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December 22, 2022

Ms. Jennifer Bomba
Community Development Director
Calhoun County
315 West Green Street
Marshall, Michigan 49068

Via E-mail: jbomba@calhouncountymi.gov

RE: Geodynamic Services
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01

Dear Ms. Bomba:

This report presents the results of our recent geodynamic testing and evaluation completed for a possible manufacturing facility to be constructed within the Marshall Megasite.

PROJECT BACKGROUND

The Marshall Megasite is located in Marshall Township, Calhoun County, Michigan. In general terms, the Marshall Megasite is located south of M-96 (Michigan Avenue), north of the Kalamazoo River, east of 12 Mile Road, and west of 15 Mile Road. For this evaluation, SME was requested to perform geodynamic services within a portion of the overall Marshall Megasite north of C Drive N being considered for potential development. The area (shown in yellow on Image 1 below) comprises approximately 260 acres.

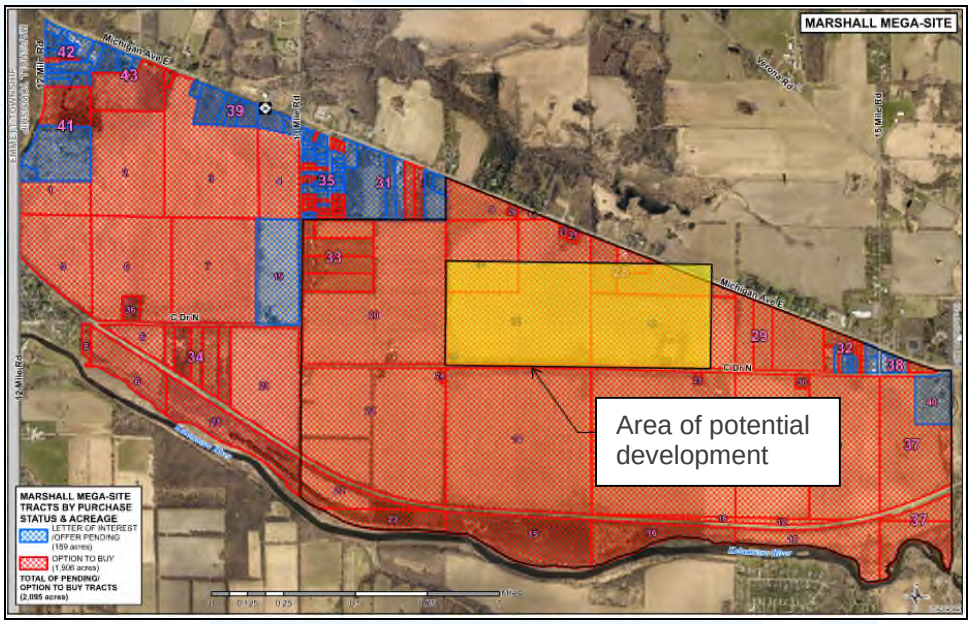


IMAGE NO. 1: Marshall Michigan Megasite Boundary and Limits Of Geodynamic Services Covered As Part of This Report

SME previously completed two preliminary geotechnical evaluation reports for the Marshall Megasite. Reference SME's geotechnical reports dated February 1, 2022 (Project No. 088106.00) for details. In these reports, we concluded Seismic Site Class D likely applied to the majority of the Marshall Megasite in the absence of shear wave velocity data available for further analysis. SME has since been requested to obtain geodynamic properties of the site soils and sandstone for exploring the possibility of assigning a more favorable seismic site class that could result in cost savings for future projects. Our initial phase of testing (with results presented in this report) includes the area of potential development included in Image 1 above. We plan to complete additional geodynamic field testing for the remainder of the site in a future phase of work.

GEODYNAMIC EVALUATION

MAM AND MASW FIELD TESTING AND ANALYSIS

SME visited the site on December 5 and 6, 2022, to perform Multi-Channel Analysis of Surface Waves (MASW) and Microtremor Array Method (MAM) tests within/near the proposed limits of the manufacturing facility parcel. The purpose of the testing was to measure shear wave velocities in the upper 100 feet of the subsurface profile. The surface waves were recorded at the ground surface along a series of low-frequency geophones aligned in a specific pattern at six locations. The test locations/geophone arrangements are shown on the attached Geophysical Test Location Diagram (Figure 1).

