<5	<5	<5	<1	<5	<5	74	<5	<5	<5
Tetrachloroethene	<5	41	56	69	80	<5	<5	100	6	8	<5
1,1,1-Trichloroethane	6	27	6	<5	4	<5	<5	15	76	<5	10
Trichloroethene	<5	<5	<5	<5	<1	<5	<5	8	<5	<5	<5
Vinyl Chloride	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10	<10
Non Chlorinated Volatile Organics	0	0	0	0	0	0	0	0	0	0	0
Chlorinated Volatile Organics	6	68	62	69	84	0	0	197	82	8	10
Total Volatile Organics	6	68	62	69	84	0	0	197	82	8	10

AS = Air Sparging Well (~65')
MW = Monitoring Well (~20')
DMW = Deep Monitoring Well (~40')
NS - No Standard
All concentrations reported as micrograms per liter (ug/L)
* cis-isomer only
Dates indicate time sampled

Table 3 (cont.)
Harman-Motive, Inc.
Martinsville, IN
Heritage Ground Water Results

Well Identification Laboratory ID number Total Well Depth (ft.) Parameter/Well Identification	MW-26 A354187 18 09/14/95	MW-27 A354188 19 09/14/95	MW-28 A354189 17 09/14/95	MW-29 A354190 17 09/14/95	MW-30 A354191 17 09/14/95	MW-31 A354182 18 09/14/95	MW-32 A354192 18 09/14/95	MW-33 A356588 18 10/09/95	RR WELL A354186 25 09/14/95	IDEM VRP Regulatory Standard Industrial	IDEM VRP Regulatory Standard Residential
Acetone	<25	36,000	<25	<25	<25	<20	<25	<25	<20	10,200	3,040
Methyl Ethyl Ketone	<10	9,700	<10	<10	<10	<10	<10	<10	<10	5,110	918
Toluene	<1	<1	<1	<1	<1	<5	<1	<1	<5	20,400	1,000
Chloromethane	<1	<1	<1	<1	<1	<10	<1	<1	<10	NS	NS
1,1-Dichloroethane	<1	<1	<1	<1	<1	<5	31	<1	<5	10,200	64
1,1-Dichloroethene	<1	<1	<1	<1	<1	<5	3	<1	14	7	7
1,2-Dichloroethene (Cis and Trans)	<1	<1	<1	(4.4)	<1	15	596	<1	13	1,020*	70*
Tetrachloroethene	<1	<1	53	220	<1	<5	940	<1	10,000	56	5
1,1,1-Trichloroethane	<1	<1	3	2	<1	240	65	7.9	1,200	9,200	200
Trichloroethene	<1	<1	10	12	<1	6	140	<1	160	260	5
Vinyl Chloride	<1	<1	<1	<1	<1	<10	55	<1	<10	10	2
Non Chlorinated Volatile Organics	0	45,700	0	0	0	0	0	0	0	-	-
Chlorinated Volatile Organics	0	0	66	234	0	261	1,830	7.9	11,387	-	-
Total Volatile Organics	0	45,700	66	234	0	261	1,830	7.9	11,387	-	-

AS = Air Sparging Well (~65')
MW = Monitoring Well (~20')
DMW = Deep Monitoring Well (~40')
NS - No Standard
All concentrations reported as micrograms per liter (ug/L)
* cis-isomer only
Dates indicate time sampled

