HAGER-RICHTER
GEOSCIENCE, INC.

SEISMIC REFRACTION SURVEY
MARX RESIDENCE SITE
TOWN OF NEW CASTLE
WESTCHESTER COUNTY, NEW YORK

Prepared for:

New York State Department of Environmental Conservation
Bureau of Eastern Remedial Action
Division of Hazardous Waste Remediation
50 Wolf Road
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File 91J35
December, 1991

Seismic Refraction Survey
Marx Residence Site, Town of New Castle
Westchester County, New York
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0. EXECUTIVE SUMMARY

Hager-Richter Geoscience, Inc. conducted a seismic refraction survey at the Marx Residence Site (NYSDEC Site No. 360024), in the Town of New Castle, Westchester County, New York, in December, 1991 for the New York State Department of Environmental Conservation (NYSDEC). The geophysical survey was performed as part of an RI of the Site by the NYSDEC.

The objective of the survey was to determine the configuration of the bedrock surface at the Site and, if possible, to locate a possible bedrock ridge that might control groundwater flow.

The seismic refraction survey consisted of five seismic lines consisting of six spreads, for a total of 690 feet. Four of the spreads were oriented in an east-west direction and the remaining two in a north-south direction. All the seismic lines were located on the Marx property.

Materials with two distinct velocities were detected in the seismic refraction survey. The upper material, interpreted to be unsaturated sediments, exhibits a velocity range of 1000 to 1200 feet per second. The lower material has a velocity range of 10000 to 13500 feet per second and is interpreted to be competent bedrock.

The results of the seismic refraction survey indicate that bedrock elevations are relatively higher in the northern part of the site and decrease toward the south. The bedrock surface exhibits a total relief of 17 feet across the survey area, from elevations of 471 feet in the northwest to 454 feet in the south. No clear ridge is indicated, but a bedrock valley with relief of 15 to 20 feet trends approximately N20°W across the Site, passing beneath the shed and garage of the Marx residence.

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1. INTRODUCTION

Hager-Richter Geoscience, Inc. conducted a seismic refraction survey at the Marx Residence Site (NYSDEC Site No. 360024), in the Town of New Castle, Westchester County, New York, in December, 1991 for the New York State Department of Environmental Conservation (NYSDEC). The geophysical survey was performed as part of an RI of the Site by the NYSDEC.

The objective of the survey was to determine the configuration of the bedrock surface at the Site and, if possible, to locate a possible bedrock ridge that might control groundwater flow.

The Site is a private residence in the Town of New Castle (Figure 1), located at 85 Armonk Road, also known as State Route 128. The area of interest is approximately 3/4 acre in size, and consists of a house with attached garage, shed, and porch and surrounding grounds with lawn and trees. The surface is relatively flat with occasional standing water to the east and west of the buildings, particularly toward Armonk Road, a busy thoroughfare. To the north and farther east, the land rises rapidly, and outcrops of steeply dipping banded gneiss are visible.

Hager-Richter personnel Jeffrey Reid and Roger Yang conducted the seismic refraction survey on Tuesday, December 17, 1991. The field operations were coordinated by Mr. James Quinn and Mr. Michael Komoroske of the NYSDEC, who observed the field operations and provided logistical support. All work was conducted under Level D personal protection. The seismic refraction data were analyzed and interpreted at the Hager-Richter offices. Original data and field notes will be retained in the Hager-Richter files for a minimum of three years.

2. EQUIPMENT AND PROCEDURES

2.1 General

We used a 24-channel Bison Model 9024 Digital Instantaneous Floating Point Stacking Seismograph to perform the seismic refraction survey. The Model 9024 is a "state of the art" microprocessor controlled instrument that records data digitally and on paper seismograms. The stored data were transferred to a laptop computer at the end of the field effort.

The seismograph was coupled to two 12-element seismic spread cables for a total of 24 geophones. A five-foot geophone spacing sufficient to record arrivals from bedrock was selected.

Seismic energy was provided by a 12-lb sledge hammer striking a steel base plate. The number of stacks per shot point is variable, and the quality of the stacked seismic signal for each shot point was verified in the field with the paper record. The shot points were arranged to provide reversed profiles. Shot points (and geophone locations, if necessary) were flagged in the field.

The seismic data were analyzed using the Generalized Reciprocal Method (GRM) of seismic refraction interpretation. GRM has several advantages over other seismic refraction interpretation methods such as the Time-Intercept or Crossover-Distance methods. GRM allows for some variation in the surface topography as well as lateral variation in the seismic velocity of the upper layers. The method uses a principle of migration whereby the refractor need only be planar over a short distance, thus allowing the calculation of depth to an undulating interface. In addition, GRM is relatively insensitive to dip angles as high as 20°, unlike most other methods that can be sensitive to dips as low as 5°. GRM also allows for the calculation of depth below each geophone instead of below only the shot points as in the Time-Intercept and Crossover Distance methods. The GRM program that we use for data analysis contains several internal tests for data consistency.

The results were used to construct an interpreted velocity profile of the subsurface for each seismic line. The velocities of seismic waves are strong functions of the types of geologic material through which they pass. One can thus infer the general subsurface stratigraphy from the velocities exhibited.

