# Appendix 2.5B—High Resolution Compressional Seismic Survey Field Report

(Excludes Appendices)

Prepared by
Bay Geophysical, Inc.
February 8, 2006

Bay Geophysical, Inc.

# FIELD REPORT

## High Resolution Compressional Seismic Survey Vogtle Electric Generating Plant Burke County, Georgia

*Prepared for:*

**Southern Nuclear Operating Company**
**Work Order SN050193**

*Birmingham, AL*

**February 8, 2006**
Bay Project Number: **6011SNC**

*Prepared By:*


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# Bay Geophysical

March 16, 2006

Donald Moore
Southern Nuclear
Building 42
Inverness Center Parkway
Birmingham, AL 35242
(205) 992-6672

Re: Final Deliverables, Seismic Surveys Vogtle Electric Generating Plant

Don,

Please find enclosed the final deliverables for the Vogtle Electric Generating Plant. This package includes:

1. Corrected text as per Randy Cumbest's request in the final field report. This replaces all text of the report that you already have.
2. I copy of the CDROM for Appendix E, .SEGY files for the reflection data. Final static information is supplied in the .a_db files. This CDROM replaces the existing CDROM in Appendix E.
3. Appendix E plots of the extended processing of the reflection Lines 1 through 4. The extended versions have FX Decon, FX Decon (fx) with Spectral Whitening (whtfx) and FX Decon, Spectral Whitening and Migration (whtfx-migr) applied. These versions can be appended to the existing seismic reflection plots (stack 1) in this appendix.
4. I copy of the CDROM for Appendix F, .SEGY files for the depth migration sections, .PDF files of the refraction inversions and .PDF files of the depth migration sections. Paper plots of the depth migration sections can be appended to the existing refraction plots in this appendix. The CDROM can replace the existing CDROM in this appendix. Also, a brief report from Optim regarding processing information can be put into Appendix F as well.

This should conclude the deliverable part of this project. These deliverables have also been sent to Scott Lindvall of Lettis & Associates, Inc. and Randy Cumbest. If you have any questions, please call.

Best Regards,

Phil Van Hollebeke
Bay Geophysical, Inc.



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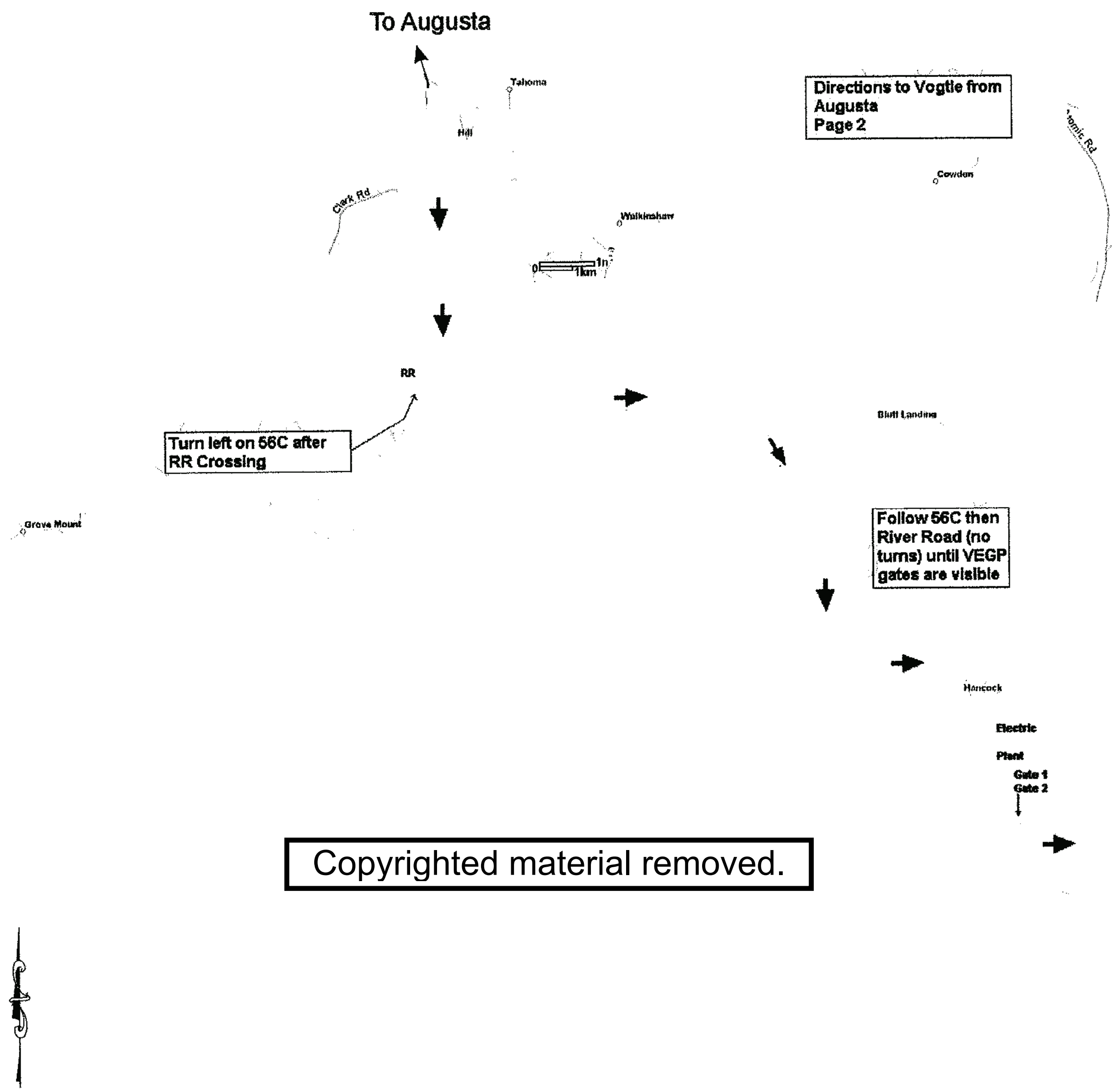