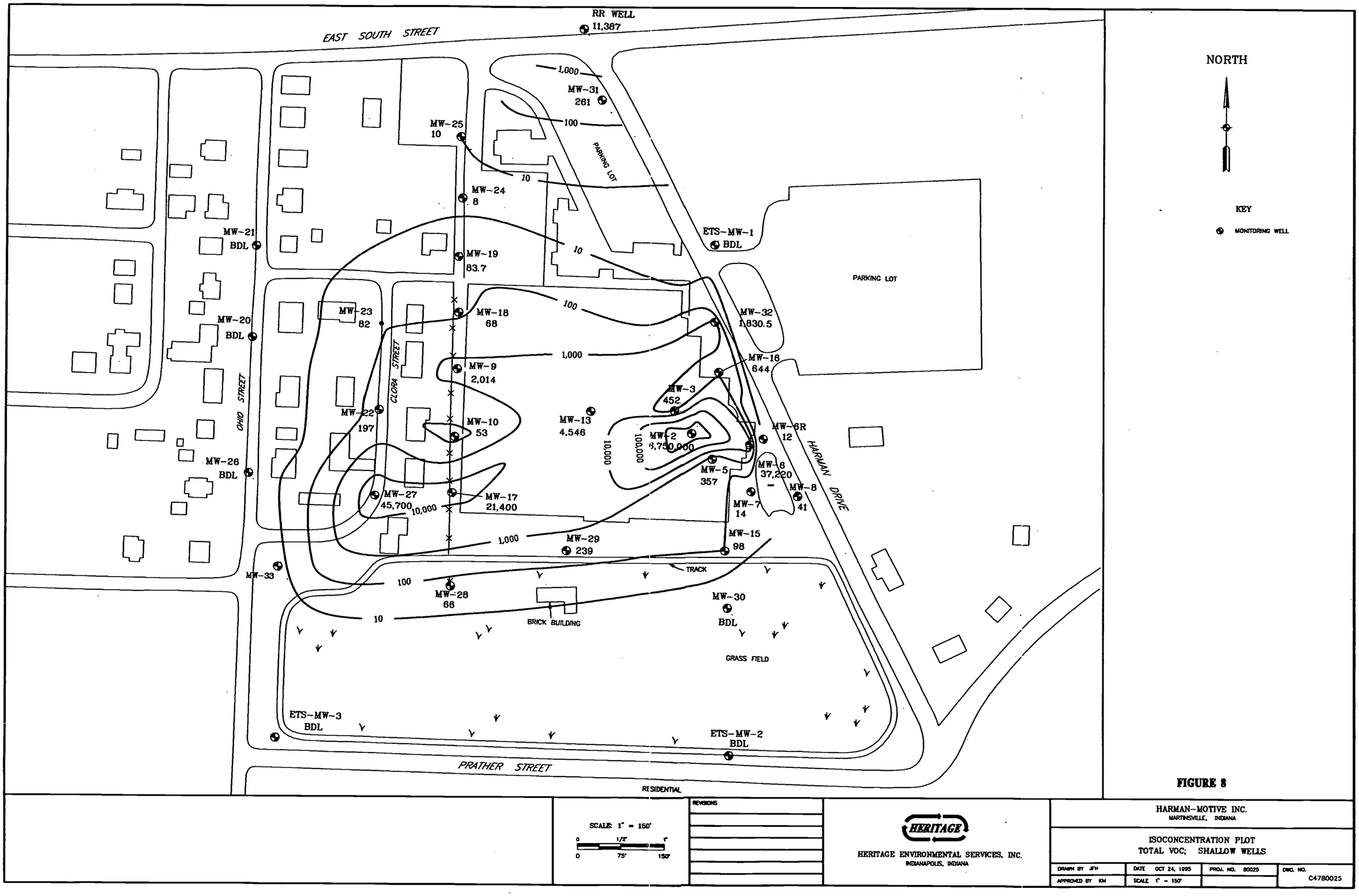


FIGURE 8

SCALE: 1" = 150'

0 1/2" 1"

0 75' 150'

REVISIONS

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA

ISOCONCENTRATION PLOT
TOTAL VOC; SHALLOW WELLS

DRAWN BY JFH	DATE OCT 24, 1995	PROJ. NO. 80025	DWG. NO. C4780025
APPROVED BY KM	SCALE 1" = 150'		