A widespread misconception about the seismic refraction method is that one cannot detect layers of lower velocity material underlying higher velocity material, a common situation in stratified sediments. If present and undetected, the lower velocity layers can cause large errors in the thickness calculated for the various layers. However, the GRM technique provides for the detection of such low velocity layers and, more importantly, provides correct depths to refracting horizons below any low velocity layers that may be present. Typical uncertainties in depths determined seismically are 10% or 1 foot, whichever is larger.

2.2 Site Specific

Seismic refraction data at the Site were collected with a 5-foot geophone spacing for all seismic lines; each 24-channel spread was 115 feet long. The seismic refraction survey consisted of five lines totaling 690 feet. The locations of the seismic lines are shown on Figure 2.

Five shot points were made for each 24-channel spread. Offset shot points varying from 20 to 50 feet were made from each end of the spreads. Shot points were also located at each end and at the 13th geophone of each spread. The shot points were located to provide reversed bedrock arrivals from all or most of the geophones.

Profiles longer than 115 feet were made by end-to-end extensions of individual spreads, with the last geophone of one spread reoccupied as the first geophone of the next spread for data continuity. Where possible, cross profiles were located to reoccupy previous geophone locations as a check for data consistency. The locations of the seismic refraction lines were selected in coordination with NYSDEC.

Elevations for the shot points were obtained from a topographic map of the Site provided by NYSDEC (Figure 2), and are probably accurate to +/- 1 foot.

3. RESULTS AND DISCUSSION

3.1 General

Despite the Site's location adjacent to a busy roadway, the seismic data collected at the Site are good to excellent. Table 1 lists the depths and elevations of bedrock as determined from the seismic refraction data.

Two distinct types of materials were defined in the analysis of the seismic refraction data for the present survey. The upper material, interpreted to consist of unsaturated sediments, shows a velocity range of 1000 to 1200 feet per second. The lower material, interpreted to be competent bedrock, exhibits a velocity range of 10000 to 13500 feet per second.

The presence of material with an intermediate velocity, due to the transition from unsaturated to saturated conditions, was not detected on the basis of the seismic data. That result likely indicates that the water table generally occurs either below or no more than a foot or two above bedrock. Although such a thin saturated zone generally cannot be detected on the basis of seismic refraction data, its presence can introduce errors into the calculated bedrock depths.

Depths of bedrock were determined independently on different seismic lines at three locations, providing an objective measure of the precision of the seismic refraction method as actually performed at this Site. The data are presented in Table 2. The mean difference and standard deviation are 0.60 foot and 0.55 foot, respectively.

3.2 Profiles

Seismic Line 1. Seismic Line 1 is 230 feet long, oriented west-east, and is located along the southern property line of the Site. The interpretation of the seismic refraction data is shown in Figure 3. Seismic Line 1 intersects the southern ends of seismic lines 4 and 5. The bedrock surface along this line begins and ends at an elevation of 458 feet, with minor changes in elevation along the line.

Seismic Line 2. Seismic Line 2 is located north of and approximately parallel to Seismic Line 1. The interpretation of the seismic refraction data is shown in Figure 4. The bedrock surface decreases from 459 feet near the western side of the line to 458 feet at the eastern end.

Seismic Line 3. Seismic Line 3 is located at the northern edge of the Site, and is oriented approximately west-east. The interpretation of the seismic refraction data is shown in Figure 5. The bedrock surface rises irregularly from an elevation of 459 feet to 471 feet from west to east. Banded gneiss was seen outcropping to the northeast of Seismic Line 3.

Seismic Line 4. Seismic Line 4 is oriented north-south, perpendicular to seismic lines 1, 2, and 3. It located near the porch on the east side of the Marx dwelling. Station 1+15 of Seismic Line 4 coincides with Station 1+45 of Seismic Line 1. It crosses Seismic Line 2 at Station 0+40. The interpretation of the seismic refraction data is shown in Figure 6. The bedrock surface along this line gently decreases from an elevation of 469 feet in the north to 459 feet in the south. Outcrops of banded gneiss were visible to the north and east of Seismic Line 4.

Seismic Line 5. Seismic Line 5 is oriented north-south, approximately parallel to Seismic Line 4 and is located on the west side of the Marx dwelling. Station 1+15 of Seismic Line 5 coincides with Station 0+75 of Seismic Line 1. The interpretation of the seismic refraction data is shown in Figure 7. Bedrock shows a slight rise in the center of the line, varying between elevations of 456 and 461 feet along this line.

3.3 Integrated Interpretation

The results of the seismic refraction profiling are integrated into a bedrock contour map in Figure 8. The contour map should be considered as a general guide to bedrock elevations in areas between lines and where depth data are sparse, as in the eastern and western portions of the Site. We have a high degree of confidence for the validity of contours in areas between seismic lines. The contours for areas outside seismic lines are best estimates, with the degree of confidence decreasing with increasing distance from points at which data were collected. .

In the areas of the survey, bedrock elevations vary from 471 feet in the northwest portion of the site and 454 feet in the south, for a total relief of 17 feet. The bedrock contour map indicates a gradual decrease in bedrock elevation from north to south across the Site, as well as a possible bedrock valley trending approximately N20°W and passing under the shed and garage of the Marx residence. No clear bedrock ridge is evident on the contour map.