At the field survey locations, MASW and MAM tests were performed to produce a shear wave velocity profile for the site. The MASW and MAM testing was conducted using a 16-channel Geometrics ES3000 seismograph and 4.5 Hz (natural frequency) vertical geophones. For the MASW testing, which is also referred to as the "active" source method, the geophones were spaced in a linear geometry at intervals of 5 or 10 feet, and surface waves generated by a person striking a 16-pound sledgehammer against a metal plate on the ground surface. MASW was used to record the higher-frequency surface waves at relatively shallow depths in the profile.

MAM testing, which is also referred to as the "passive" source method, was conducted with an "L-shaped" array. We used a geophone spacing of 30 feet in an array with 150-foot lines in two nearly perpendicular directions. The MAM method collects "passive" vibration data from ambient or background vibration sources (microtremors). MAM was used to record the lower-frequency surface waves within the deeper portions of the profile. Since the source locations of the microtremors are not known, the two-dimensional array geometry was used to distinguish the direction of the microtremors, which is critical in analyzing the collected data.

The analysis was conducted using the OYO Corporation's SeisImager/SW software *(Pickwin and Wave Eq)*. Recorded surface waves were transformed from the time domain into the frequency domain, from which the phase characteristics of the surface waves were determined. A dispersion curve (also known as the phase velocity curve) was developed allowing the phase velocity (C_f) of particular frequency waves to be calculated. By combining the dispersion curves from both MASW and MAM tests prior to the inversion process, a wider range of frequency surface waves, which corresponds to a wider range of velocities at both shallow and deeper depths within the soil profile was obtained. The dispersion curve was then transformed into the shear-wave velocity profile through complex inversion and interactive processing. Graphical shear wave velocity profiles for the 6 test locations are included in Figure No. 2 through 7 attached to this report.

SEISMIC SITE CLASSIFICATION

The table below summarizes the average shear wave velocities calculated in the upper 100 feet of the subsurface profile at the test locations.

TABLE 1: AVERAGE SHEAR WAVE VELOCITY SUMMARY

TEST LOCATION	AVERAGE SHEAR WAVE VELOCITY (FT/SEC)
1	1,649
2	1,492
3	1,561
4	1,556
5	1,703
6	1,443

NOTE: Average velocity calculated within the upper 100 feet of the subsurface profile.

The average shear wave velocity in the upper 100 feet of the subsurface profile varied from 1,441 to 1,703 feet per second at the locations tested. Based on this information, **Seismic Site Class C** applies for the proposed manufacturing facility, referencing Table 20.3-1 in ASCE Standard ASCE/SEI 7-16.

The proposed manufacturing facility is located at the approximate geographic location latitude N42.27272 degrees and longitude W85.02383 degrees. Based on the location of the site, the mapped and calculated accelerations are summarized in the table below. Based on the referenced design values, **Seismic Design Category A** is applicable for this site for both Risk Category 3 and 4. The Risk Category of the structure shall be determined by the structural engineer.

TABLE 2: SEISMIC DESIGN PARAMETERS

SEISMIC DESIGN PARAMETERS FROM 2015 MBC/ASCE 7-16	SEISMIC DESIGN VALUES
Latitude	N42.27272
Longitude	W85.02383
Site Class per Table 20.3-1 of ASCE 7-16	C
Spectral Acceleration for Short Periods (Ss)	0.117g
Spectral Accelerations for 1-Second Periods (S_1)	0.052g
Design Spectral Response Acceleration at Short Periods (S_{DS})	0.101g
Design Spectral Response Acceleration at 1-Second Period (S_{D1})	0.052g
Seismic Design Category, per Section 11.6 of ASCE 7-16	A

GENERAL COMMENTS

This report has been prepared in accordance with generally accepted geodynamic engineering practices to assist in the design of this project. This report provides recommendations regarding seismic design based on MAM/MASW surveys at the site shown at the approximate locations on the attached Geophysical Test Location Diagram, the available soil borings, and our experience with local geologic conditions. Additional testing will be required to evaluate the seismic design parameters across the remainder of the site, i.e. outside of the limits depicted in Image 1.

This report has been prepared solely for the use of the client (with reliance to the property buyer) for the project boundary specifically described in this report.

We appreciate the opportunity to serve you on this project. If you have questions regarding this report or the attached information, please contact us.