Figure 1-1
General Location of
Vogtle Electrical Generation Plant
Burke County, GA
Work Order SN050193

Approved By: NAS Date:

Not scale

# 1.0 INTRODUCTION

Bay Geophysical, Inc. (Bay) performed high resolution seismic compressional (P-) wave surveys in eastern Georgia within the Vogtle Electric Generating Plant (VEGP) south of Augusta, GA in Burke County for Southern Nuclear Operating Company (SNOC). This report details the daily field activities performed in January and February 2006.

The general location of the VEGP is illustrated in Figure 1-1. The work performed by Bay consisted of the acquisition of high resolution compressional (P- Wave) seismic reflection and refraction data and final field report generation. The land survey was performed by Georgia Power and contracted under SNOC. Bay sub-contracted Sterling Seismic Services to process the seismic reflection data and Optim Software (Optim) to process the seismic refraction data. The results of these surveys will be interpreted by others as directed by SNOC.

Deliverables by Bay will include all daily logs, observer's logs, various system and acquisition tests, raw seismic refraction and reflection data, processed seismic refraction and reflection data and a final field report summarizing all deliverables.

## 1.1 Purpose of the Survey

The objective of the geophysical survey was to image the Pen Branch Fault that is thought to intersect beneath VEGP in a northeast to southwest trend. The objective of the seismic reflection data is to image the subsurface formations and any offsets as a result of faulting. The objective of the seismic refraction data is to perform a depth migration to image the dip of the fault.

The total field effort consisted of acquiring reflection and refraction seismic data acquisition. The four seismic reflection profiles totaled 3140 records and 3 seismic refraction profiles totaling 434 records. As seen from the line location map in Figure 1-1, all of the seismic lines were acquired within the VEGP property, except for Line VEGP3. The end of this line, after crossing Hancock Road, traverses onto private property.

The initial P- Wave parameter testing began on January 24, 2006 on Line 1. Data acquisition began immediately after parameter testing and was completed on February 9, 2006. All data were submitted to Sterling and Optim after the completion of each line. The results, without interpretation, of the final processing are included in this report in SEG standard SEGY formatted files.

# 2.0 SITE DESCRIPTION

## 2.1 Line Locations and Site Conditions

### *2.1.1 Line Locations*

The seismic reflection lines were located within VEGP along existing roads, power lines and cross country. The general locations of these lines are displayed in Figure 1-2, while the shotpoint maps for the reflection and refraction surveys are displayed in Figures 1-2A and 1-2B respectively.