4. CONCLUSIONS

The seismic refraction survey at the Marx Residence Site in the Town of New Castle, Westchester County, New York, indicates that bedrock occurs between 5 and 13 feet below ground surface and that it slopes generally from north to south across the survey area. No clear ridge is indicated, but a bedrock valley with relief of 15 to 20 feet trends approximately N20°W across the Site, passing beneath the shed and garage of the Marx residence.

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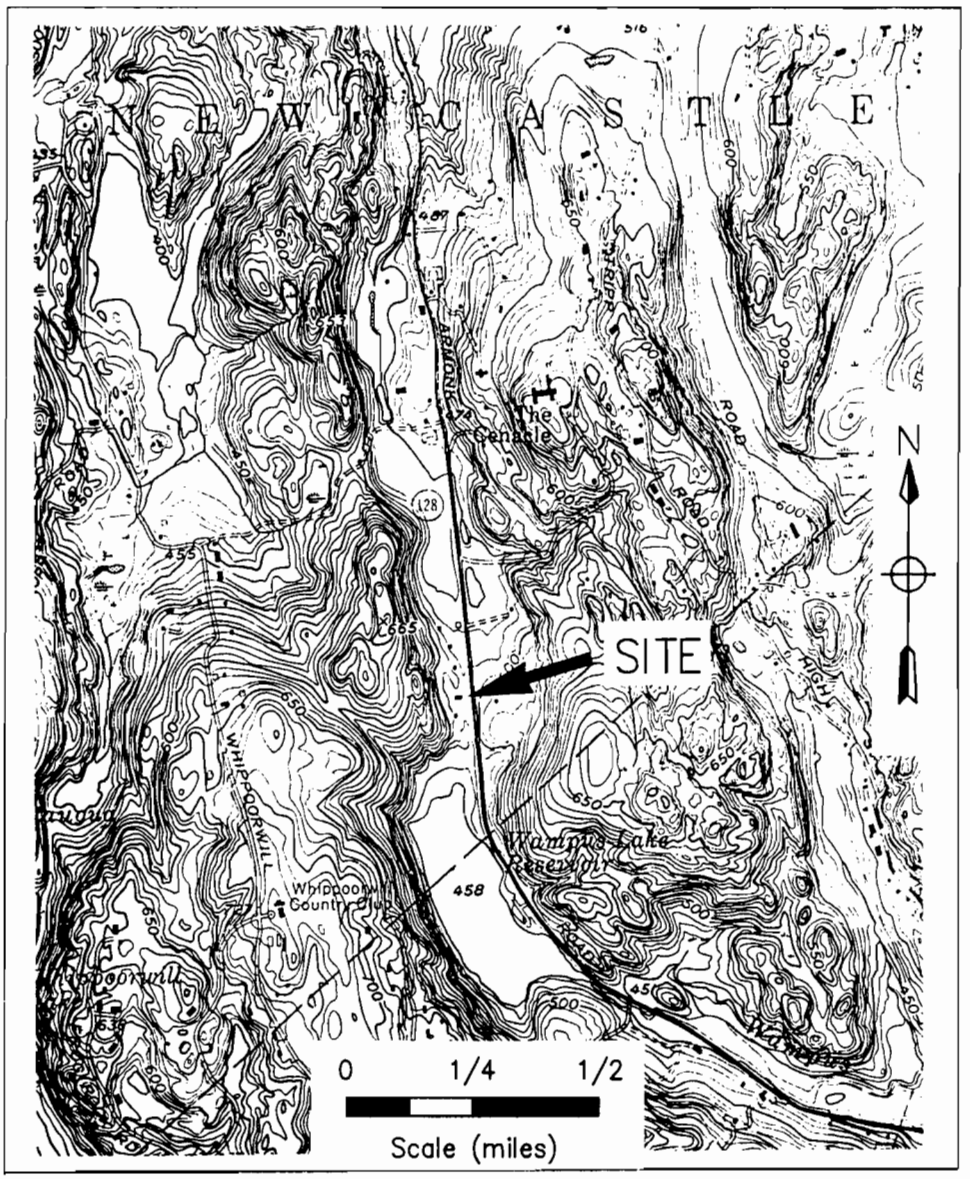

Figure 1. General location of the Site. Source: USGS Mount Kisco Quadrangle topographic map.