Sincerely,

SME

Alex Kuisell
Dec 22 2022 2:50 PM

FOR Alex Kuisell
Dec 22 2022 2:51 PM

WRITTEN BY:
Alex Kuisell
Senior Project Engineer

REVIEWED BY:
Christopher G. Naida, PE
Senior Consultant

Aaron Reed
Dec 22 2022 2:34 PM

PROJECT MANAGER:
Aaron J. Reed, PE
Senior Consultant

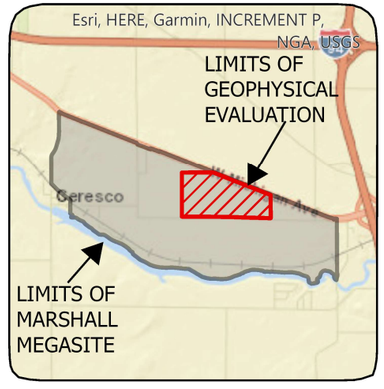
Attachments:
Figure 1: Geophysical Test Location Diagram
Figure 2: Shear Wave Velocity Profile (Location 1)
Figure 3: Shear Wave Velocity Profile (Location 2)
Figure 4: Shear Wave Velocity Profile (Location 3)
Figure 5: Shear Wave Velocity Profile (Location 4)
Figure 6: Shear Wave Velocity Profile (Location 5)
Figure 7: Shear Wave Velocity Profile (Location 6)

N

0 220 440 Feet

Legend

- APPROXIMATE MARSHALL MEGASITE BOUNDARY
- APPROXIMATE MAM TEST LOCATION
- APPROXIMATE MASW TEST LOCATION
- TEST LOCATION