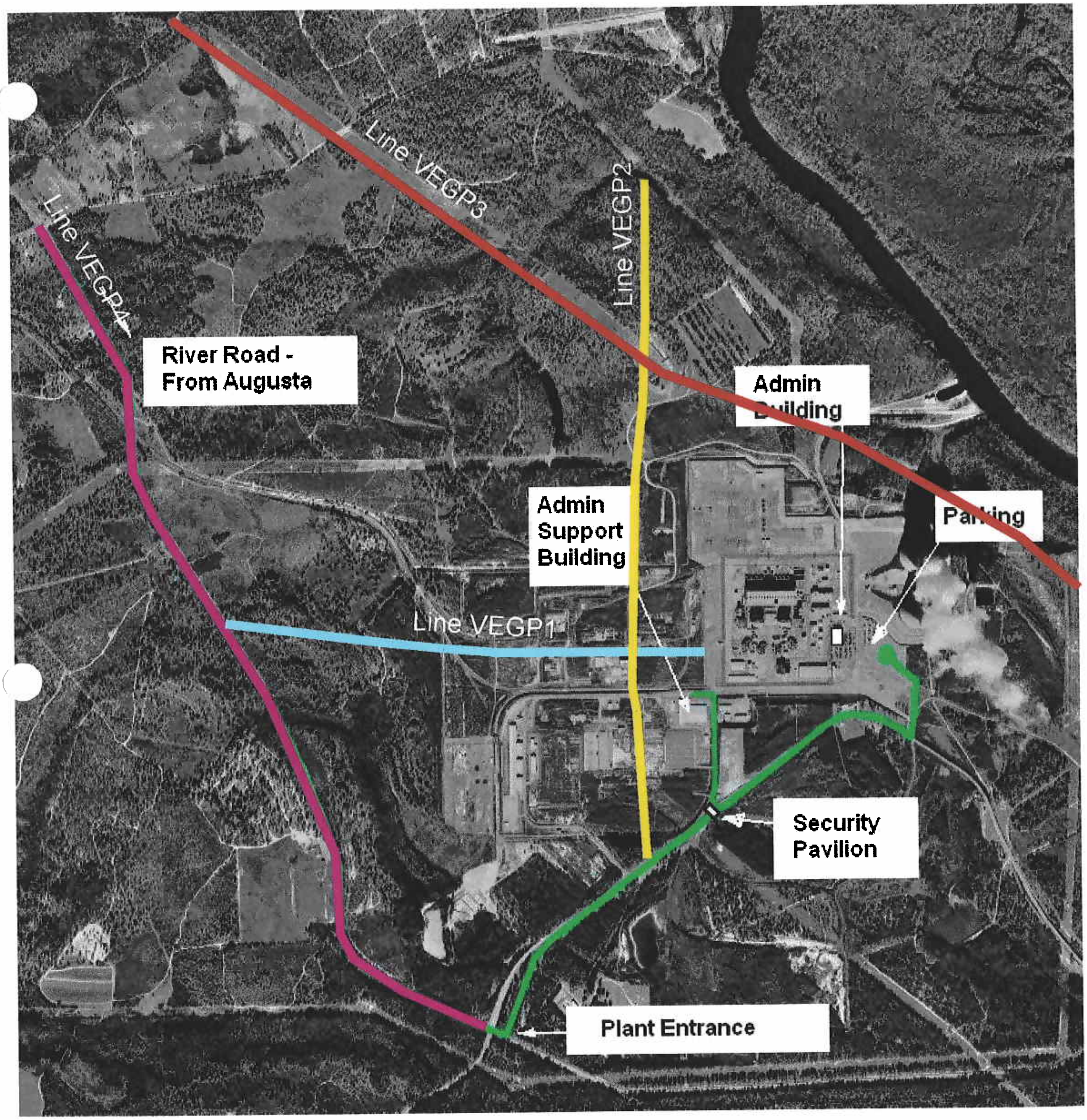
Lines 1, 2 and 3 reflection were acquired with 10 foot receiver and 10 foot source intervals and Line 4 reflection was acquired with 20 foot receivers and 20 foot source intervals as requested by SNOC. Refraction Lines 1, 3 and 4 were acquired with 50 foot receivers and 100 foot source intervals. Table 2.1.1.1 below summarizes the length of each line and a brief description of their location.