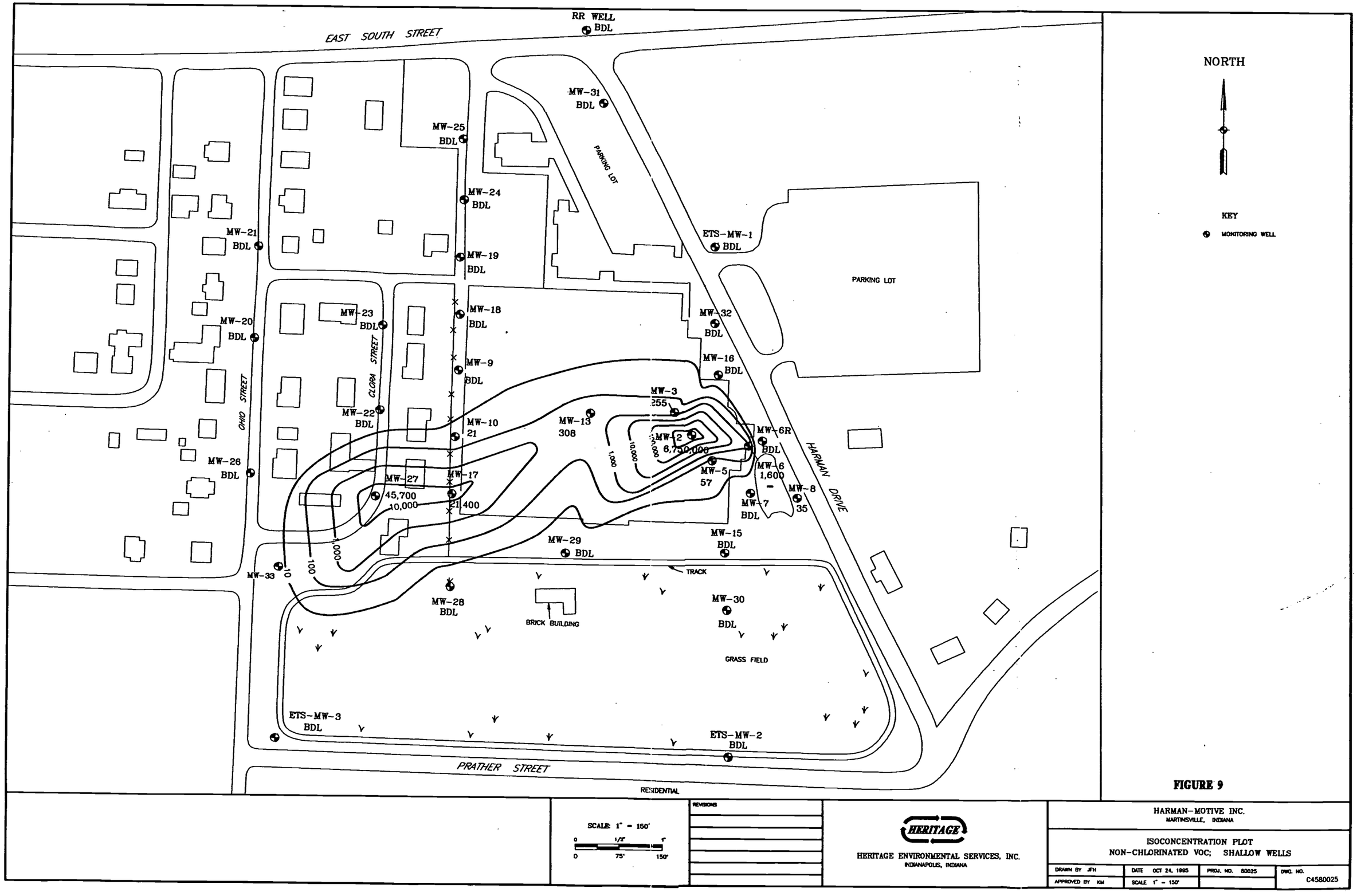


FIGURE 9

SCALE: 1" = 150'

0 1/2" 1"

0 75' 150'

REVISIONS

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

HARMAN–MOTIVE INC.
MARTINSVILLE, INDIANA

ISOCONCENTRATION PLOT
NON–CHLORINATED VOC; SHALLOW WELLS

DRAWN BY JFH	DATE OCT 24, 1995	PROJ. NO. 80025	DWG. NO. C4580025
APPROVED BY KM	SCALE 1" = 150'		

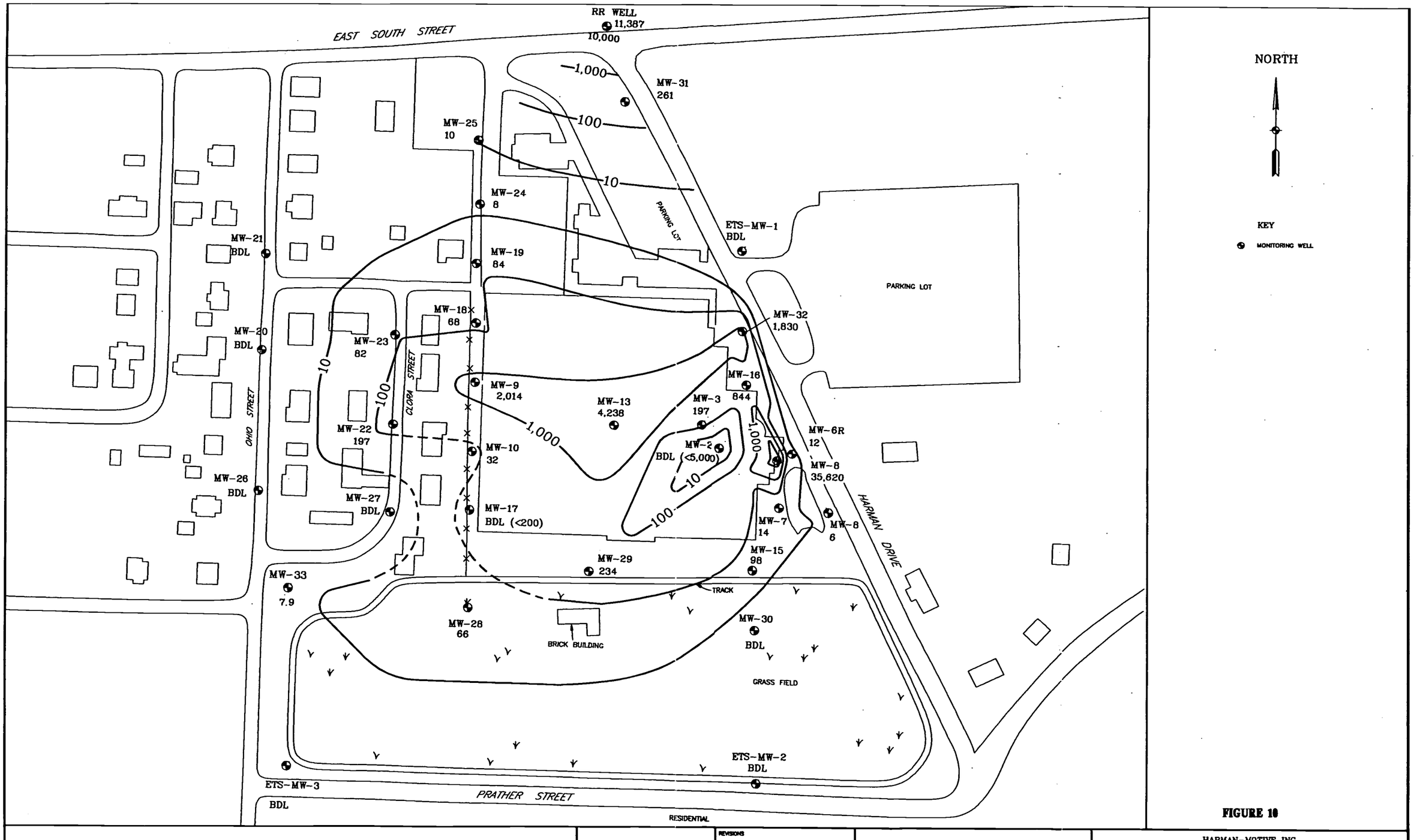


FIGURE 10

SCALE: 1" = 150'