LOCATION MAP
NOT TO SCALE

SME

Project Name:
MARSHALL MEGASITE: GEOTECHNICAL

Project Location:
CALHOUN COUNTY, MICHIGAN

Sheet Name:
GEOPHYSICAL TEST LOCATION PLAN

No.	Revision Date

Date: 12-20-2022

GIS TECHNICIAN: T. MAHANY

Designer: A. KUISELL

Scale: AS SHOWN

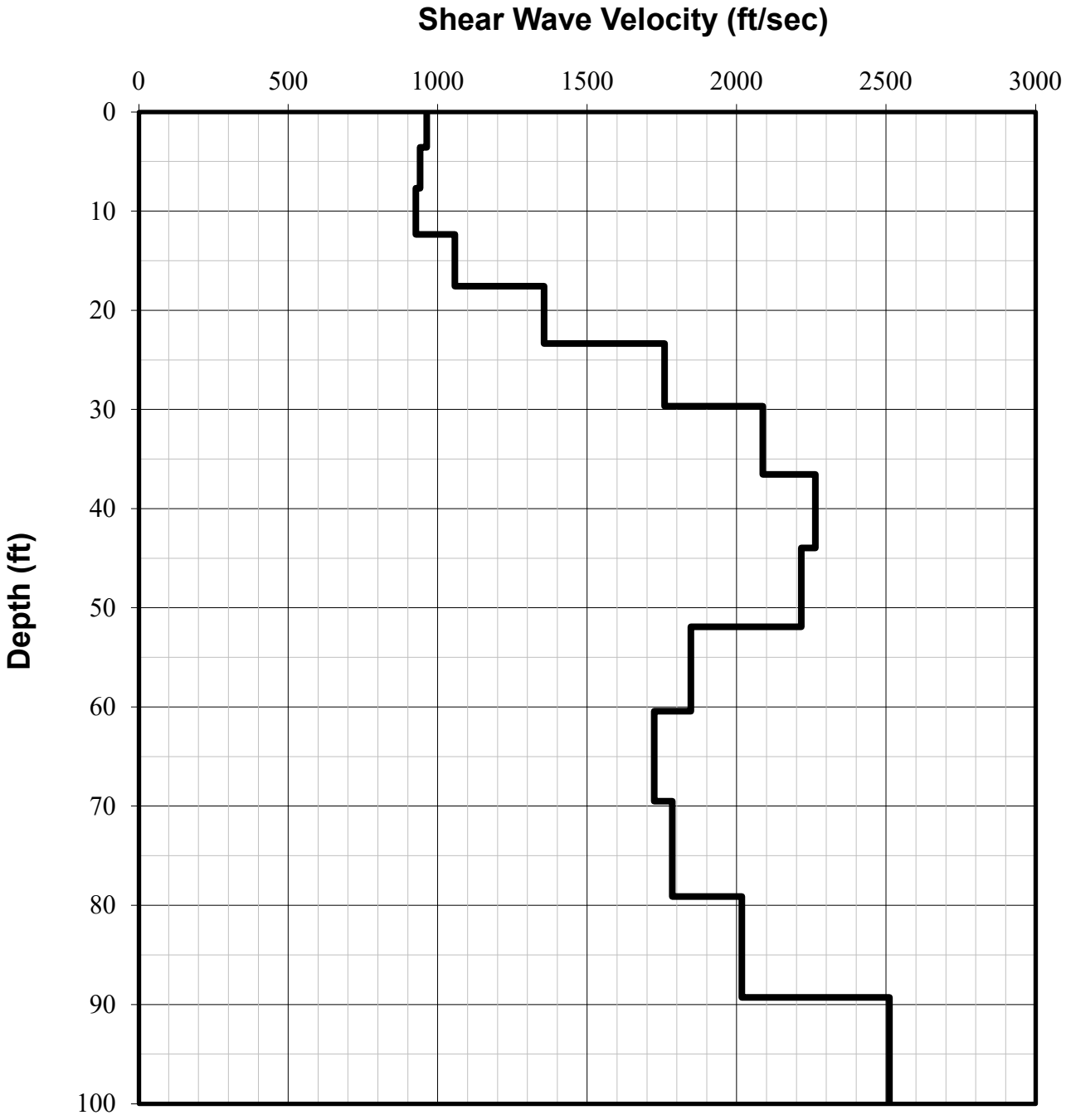
Project: 091434.01

Figure No.: **1**

MAP NOTE: SCALE DEPICTED IS MEANT FOR 11' X 17" AND WILL SCALE INCORRECTLY IF PRINTED ON ANY OTHER SIZE MEDIA

FIGURE 2

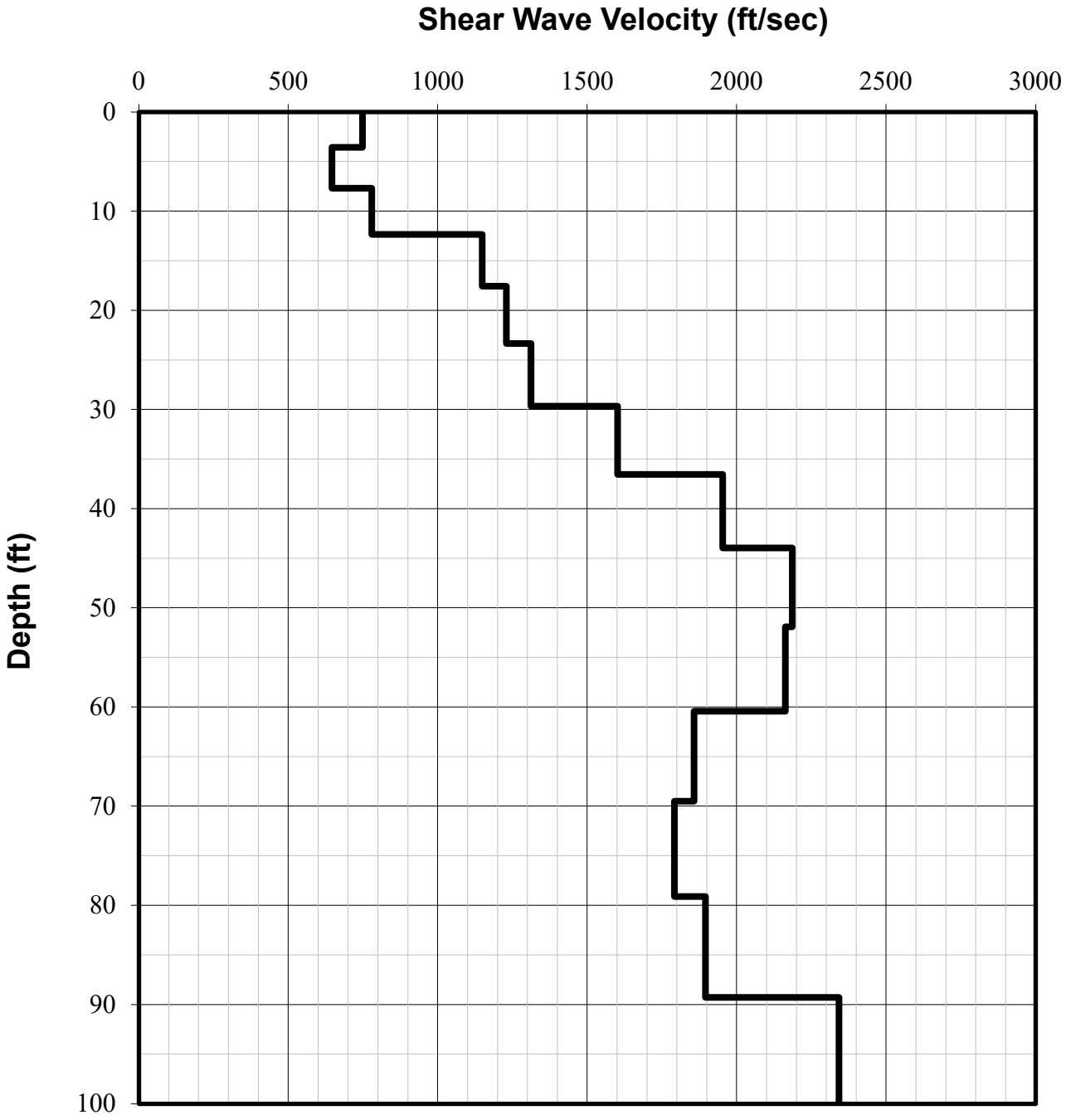
SHEAR WAVE VELOCITY PROFILE - Test Location #1
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,649 ft/sec