Table 2.1.1.1
Survey Line Lengths and Locations

| Line | Length | Type | Location |
|---|---|---|---|
| 1 | 5,970 | Reflection and Refraction | Starts at River Road and runs east toward generating plant |
| 2 | 6,400 | Reflection Only | Runs south to north along the west end of the generating plant and crosses Lines 1 and 2 |
| 3 | 13,000 | Reflection and Refraction | Runs southeast to northwest beneath power line along the south edge of Savannah River |
| 4 | 11,980 | Reflection and Refraction | Starts at the plant access road along River Road to the northwest |

### *2.1.2 Site Conditions*

Geophones and cables were placed off roadways as road ditches provided better coupling of geophones and reduced the obstruction of normal vehicular traffic on VEGP property. The vibrator operated adjacent to the road right of way, moving with traffic. The vibrator was not authorized to work on the road surface. When larger or heavier traffic existed, data acquisition halted briefly until the traffic passed.

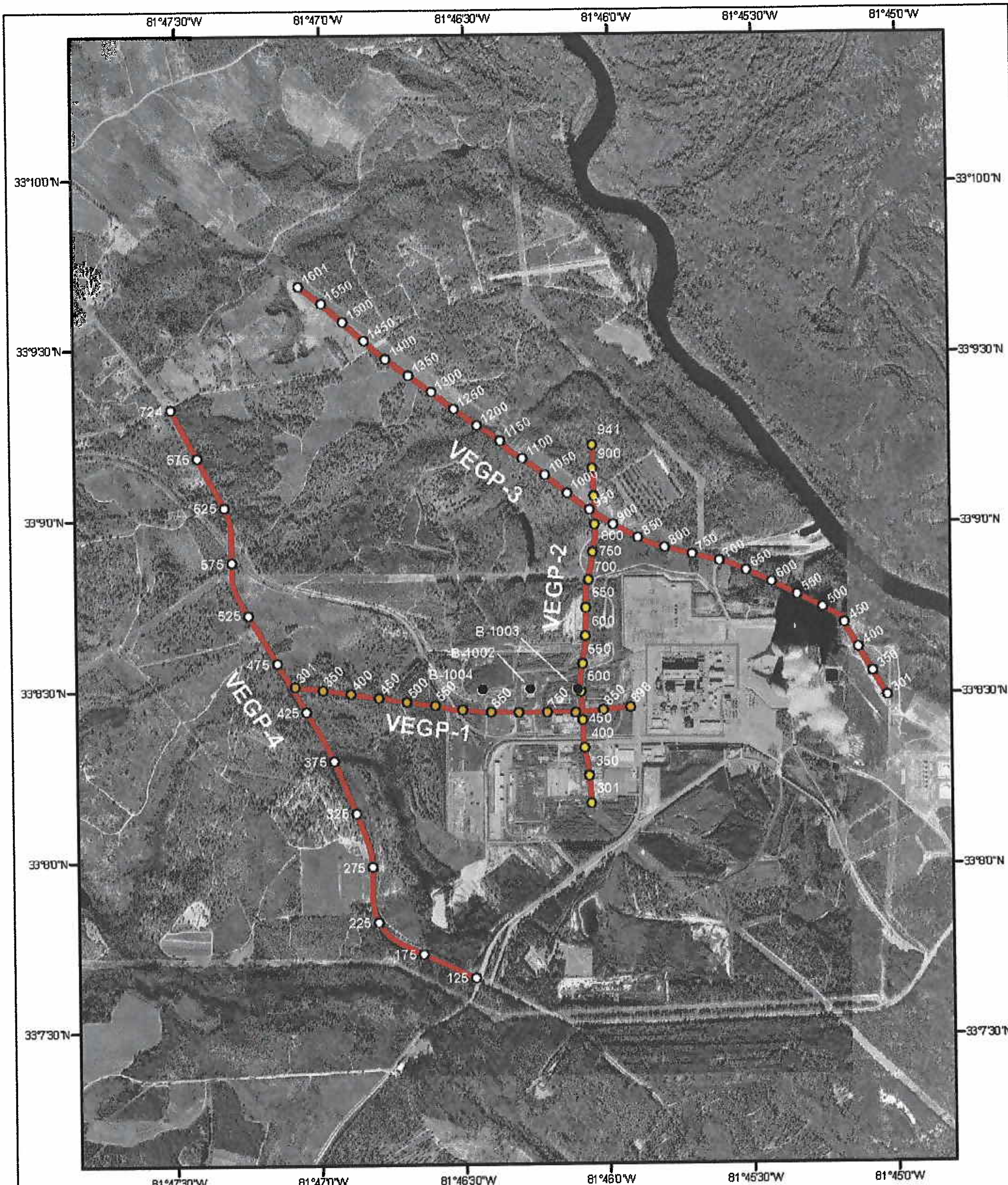



Approved By: NMS

Date: 03/10/06

Figure 1-2
Site Map With Line Locations
Vogtle Electrical Generation Plant
Burke County, GA
Work Order SN050193

Not to scale




**Explanation**

- Vibe Points
- Vogtle Borings

0 0.25 0.5 1 Miles

N

Map Provided by William Lettis & Associates, Inc.