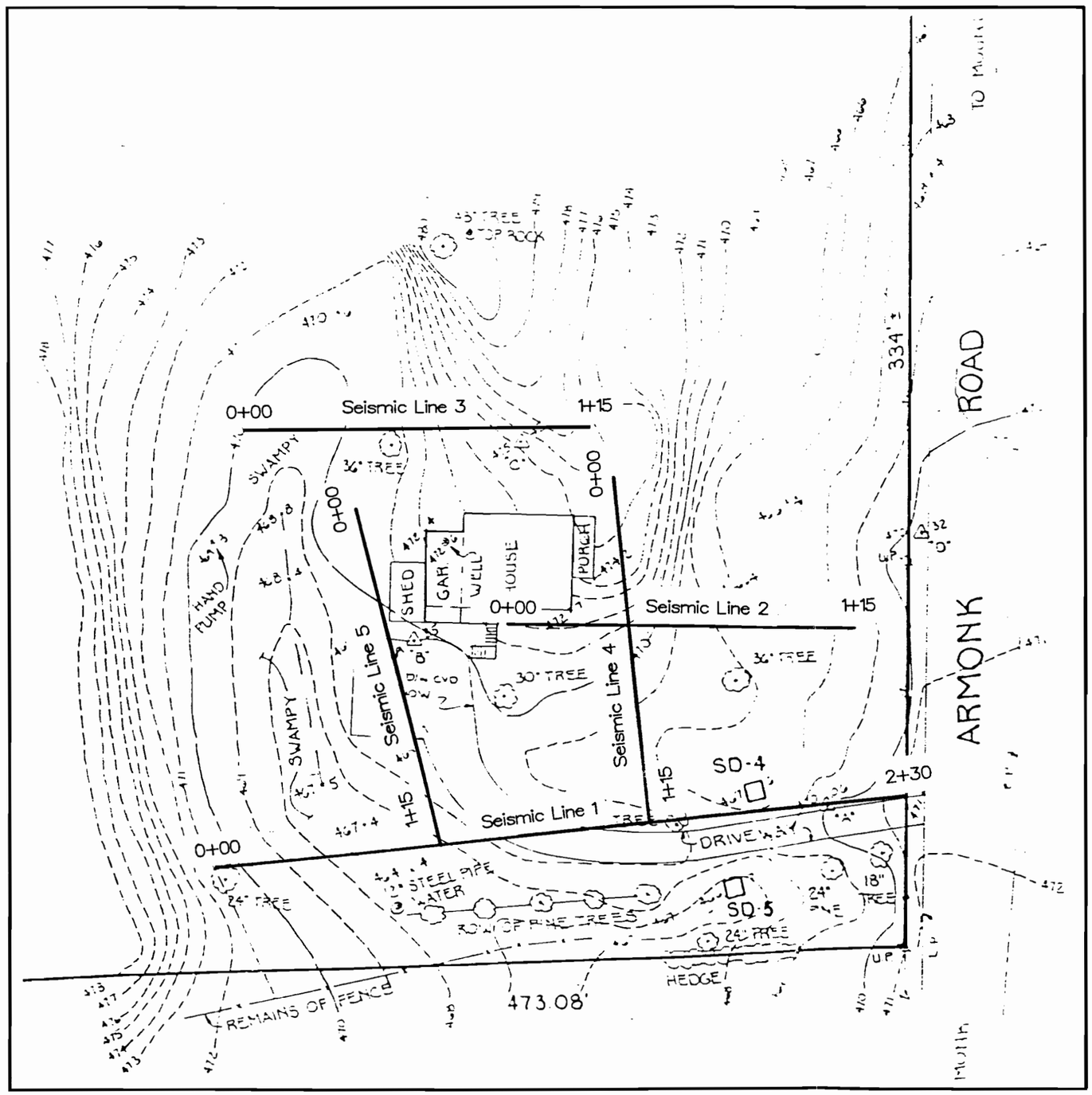

Figure 2
Locations of Seismic Lines
Marx Residence Site
New Castle, New York

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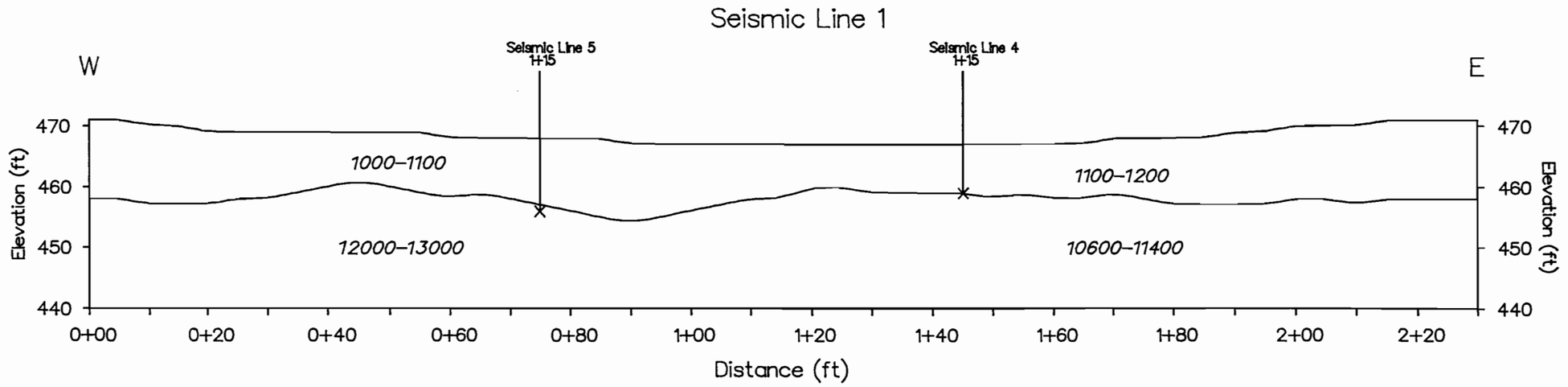