0 1/2 1"

0 75' 150'

REVISIONS

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA

ISOCONCENTRATION PLOT
CHLORINATED VOC; SHALLOW WELLS

DRAWN BY JFH	DATE OCT 26, 1995	PROJ. NO. 80025	DWG. NO. C4680025
APPROVED BY KM	SCALE 1" = 150'		

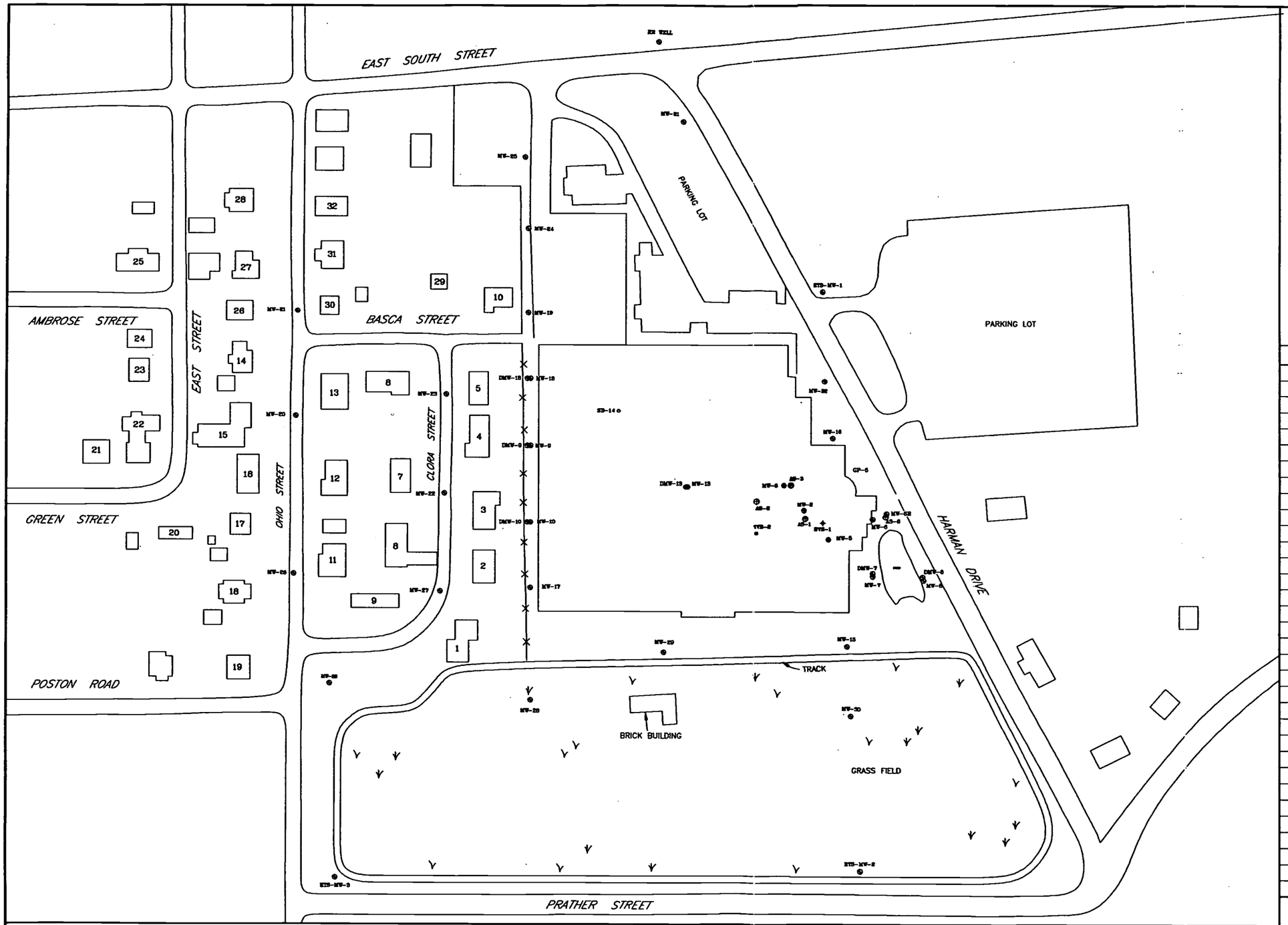
4.0 EXPOSURE MANAGEMENT AREA

Harman-Motive has determined that due to the off-site migration of VOCs dissolved in ground water, it is appropriate to establish an exposure management area to protect human health in the off-site contamination area.