Figure 1-2A
Reflection Shotpoint Map
Vogtle Electrical Generation Plant
Burke County, GA
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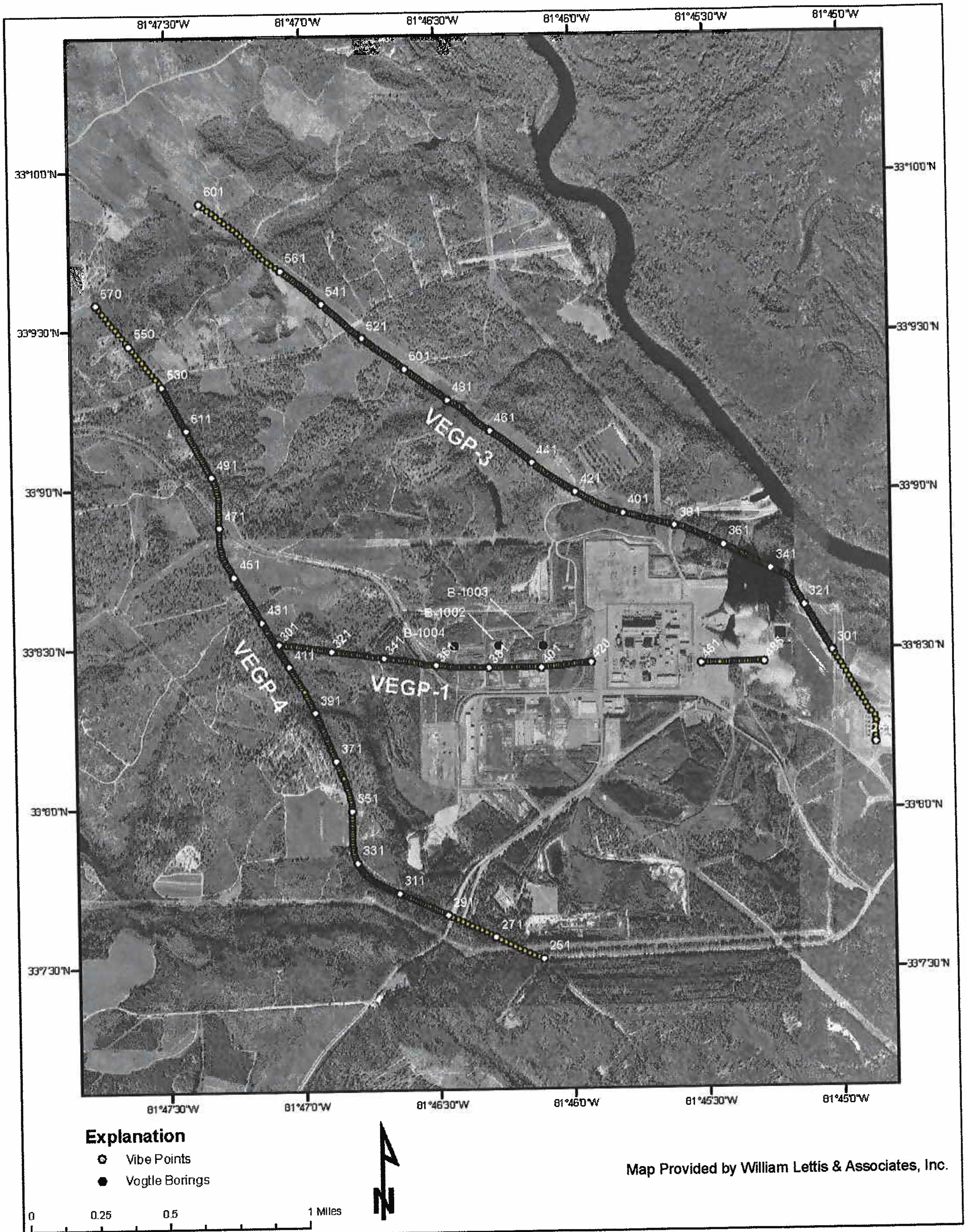