LEGEND

4800–5500 Velocity In Feet/Second

SL1 Intersecting Seismic Line With Bedrock Elevation

Scale In Feet

0 10 20 40

Figure 3
Seismic Line 1
Marx Residence Site
New Castle, New York

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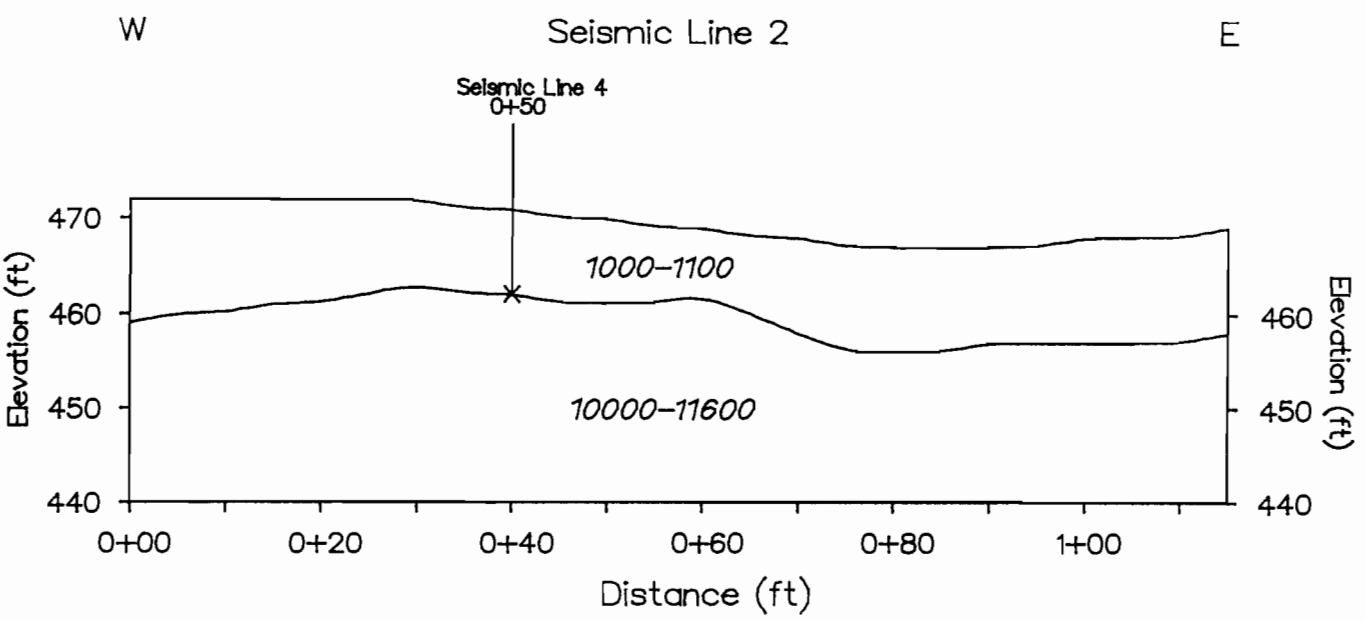

LEGEND

4800–5500 Velocity In Feet/Second

SL1 Intersecting Seismic Line With Bedrock Elevation

Scale In Feet

0 10 20 40

Figure 4
Seismic Line 2
Marx Residence Site
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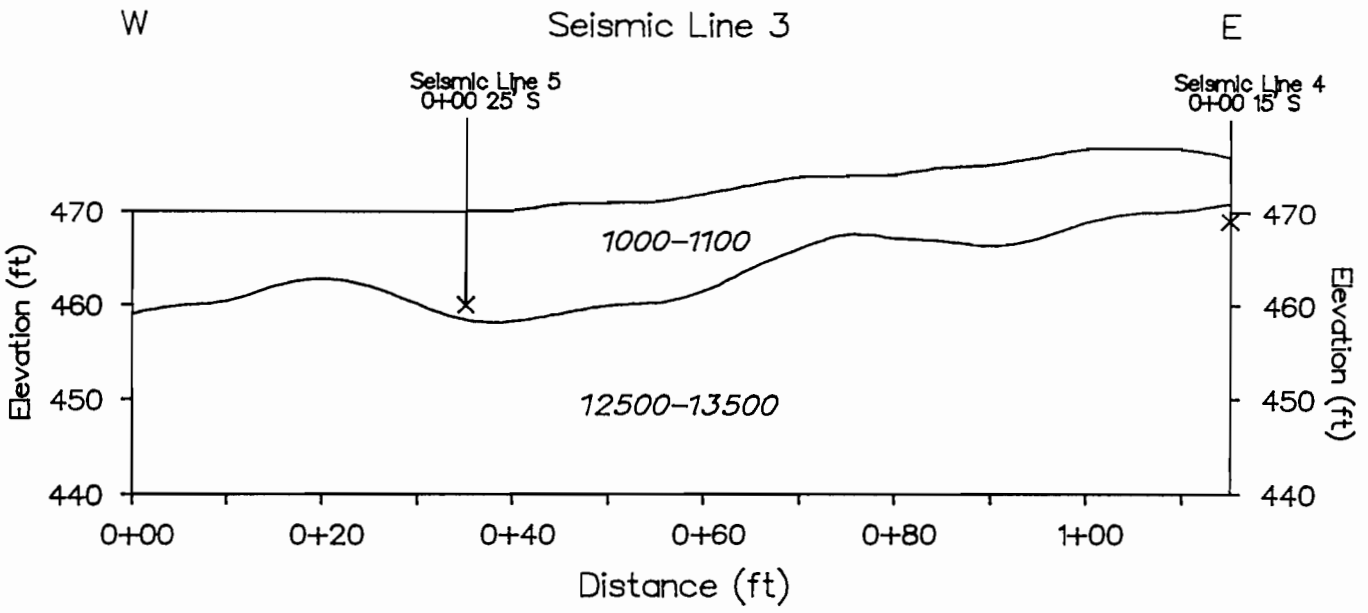