As stated previously, Harman-Motive has contacted the City of Martinsville water utility to determine if all downgradient residences/businesses are connected to the water utility. Information provided by the City of Martinsville indicate all residences and businesses immediately downgradient from the site are served by the water utility with one exception. One downgradient water well has been identified by Harman-Motive located at 1240 S. Ohio St. The water well at that address is reportedly about 20 feet deep. A ground water monitoring well (MW-20) installed by Heritage in Ohio Street immediately upgradient from this residence indicated that the well is free from VOCs. Harman-Motive will offer to connect the 1240 S. Ohio street residence to the Martinsville water utility, thereby eliminating any potential exposure to impacted ground water via the drinking water route.

Harman-Motive will also determine if the residences/businesses that are underlain by impacted ground water have basements or old water wells. If water wells are present, Harman-Motive will offer to sample the ground water from those wells and will take appropriate action if those wells disclose impact. If basements are present, Harman-Motive make inquiry about any ground water seepage through basement walls. Information for residences/businesses will be maintained and recorded as shown on Figure 11.

Ground water monitoring will continue throughout the proposed remediation of the facility.



NORTH

KEY

- AIR SPARGING WELL
- MONITORING WELL
- SOIL BORING

NAME	ADDRESS	WATER SOURCE
1	1399 CLORA STREET	
2	1385 CLORA STREET	
3	1355 CLORA STREET	
4	1335 CLORA STREET	
5	1305 CLORA STREET	
8	1304 CLORA STREET	
7	1334 CLORA STREET	
8	1354 CLORA STREET	
9	1398 CLORA STREET	
10	540 BASCA STREET	
11	1339 OHIO STREET	
12	1309 OHIO STREET	
13	1209 OHIO STREET	
14	1210 OHIO STREET	
15	1240 OHIO STREET	
16	1260 OHIO STREET	
17	1310 OHIO STREET	
18	1340 OHIO STREET	
19	1390 OHIO ST. (BIZZY BEE)	
20	399 GREEN STREET	
21	360 GREEN STREET	
22	390 GREEN STREET	
23	1260 EAST STREET	
24	389 AMBROSE STREET	
25	390 AMBROSE STREET	
26	1180 EAST STREET	
27	1160 EAST STREET	
28	1140 EAST STREET	
29	520 BASCA STREET	
30	1189 OHIO STREET	
31	1159 OHIO STREET	
32	1139 OHIO STREET	

FIGURE 11

SCALE: 1" = 150'

0 1/2" 1"

0 75' 150'

REVISIONS

HERITAGE ENVIRONMENTAL SERVICES, INC.
INDIANAPOLIS, INDIANA

HARMAN-MOTIVE INC.
MARTINSVILLE, INDIANA

WATER UTILITY SERVICE MAP

DRAWN BY JFH	DATE OCT 25, 1995	PROJ. NO. 80025	DWG. NO. B9880025
APPROVED BY KM	SCALE 1" = 150'		

5.0 REMEDIATION PLAN

As a part of site investigation activities various testing was conducted to design for soil vapor extraction/air sparging and *in situ* biological remediation technologies. The results of these tests are described below.

5.1 Soil Vapor Extraction/Air Sparging Pilot Scale Testing

The removal of compounds from the subsurface by soil vapor extraction/air sparging and in situ degradation is a function of the chemical and physical properties of the compound(s) to be removed, soil texture, structure, temperature, moisture and carbon content; induced negative pressure, bacteria type and amount present, and the "cap" for the soils. Subsurface air sparging to aid in the remediation of ground water is also proposed for this site.

A pilot scale test involving air sparging and SVE was conducted on June 30, 1995 at the Harman facility. Tests were conducted using one air sparging well (AS-1) and monitoring was conducted at three monitoring well locations -- MW-2, MW-3, and MW-4. This testing was aimed at defining air flow rates and well spacings for full scale operations and determining if the *in situ* technology was a viable technology. Analytical testing was performed during the pilot scale test to serve as a baseline for contaminant mass removal information. The data collected also was used to calculate the mass of volatile compound discharge, *i.e.*, air emissions.

The pilot scale testing for the SVE was conducted using a vapor extraction unit equipped with a 5HP blower. Compressed air for the air sparging testing were conducted using plant compressed air. The SVE unit rated for a maximum vacuum/flow combination of 7 inches of mercury and 60 cfm, ambient air was bled in to prevent the vacuum blower from starving. The air sparging test was conducted using air pressures that ranged from 55 to 70 psi and flow rates ranging from 4 SCFM to 40 SCFM (Appendix 4).

The monitoring results of the testing suggested that negative pressures were induced up to 30 feet from the vacuum extraction well with the pilot scale study. Extrapolation of data and design for full scale soil vapor extraction has resulted in design of a conservative 25 feet radius of influence for soil vapor extraction wells in the interior portion of the Harman facility. Wider spacing may be used outside the facility.

The air sparging pilot testing suggested that the air injection was capable of influencing a 60 feet radius of influence with the air injection pressures/volumes used. Positive pressures and elevated PID readings were readily apparent in nearby monitoring wells upon operation of the pilot testing for air injection. Extrapolation of data for full-scale design suggests that a 30-feet radius of influence will be used for the air sparging operation inside the Harman-Motive facility.

The full scale SVE-air sparging system will be operated on a timed and a pulsed basis throughout the project to achieve optimum remediation. Initially, SVE and sparging will be operated at the facility and this mode of operation will be followed by the implementation of the *in situ* bioremediation technology described in Section 5.3.