Figure 1-2B
Refraction Shotpoint Map
Vogtle Electrical Generation Plant
Burke County, GA
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Some site noise was observed along Lines 1, 2 and 3. The majority of the noise was determined to originate from the plant. Specifically, the second half of Line 1 and the center portion of Line 2 experienced turbine noise. Line 3 experienced similar noise but its location being further from the plant than Lines 1 and 2; the noise may be attributed to geology. During seismic data acquisition, 6 sweeps was the nominal stack used. In noisy areas, the number of sweeps was increased to help improve the signal in an attempt to overcome some of the noise emanating from the plant. In some cases, for instance Line 1 and 2, this did improve the data; however this did not improve the data on Line 3. Since the increase in number of sweeps on Line 3 did not improve the data, it is possible that the noisier records could be attributed to localized geology.

# 3.0 GEOPHYSICAL SURVEY METHODS

## 3.1 Seismic Reflection

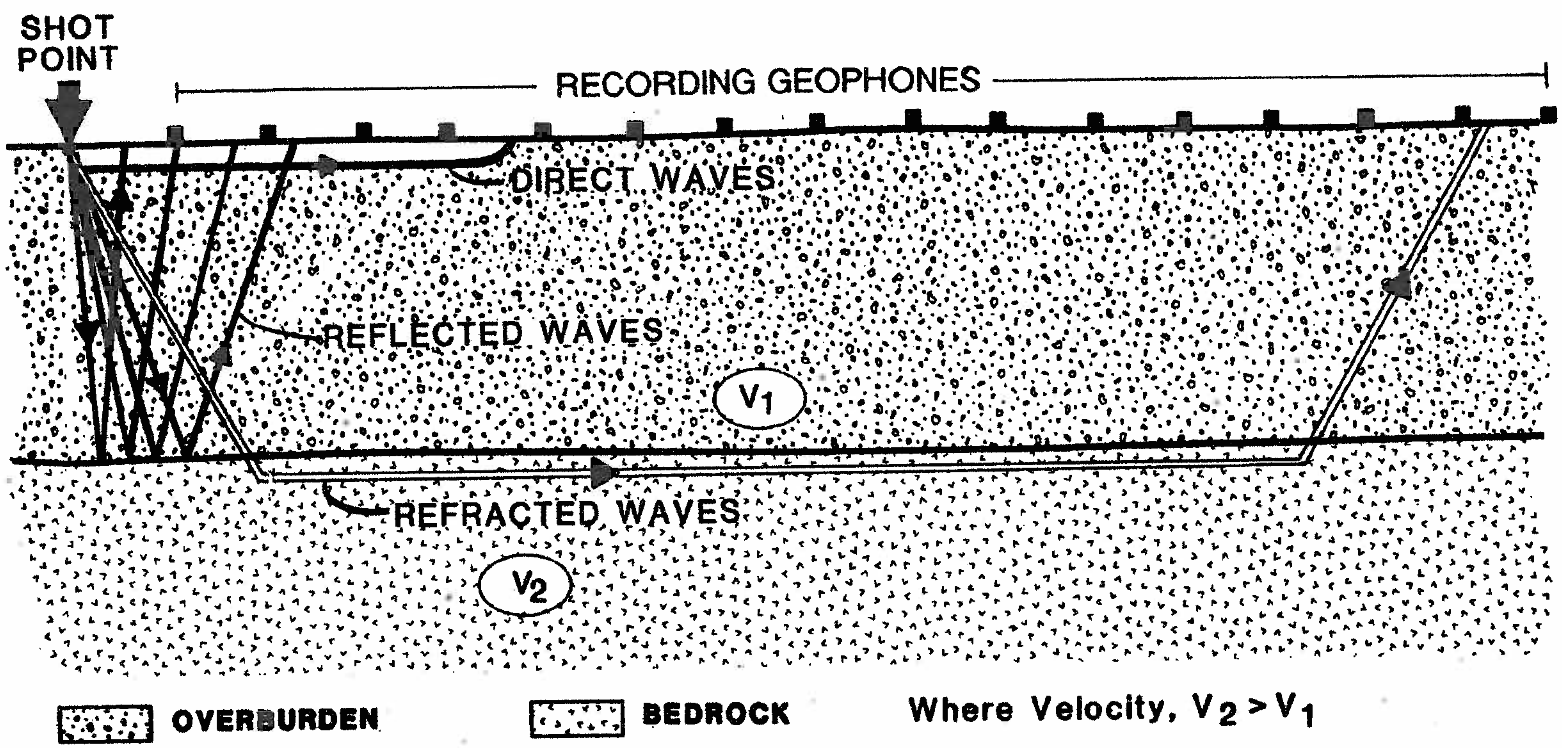
### *3.1.1 Introduction*

Seismic reflection profiling is a geophysical method that has been used extensively since the 1950's. It is the most widely used geophysical technique today, primarily in the search for hydrocarbon resources in depth ranging from 1,000 to 20,000 feet. This report will not go into detail on the method as extensive references exist (Dobrin, 1988).