LEGEND

4800–5500 Velocity In Feet/Second

SL1 Intersecting Seismic Line With Bedrock Elevation

Scale In Feet

0 10 20 40

Figure 5
Seismic Line 3
Marx Residence Site
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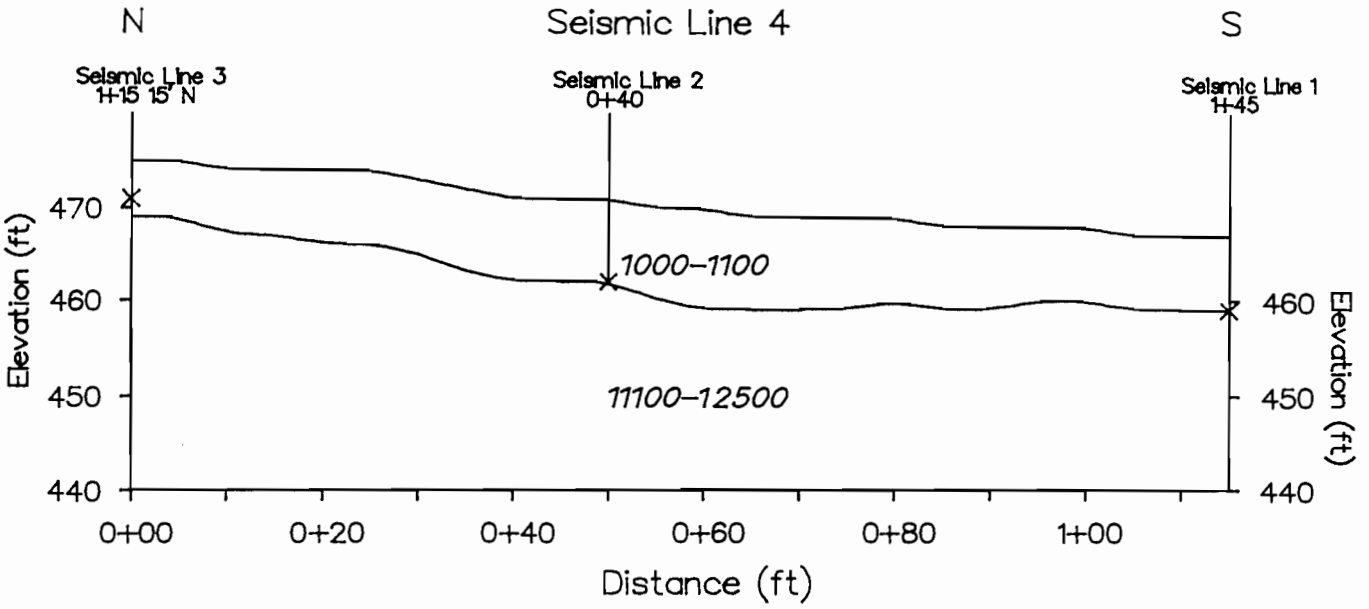

LEGEND

4800–5500 Velocity In Feet/Second

SL1 Intersecting Seismic Line With Bedrock Elevation

Scale In Feet

0 10 20 40

Figure 6
Seismic Line 4
Marx Residence Site
New Castle, New York

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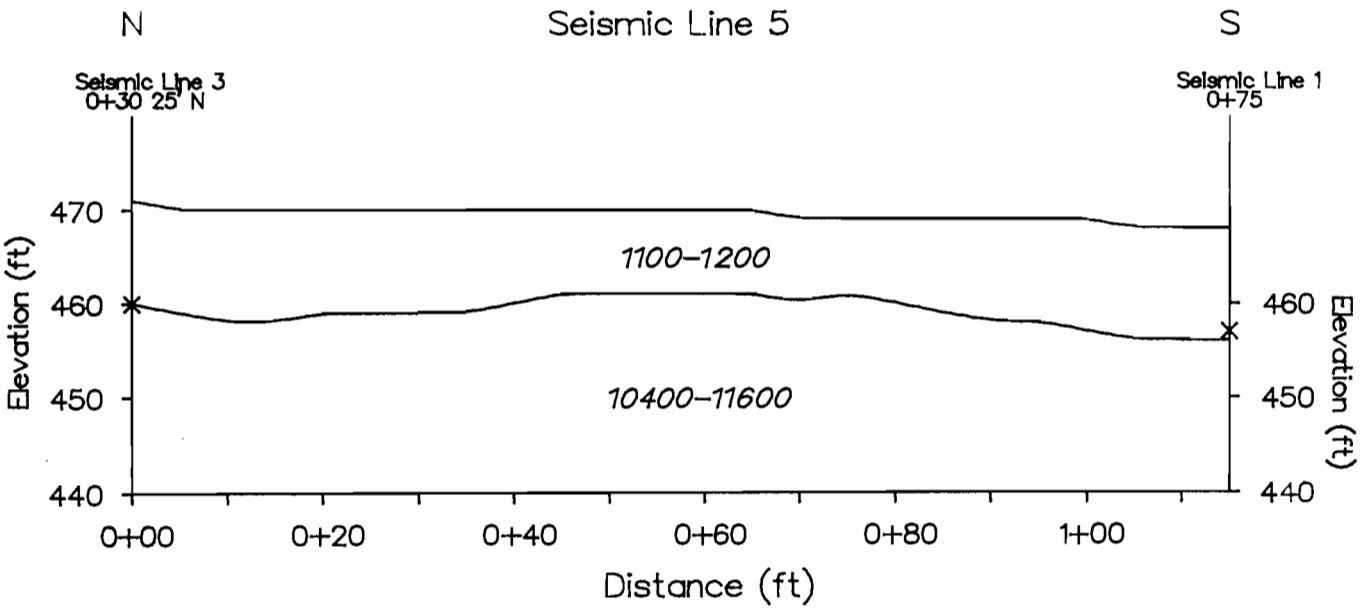