5.2 Biologic Testing and Air Monitoring Results

Laboratory analyses were conducted on soil and water samples to evaluate the biological activity associated with the samples at the site. Additionally, field measurements were made to determine the dissolved oxygen levels in ground water. These samples provide information on the present level of subsurface biological activity and a baseline to measure future biologic enrichments. The biological testing was conducted by BioRenewal Technologies Inc. of Madison, Wisconsin.

Testing conducted included microbial data testing, existing nutrient conditions, and soil physical conditions. Two (2) soil samples were tested -- one from MW-3 (8-10 feet depth) and one from SVE-1 (8 feet depth). The results of

the soil testing are provided in Table 4. Overall, these data suggest that bacteria capable of degrading hydrocarbon and chlorinated VOCs are present in the subsurface, but augmentation is needed to provide an environment for significant bioremediation. The proposed augmentation scenario is described in Section 5.3.

Air monitoring conducted during the pilot scale tests revealed that several compounds, including hydrocarbon and chlorinated hydrocarbon solvents were detected. Table 5 provides a listing of the photochemically reactive volatile organic compounds regulated by the Indiana Air Pollution Control Board.

The air monitoring conducted also suggests that some biologic degradation is already occurring in the subsurface based on (elevated) carbon dioxide levels measured during SVE pilot testing.

Physical characteristics of the chlorinated VOCs and hydrocarbon VOCs identified on this project are listed in Table 6.

5.3 Proposed Full-Scale Remediation Scenario

In-situ bioremediation has been demonstrated on a large test site at the Department of Energy Savannah River Site (SRS) in South Carolina. The SRS was faced with a large historical 2 million pound TCE release from a lagoon and associated process sewer line. They developed and patented two technologies, one for *in situ* air sparging, and another for *in situ* bioremediation. Starting in 1991, they installed a horizontal air sparging well underneath a 300 foot long section of leaking chemical sewer. They also installed a 300 foot long horizontal SVE well above the plume. In the first stages of the project, they performed a soil vapor (vacuum) extraction test. This was followed by an air injection trial in the lower well with very encouraging results. They also noticed a significant growth of biological activity during the air sparging portion of their demonstration.

Table 4

Harman-Motive, Inc.

Martinsville, IN

Microbial Data Summary and Nutrient Conditions

		Soil		Groundwater	
		MW-3; 8-10 ft	SVE-4; 8ft	1MW-2	1MW-3
Total Microbial Population	cfu/gm	1.73E+06	1.13E+05	7.89E+05	8.9E+05
Acetone Degrader Population	cfu/gm	1.76E+05	2.55E+04	1.42E+05	8.95E+04
Growth Conditions		Aerobic	Aerobic	Aerobic	Aerobic
MEK Degrader Population	cfu/gm	1.64E+05	1.88E+04	1.23E+05	8.19E+04
Growth Conditions		Aerobic	Aerobic	Aerobic	Aerobic
Putative TCE Degrader Enrichment Results					
Methanotrophs		+,+	+,+	+,+	+,+
Active SMMO		++,-	-,-	-,-	+,+
Total Kjeldahl Nitrogen (TKN)	ppm	354	178	n/a	n/a
Ammonium Nitrogen (NH4-N)	ppm	4.5	3.5	n/a	n/a
Available Phosphorous (P)	ppm	33	13	n/a	n/a
Available Potassium (K)	ppm	85	55	n/a	n/a
% Organic Matter	%	0.7%	0.3%	n/a	n/a
Total Organic Carbon (TOC)		2,730	1,170	n/a	n/a
C:N Ratio		8	7	n/a	n/a
C:P Ratio		83	90	n/a	n/a
pH		7.7	7	n/a	n/a
% Moisture	%	10.8%	10.3%	n/a	n/a
% Solids	%	89.2%	89.7%	n/a	n/a

cfu/gm: colony forming units per gram of dry soil weight

n/a: not applicable

Table 5
Harman-Motive, Inc.
Martinsville, IN
Calculated Potential VOC Emissions From SVE Exhaust

Constituent	Molecular Weight	Avg. conc. (ppm V/V)	POTENTIAL EMISSIONS lb/hr	lb/day	ton/yr
benzene	78.11	0.41	0.0022	0.0521	0.0095
ethyl benzene	106.17	0.95	0.0068	0.1640	0.0299
m&p xylene	106.17	2.55	0.0183	0.4401	0.0803
o xylene	106.17	0.78	0.0056	0.1346	0.0246
trichloroethylene	165.83	0.17	0.0019	0.0458	0.0084
toluene	92.14	6.24	0.0389	0.9347	0.1706
c5 - c10	100.2	99.89	0.6780	16.272	2.9696
mek	72.11	2	0.0098	0.2345	0.0428
vinyl chloride	62.5	6	0.0254	0.6097	0.1113
trans 1,2 dichloroethylene	97	0.2	0.0013	0.0315	0.0058
chloroform	119.4	0.01	0.0001	0.0019	0.0004
carbon tetrachloride	153.8	0.01	0.0001	0.0025	0.0005
tetrachloroethylene	165.83	1.01	0.0113	0.2712	0.0495
acetone *	58.08	259	1.0190	24.4556	4.4631
	TOTAL	120.22	0.7998	19.1947	3.5030
	REGULATORY THRESHOLD		3 lb/hr (registration)	15 lb/day	25 ton/yr (permit)

Notes:

* Acetone emissions not included in total based on draft rule published in the September 1, 1995 Federal Register indicating that acetone will be added to the list of nonphotochemically reactive hydrocarbons.