FIGURE 3

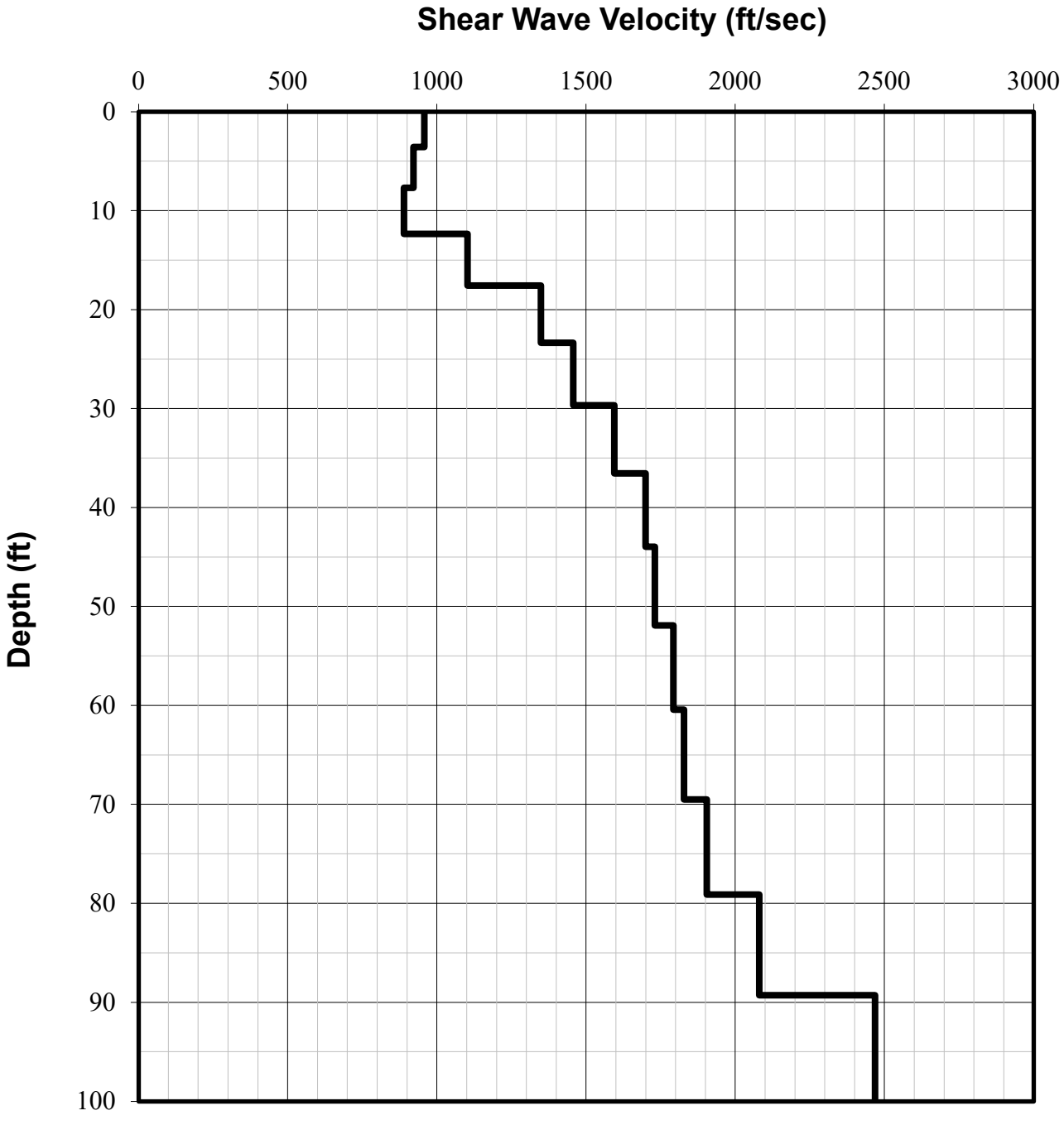
SHEAR WAVE VELOCITY PROFILE - Test Location #2
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,492 ft/sec