LEGEND

4800–5500 Velocity In Feet/Second

SL1 Intersecting Seismic Line With Bedrock Elevation

Scale In Feet

0 10 20 40

Figure 7
Seismic Line 5
Marx Residence Site
New Castle, New York

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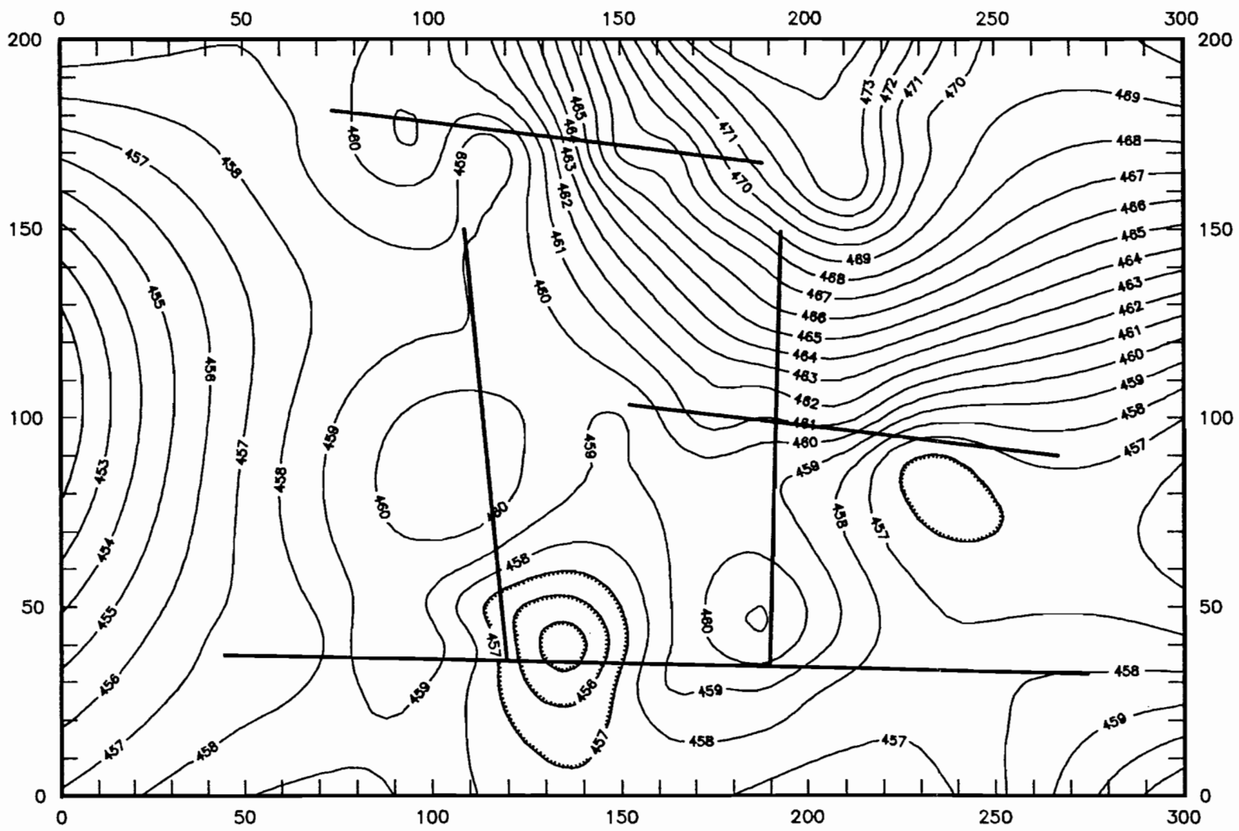

N

SCALE IN FEET

0 20 40 80

Contour Interval = 1 Foot

Seismic Line

Figure 8
Bedrock Surface Contour Map
Marx Residence Site
New Castle, New York

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TABLE 1
SUMMARY OF SEISMIC REFRACTION RESULTS
MARX RESIDENCE SITE
NEW CASTLE, NEW YORK