Maximum potential emissions based on continuous operation for 8,760 hours per year at the contaminant concentrations observed during the pilot-scale testing.

Contaminants with unquantified concentrations assumed to be present at the analytical detection limit.

Air flow rate = 440 cfm.

Table 6
Harman-Motive, Inc.
Martinsville, IN
Physical Properties Table

	Abbrev.	Formula	MW lb/lbmole	Specific Gravity liquid	Specific Gravity vapor	Boiling Point °F	Water Solubility lb/100 lb H2O @68°	Vapor Pressure psi @70°F	Henry's Law Constant atm·m³/mol@20°C	Log Octanol-Water Partion Coefficient
Acetone	ACE	CH3COCH3	58.08	0.791	2.0	133	miscible	4.791	6.8E-06	-0.24
Methyl Ethyl Ketone	MEK	CH3COCH2CH3	72.11	0.806	2.5	175.3	27.000	1.461	2.4E-05	0.29
Toluene	TOL	C6H5CH3	92.14	0.867	3.14	231.1	0.050	0.449	6.64E-03	2.73
Chloromethane	CM	CH3Cl	50.49	0.997	1.7	-11.6	0.600	67.520 @65°F	2.4E-02	0.91
1,1 - Dichloroethane	1,1-DCA	C2H4Cl2	98.97	1.174	3.42	135.14	0.500	5.879	5.45E-04	1.79
1,1 - Dichloroethene	1,1-DCE	CH2=CCl2	96.95	1.21	3.3	88.9	0.500	10.06	1.5E-03	2.13
cis-1,2 - Dichloroethene	c-1,2-DCE	ClCH=CHCl	97	1.27	3.34	140	0.630	4.297	7.5E-03	
trans-1,2 - Dichloroethene	t-1,2-DCE	ClCH=CHCl	97	1.27	3.34	118	0.630	4.297	5.3E-03	1.48
1,1,1-Trichloroethane	1,1,1-TCA	CH3CCl3	133.41	1.31	4.6	165	0.070	2.099	4.92E-03	2.49
Trichloroethene	TCE	CHCl=CCl2	131.39	1.46	4.5	189	0.110@77°F	1.166	8.92E-03	2.29
Tetrachloroethene	PCE	Cl2C=CCl2	165.83	1.63	5.83	250	0.016	0.318	2.87E-02	2.6
Vinyl Chloride	VC	CH2=CHCl	62.5	0.969	2.2	7.2	0.600	50.94	1.1E-02	1.38

References: "The Hazardous Waste Consultant"; November/December 1986; 4-22,4-24.
"Handbook of Chemistry and Physics, 71st ed.", 1990-1991; 160-25,27
"Chemical Hazard Response Information System, Vol 2"; 1985
"Dangerous Properties of Industrial Materials, 6th ed."; Sax, N. I.; 1984

SRS engineers were aware of various university research into the co-metabolism of TCE, DCE, and other chlorinated compounds by methanotrophic bacteria. Bacteria were known to exist that would grow and develop on a simple hydrocarbon feed stock, such as methane or propane. When these methanatrophic bacteria are deprived of the methane feed stock, they co-metabolize TCE, PCE and other chlorinated compounds to CO_2 and chloride ion. This approach was implemented on a full scale basis by DOE at the SRS test site in 1992. This process yielded remarkable results in the span of fourteen months, displaying a significant reduction in ground water and soil contaminants. In many cases, the ground water samples met or approached the 5 ppb drinking water limit for TCE. The DOE holds patents on several versions of this technology.

Heritage has licensed the air sparging technology, the bioremediation technology, and the vapor-phase phosphate addition technology from the Department of Energy. Work at the demonstration site has continued over a period of four years with an annual budget of 1 to 2 million dollars per year. The Savannah River test site is approximately 100' wide x 300' long x 170' deep and is similar in size to the Harman plume area.

The main advantage of this technology for this site is that it offers the opportunity to significantly reduce the amount of time necessary to remediate the site. The *in situ* bioremediation process not only treats the ground water *in situ*, but also the saturated soils under the water table as well as the permeable vadose zone soils.

5.3.1 *Air Injection System*

Air would be injected into the base of the sand aquifer, just below the plume, through a network of approximately eighteen (18) air injection wells. These wells would be screened at the bottom five feet of each well. Well installation details would be the same as for a 2-inch monitoring well. They can be used as ground water monitoring or pumping wells, as well as air injection wells. Based on the air injection pilot test, each well will receive approximately 16

scfm of compressed air. Each well would be served by an individual 1/2 inch air distribution pipe with a shut-off valve. Air injection wells are spaced at the locations shown on Figure 12. Well screens are to be installed between approximately 58 and 75 below site grade (bsg).