FIGURE 4

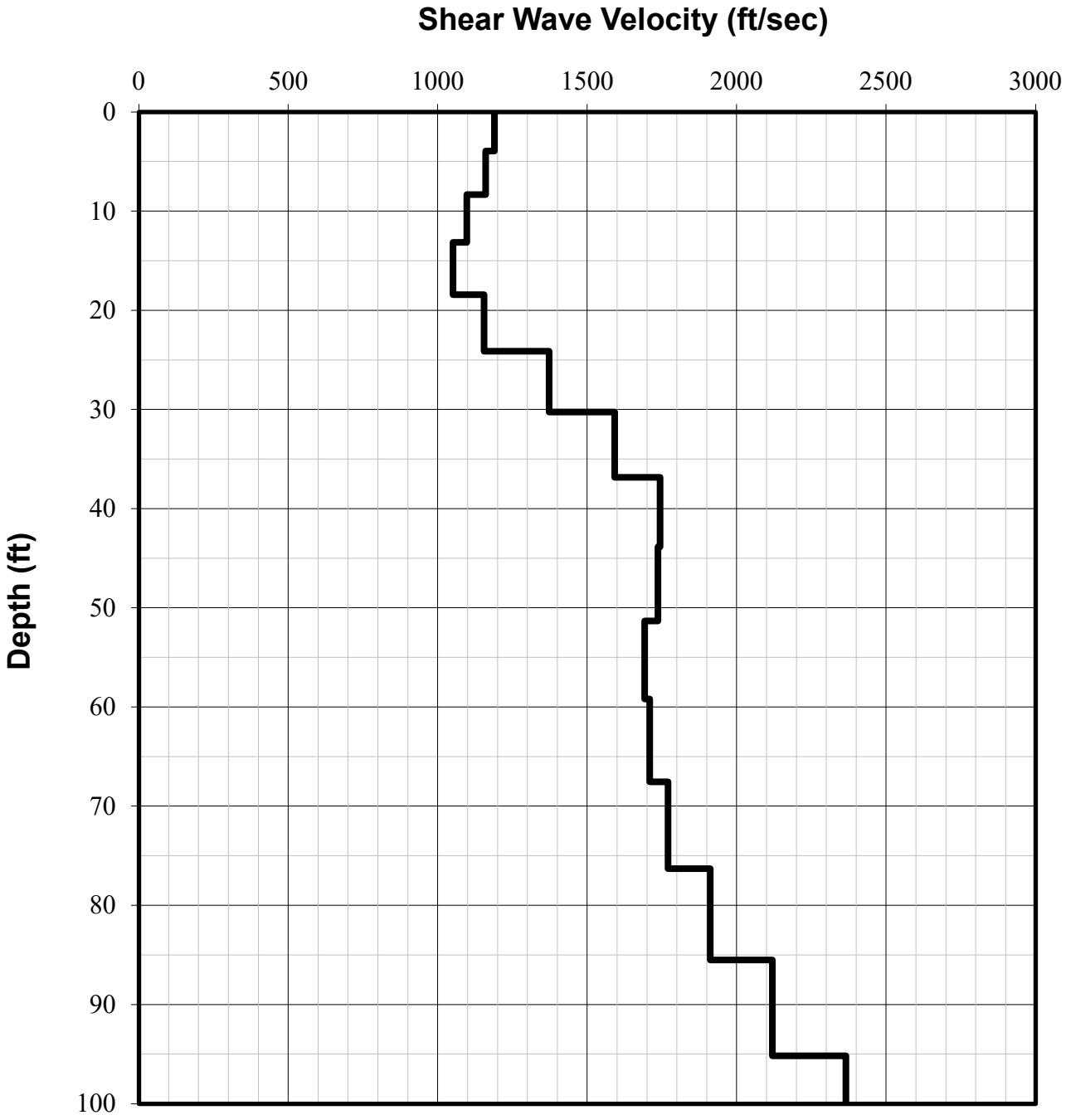
SHEAR WAVE VELOCITY PROFILE - Test Location #3
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,561 ft/sec