Several seismic methods have been extensively used in environmental and engineering investigations over the past two decades. The most commonly used are seismic refraction and reflection. Both methods rely on the ability to record seismic signals and determine the time it takes for seismic energy to travel from a seismic source through the subsurface to a receiver (geophone). What differentiates the two methods is the path that the seismic energy travels. Ray paths for both reflected and refracted signals are shown in Figure 3-1, which illustrates the common case where competent bedrock is overlain by overburden.

The refracted wave travels down through the overburden and is critically refracted at the overburden/bedrock interface and is displayed in Figure 3-1. (Note: While the figure shows refraction at the bedrock-overburden interface, refraction will occur at any interface where the densities and seismic wave velocities of the underlying units are significantly higher). The wave travels along the surface of the bedrock and then upward to the geophones. The wave travels at overburden velocities on the up and down path to the bedrock surface and at bedrock velocities when traveling along the bedrock surface.

The basic principles of the reflection technique are also illustrated in Figure 3-1. The seismic reflection method involves projecting a wave down from the surface, and then recording the returning wave back at the surface as it reflects off formations at depth. Seismic energy will also be reflected, refracted and diffracted at boundaries in the subsurface, in accordance with Snell's Law. The main design consideration for a successful seismic reflection survey is the ability to separate the reflected energy from other arrivals in processing.




# SEISMIC RAYPATH GEOMETRY

Figure 3-1

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Burke County, GA

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A seismic reflection occurs when an acoustic wave front encounters an impedance boundary in the subsurface. Seismic impedance depends on both the velocity and density of a rock, and impedance boundaries occur where these rock properties change abruptly, usually due to changes in lithology. The reflection coefficient, R, across an interface, is expressed by a function relating the acoustic impedance of adjacent layers. R determines the relative amplitude of the reflected wavelet.

$$\mathbf{R} = \frac{\sigma_2 \mathbf{V}_2 - \sigma_1 \mathbf{V}_1}{\sigma_2 \mathbf{V}_2 + \sigma_1 \mathbf{V}_1}$$

Where, R = reflection coefficient,

$\sigma_1$, $\sigma_2$ = mass density of the material on each side of the interface, and

$V_1$, $V_2$ = seismic wave velocity on each side of the interface.

The sign of the reflection coefficient determines the polarity of the reflected wave. The magnitude of the reflection coefficient is critical to obtaining usable data. The seismic reflection technique will not work if the acoustic contrast is not sufficient to produce a clear reflection, regardless of the survey parameters or processing techniques employed. The ability of the seismic reflection method to detect an individual sedimentary bed is not only a function of the acoustic impedance at the top and bottom of the bed, but also depends on the layer thickness. The minimum resolvable bed thickness is often quoted as 1/4 to 1/8 of the wavelength at the target depth. Wavelength is inversely proportional to frequency.

When a reflecting boundary exists, it is important to optimize the field procedure and acquisition parameters to maximize the quality of the final processed data. Choosing the best field parameters involves determining the relative importance of several competing objectives, such as site constraints, equipment capabilities and processing needs.

In all geophysical surveys, the objective is to extract the usable data (i.e., in this case, reflections from various lithologic boundaries) from the unwanted background information (source generated and ambient noise). In reflection seismology, it is desirable to record high frequency, high signal-to-noise ratio reflection events from the boundary of interest. The frequency of a reflection event is largely determined by the source input frequency and the filtering effect of the ground. Often, the target reflector frequency is similar to that commonly recorded for coherent noise (in particular, the noise from ground roll), making it difficult or impossible to selectively filter out the noise. Isolation of the reflection events requires careful design of field acquisition parameters, such as the source/receiver geometry, choice of source and receiver types, as well as recording parameters, such as sampling rate and filter settings. The choice of these parameters is discussed in Sections 3.1.2.1.