5.3.2 *Soil Vapor Extraction System*

It is proposed to complement the air injection system with a soil vapor extraction (SVE) system. Twenty-four (24) SVE wells will be installed at the locations shown on the attached site plan. The SVE wells would be installed as 2-inch wells, seven (7) feet deep. These wells would also be at approximately 40-feet centers, but would be interspersed in-between the air injection wells and outside of the sparging wells. The purpose of the soil vapor extraction wells is to exert a negative pressure on the vadose zone pore spaces to desorb acetone, MEK, and other volatile constituents from the soil. The soil vapor extraction system would also serve as collection points for volatile constituents which are air stripped from the saturated soils and the ground water via sparging. Another convenient feature of soil vapor extraction wells in this system is that they can be used to monitor CO_2 evolution rates, *i.e.*, the waste products from biologic degradation. As bioremediation progresses, natural levels of CO_2 in vadose zone soils and ground water should increase. This increase can be easily monitored in the SVE wells to track bioremediation progress.

5.3.3 *Nutrient Delivery System*

Bacterial activity in the subsurface is usually limited by a lack of oxygen and trace nutrients. The air injection system will supply the necessary oxygen. Trace nutrients are proposed to be supplied by the addition of a meter to inject anhydrous ammonia. Normally phosphate addition is done by a liquid addition system, which can be complicated for a site such as this. The DOE

FIGURE 4

HERITAGE TREATMENT CENTER
INDIANAPOLIS, INDIANA

SITE PLAN

OCT 25, 1995	PROJ. NO. 29001	DWG. NO.

IDEM VFC note:
Ref. Large format dwg.
for additional information.

has patented a vapor phase phosphate nutrient addition which offers several advantages for this site. The system will include a phosphate addition metering system to be added to the air injection flow.

Shallow ground water process monitoring wells have been installed inside the building and at various locations within the plume. It is proposed to monitor these wells for nutrients and biological activity periodically to provide feedback to nutrient addition feed rates and system performance.

5.3.4 *Treatment Equipment*

It is proposed to install the air injection instrumentation, the nutrient addition equipment, the soil vapor extraction blower, a liquid knock-out pot, and a condensate transfer pump within the existing air compressor utility room at Harman-Motive. One and one-half to two inch air injection piping and 4-inch vapor suction piping will be run into the production floor aisleway overhead in the ceiling to the center of the plume area. There the piping will split to the east and the west ends of the plume. Then the main headers will tee off into the SVE suction and air injection laterals. These laterals will be then be run to each well location. Gauges and isolation valves will be installed at each well location to regulate flow and pressure.

The SVE condensate receiver is expected to accumulate between 10 and 50 gallons per day of condensed moisture from the SVE system. This condensate will contain the solvents present at concentrations similar to those present in the ground water. It is proposed that the condensate pump periodically transfer this water to the city sewer discharge. This flow (volume) is expected to be extremely low.

5.3.5 System Monitoring

Selected site monitoring wells will be sampled for acetone, MEK, PERC, TCE, DCE and VC as follows:

- Prior to treatment system startup
- During the first month of system operation
- Quarterly during the first year of operation
- Semi-annually during the second and third year of system operation
- Annually thereafter or until compliance objectives are achieved

At least five process monitoring wells located in the center of the plume will be monitored on a monthly basis during the first year of operation for:

- nutrients
- biological activity plate counts
- Acetone, MEK, PCE, TCE, DCE, and VC

This process control analysis will be performed on a bi-monthly basis (once every two months) during the second and third years of system operation.

6.0 SUMMARY

Subsurface investigations at the Harman-Motive facility in Martinsville, Indiana have revealed that shallow soils and ground water have been impacted by volatile organic compounds (VOCs). These compounds have been detected underlying the manufacturing plant, off-site toward the west, and off-site toward the northeast. Hydrocarbon VOCs, such as acetone and methyl ethyl ketone are present, and chlorinated VOCs, including tetrachlorethene and its associated degradation products have been detected. Based on the distribution of the VOCs at the site and the ground water flow conditions, it appears that different source areas may have contributed to the contamination. Contamination is migrating off of the Harman site toward the west, but contamination is migrating onto the Harman site from the northeast.

Ground water occurs at shallow depths (about 10 to 12 feet below grade) at the site and the geologic materials underlying the facility are dominated by sand. A public utility provides the water supply for the Martinsville area and all adjacent residences/businesses are connected to the utility. One downgradient residence has a private well, but a ground water monitoring well installed upgradient of that residence indicates that no volatile organic compounds are present.

A remediation plan has been developed which includes establishment of an exposure management area to assure no human exposure to VOCs, aggressive *in situ* technologies that include soil vapor extraction, air sparging and implementation of proprietary *in situ* biodegradation technologies. Monitoring throughout the remedial phase is also planned.

7.0 REFERENCES

Bailey, Z. and T. Imbrigiotta, 1982, Ground-water Resources of the Glacial Outwash Physical characteristics of the chlorinated VOCs and hydrocarbon VOCs identified on this project are listed in Table 6. along the White River, Johnson and Morgan Counties, Indiana; USGS WRI 82-4016, 87 p.

USGS, 1994, Hydrogeologic Atlas of Aquifers in Indiana, USGS WRI Report 92-4142, in cooperation with the IDNR and IDEM, (11" x17" atlas).