FIGURE 5

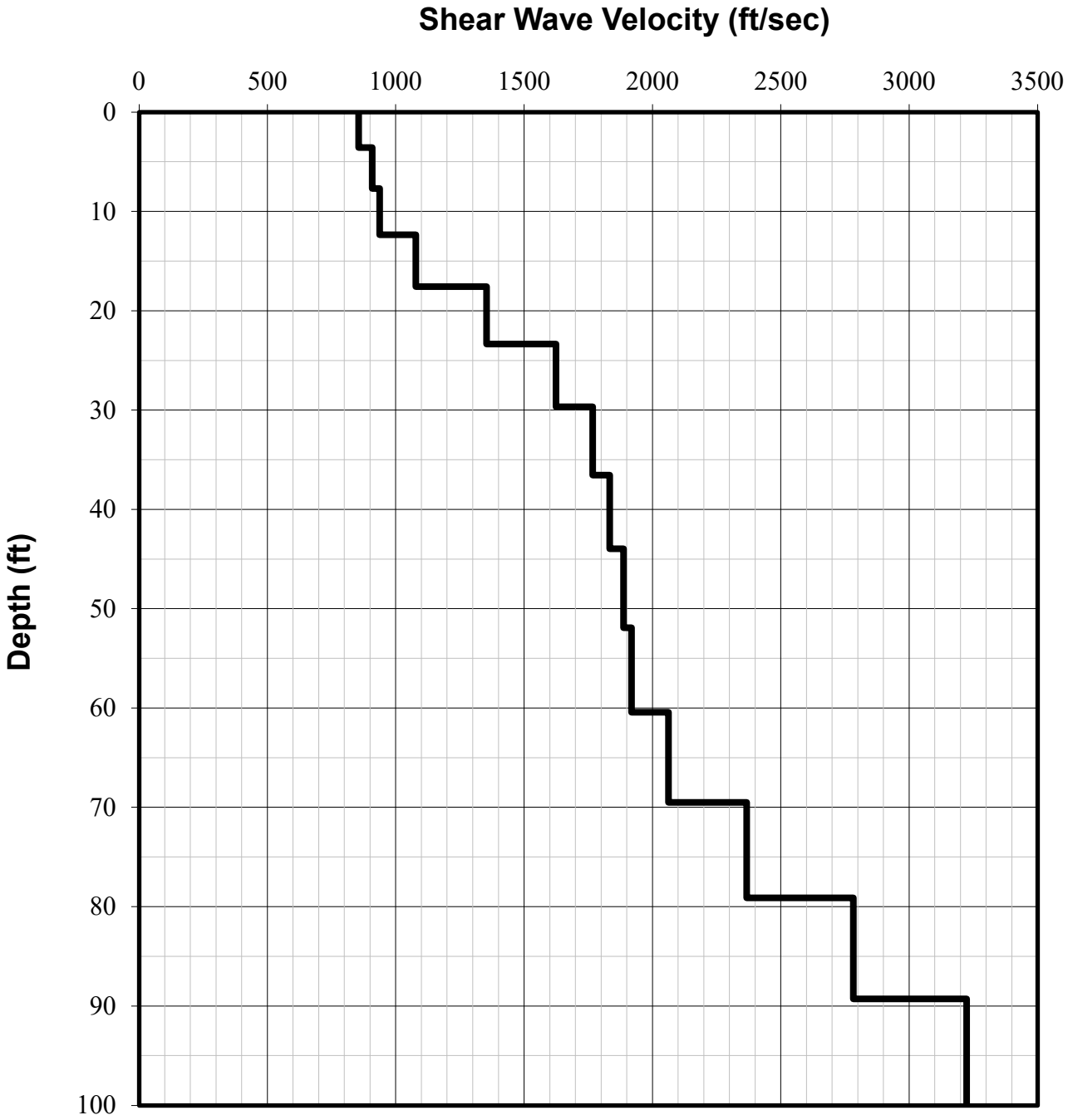
SHEAR WAVE VELOCITY PROFILE - Test Location #4
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,556 ft/sec