	GEOPHONE LOCATION (FT)	SURFACE ELEVATION (FT)	BEDROCK DEPTH (FT)	BEDROCK ELEVATION (FT)
LINE 1				
	0+00	471	13	458
	0+05	471	13	458
	0+10	470	13	457
	0+15	470	13	457
	0+20	469	12	457
	0+25	469	11	458
	0+30	469	11	458
	0+35	469	10	459
	0+40	469	9	460
	0+45	469	8	461
	0+50	469	9	460
	0+55	469	10	459
	0+60	468	10	458
	0+65	468	9	459
	0+70	468	10	458
	0+75	468	11	457
	0+80	468	12	456
	0+85	468	13	455
	0+90	467	13	454
	0+95	467	12	455
	1+00	467	11	456
	1+05	467	10	457
	1+10	467	9	458
	1+15	467	8	458
	1+20	467	7	460
	1+25	467	7	460
	1+30	467	8	459
	1+35	467	8	459
	1+40	467	8	459
	1+45	467	8	459
	1+50	467	9	458
	1+55	467	8	459
	1+60	467	9	458
	1+65	467	9	458
	1+70	468	10	459
	1+75	468	10	458
	1+80	468	11	457
	1+85	468	11	457
	1+90	469	12	457
	1+95	469	12	457

TABLE 1 (CONT.)

GEOPHONE LOCATION (ft)	SURFACE ELEVATION (Ft)	BEDROCK DEPTH (Ft)	BEDROCK ELEVATION (Ft)
LINE 1 (cont.)			
2+00	470	12	458
2+05	470	12	458
2+10	470	13	457
2+15	471	13	458
2+20	471	13	458
2+25	471	13	458
2+30	471	13	458
LINE 2			
0+00	472	13	459
0+05	472	12	460
0+10	472	12	460
0+15	472	11	461
0+20	472	11	461
0+25	472	10	462
0+30	472	9	463
0+35	471	9	462
0+40	471	9	462
0+45	470	9	461
0+50	470	9	461
0+55	469	8	461
0+60	469	7	462
0+65	468	8	460
0+70	468	10	458
0+75	467	11	456
0+80	467	11	456
0+85	467	11	456
0+90	467	10	457
0+95	467	10	457
1+00	468	11	457
1+05	468	11	457
1+10	468	11	457
1+15	469	11	458

TABLE 1 (CONT.)

GEOPHONE LOCATION (ft)	SURFACE ELEVATION (Ft)	BEDROCK DEPTH (Ft)	BEDROCK ELEVATION (Ft)
LINE 3			
0+00	470	11	459
0+05	470	10	460
0+10	470	10	460
0+15	470	8	462
0+20	470	7	463
0+25	470	8	462
0+30	470	10	460
0+35	470	12	458
0+40	470	12	458
0+45	471	12	459
0+50	471	11	460
0+55	471	11	460
0+60	472	11	461
0+65	473	9	464
0+70	474	7	466
0+75	474	6	468
0+80	474	7	467
0+85	475	8	467
0+90	475	9	466
0+95	476	9	467
1+00	477	7	469
1+05	477	7	470
1+10	477	6	470
1+15	476	5	471
LINE 4			
0+00	475	6	469
0+05	475	6	469
0+10	474	7	467
0+15	474	7	467
0+20	474	8	466
0+25	474	8	466
0+30	473	8	465
0+35	472	9	463
0+40	471	9	462
0+45	471	9	462
0+50	471	9	462
0+55	470	10	460
0+60	470	11	459
0+65	469	10	459
0+70	469	10	459
0+75	469	10	459

TABLE 1 (CONT.)

GEOPHONE LOCATION (ft)	SURFACE ELEVATION (Ft)	BEDROCK DEPTH (Ft)	BEDROCK ELEVATION (Ft)
LINE 4 (cont.)			
0+80	469	9	460
0+85	468	9	459
0+90	468	9	459
0+95	468	8	460
1+00	468	8	460
1+05	467	8	459
1+10	467	8	459
1+15	467	8	459
LINE 5			
0+00	471	11	460
0+05	470	11	459
0+10	470	12	458
0+15	470	12	458
0+20	470	11	459
0+25	470	11	459
0+30	470	11	459
0+35	470	11	459
0+40	470	10	460
0+45	470	9	461
0+50	470	9	461
0+55	470	9	461
0+60	470	9	461
0+65	470	9	461
0+70	469	9	460
0+75	469	8	461
0+80	469	9	460
0+85	469	10	459
0+90	469	11	458
0+95	469	11	458
1+00	469	13	457
1+05	468	12	456
1+10	468	12	456
1+15	468	12	456

TABLE 2
COMPARISON OF DEPTHS AT INTERSECTIONS
MARX RESIDENCE SITE
NEW CASTLE, NEW YORK

SEISMIC LINE			BEDROCK DEPTH (FT)	DIFFERENCE (FT)
Line 1	0+75		11	
Line 5	1+15		12	
				1
Line 1	1+45		8	
Line 4	1+15		8	
				0
Line 2	0+40		9	
Line 4	0+50		9	
				0
Line 3	1+15		5	
Line 4	0+00	(15' S)	6	
				1
Line 3	0+00		11	
Line 5	0+00	(25' S)	11	
				1
			Mean Difference	.60
			Standard Deviation	.55