FIGURE 6

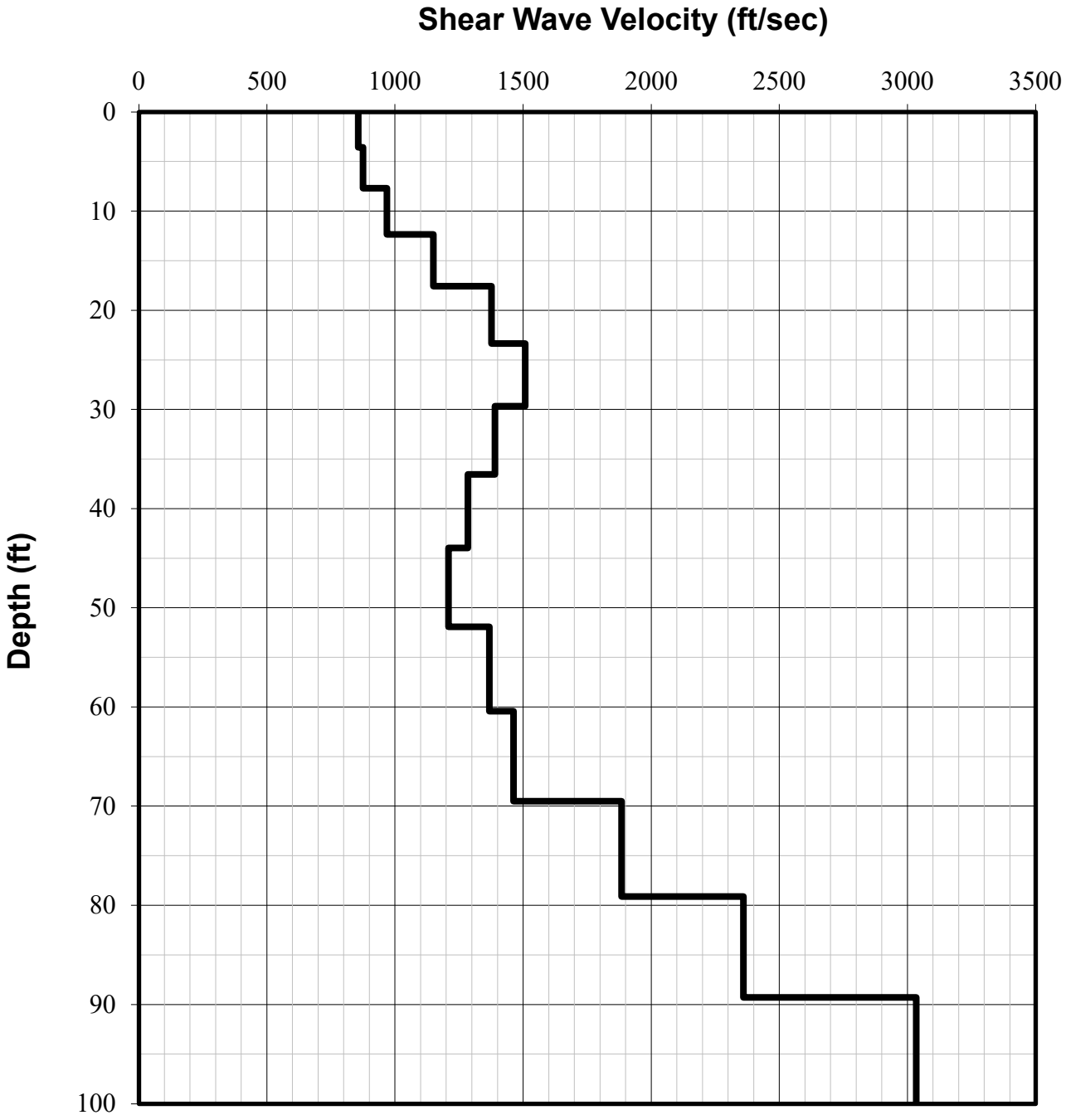
SHEAR WAVE VELOCITY PROFILE - Test Location #5
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,703 ft/sec

FIGURE 7

SHEAR WAVE VELOCITY PROFILE - Test Location #6
Marshall Megasite: Geotechnical
Marshall Township, Calhoun County, Michigan
SME Project No. 091434.01



Average Shear Wave Velocity (Upper 100 feet) = 1,443 ft/sec