A seismic source generates a number of seismic events every time it is used. These include the refraction, reflection events and ground roll. Once a certain source-receiver offset is reached (critical distance) the refracted event arrives first. The reflection events occur after the refraction and before the ground roll event.

The application of seismic reflection surveys to environmental investigations began in the 1980's and requires several adaptations to the method. These include the following:

- Ability to generate and use high frequency signals.
- Higher density shot and receiver locations.
- Record at higher sampling rates.

In addition, the processing of the data differs from oil and gas processing because coherent noise events, such as ground roll and refraction events are closer in time and velocity to the seismic. Further information on high-resolution seismic reflection surveys can be found in Steeples (1986, 1997).

## 3.1.2 Seismic Reflection Data Acquisition

Key elements of seismic reflection acquisition are the seismic source, acquisition geometry and the recording system. Optimal selection and "tuning" of these elements is critical to acquiring high-resolution seismic data. Key requirements for this survey include the ability of the source to accomplish the following:

- Generate a broadband signal, so adequate resolution could be obtained at the target horizons.
- Operate with minimum impact on the environment and ongoing site activities.
- Generate sufficient energy to image targets to depths 1000 feet.
- To record useful seismic signals at the geophones with as high a frequency content as possible.
- To start the low end of the sweep such that the appropriate depth of penetration is achieved without generating intolerable ground roll.

The key parameters in determining the acquisition geometry are the selection of the minimum and maximum offsets (i.e., distances between) of the geophones from the source. The key requirement is that the spacing must produce the ability to image geologic horizons from the surface to 800 feet below surface grade (bsg). The recording system parameters include the selection of geophones and seismograph that must be capable of sensing and recording seismic signals that have an adequate bandwidth and dynamic range to image the targets of interest. The parameters that were selected, as well as the rationale behind their selection, are discussed in the sections that follow.

### 3.1.2.1 Seismic Source

The seismic source selected for these surveys is Industrial Vehicles International (IVI) Minibuggy II for the seismic survey. The Minibuggy vibratory source is capable of generating seismic energy between 6 Hz and 350 Hz with a maximum energy force of 12,000 lbs. This vibratory source creates a frequency-modulated signal by oscillating a mass through a user-defined range of frequencies, which are transmitted into the ground. The use of vibratory sources for seismic exploration was developed in the 1970's and is used extensively for land seismic surveys. The use of a vibratory source instead of an impulse source is for several reasons including the following:

- Ability to generate the high frequencies necessary to image shallow geologic horizons, as well as attenuate low frequencies, which are the main component of coherent noise events, such as ground roll.
- Better signal to noise ratio.
- Lower sensitivity to ambient noise such as traffic.
- Low environmental impact (no discernable noise, shock or penetrations).

A vibratory source functions by holding a plate on the ground and vibrating the plate through a user-defined range of frequencies. This is known as a "sweep." The length of the sweep, peak force and frequency range can be changed during testing. The selection of these parameters is discussed in the next section.

The primary advantage of a vibratory source is that it spreads out the generation of seismic energy over a period of time. Therefore, more energy can be generated by vibratory sources than by other types of seismic sources, such as impact or explosive sources. However, the vibroseis method requires an additional processing step before the data becomes useful. This step is referred to as cross-correlation and is diagrammed in Figure 3-2.

The signal received at the geophones (Trace 2 in Figure 3-2) is actually a sum of a series of source signals from the vibrator (Trace 1) that have been shifted in time. The amount of the shift depends on the depth of the reflecting horizons and the velocities in the subsurface. To obtain the output trace (bottom trace in Figure 3-2), a mathematical algorithm called cross-correlation is used. Using knowledge of the input signal, this algorithm compresses each of the source signals summed in Trace 2 into a simple wavelet. Cross-correlation also produces the added benefit of reducing the effects of ambient noise. Once the cross-correlation is performed, the record is similar to a seismic trace that would be obtained using an impact or explosive source.

Obtaining the input signal from the Minibuggy is critical to performing the cross-correlation. This was done in real time by using a radio link that sends the signal generated by the signal generator to the seismograph. The seismograph uses this signal to correlate with the recorded data received from the geophones. The cross-correlation was performed in real time using GEO-X Aries software through a local area network.

### *3.1.2.1.1 Vibrator Sweep Testing*

In order to optimize the results from the Vibrator, several tests were run to select or adjust the following parameters:

- Sweep starting and ending frequencies.
- Sweep length.
- Number of sweeps.

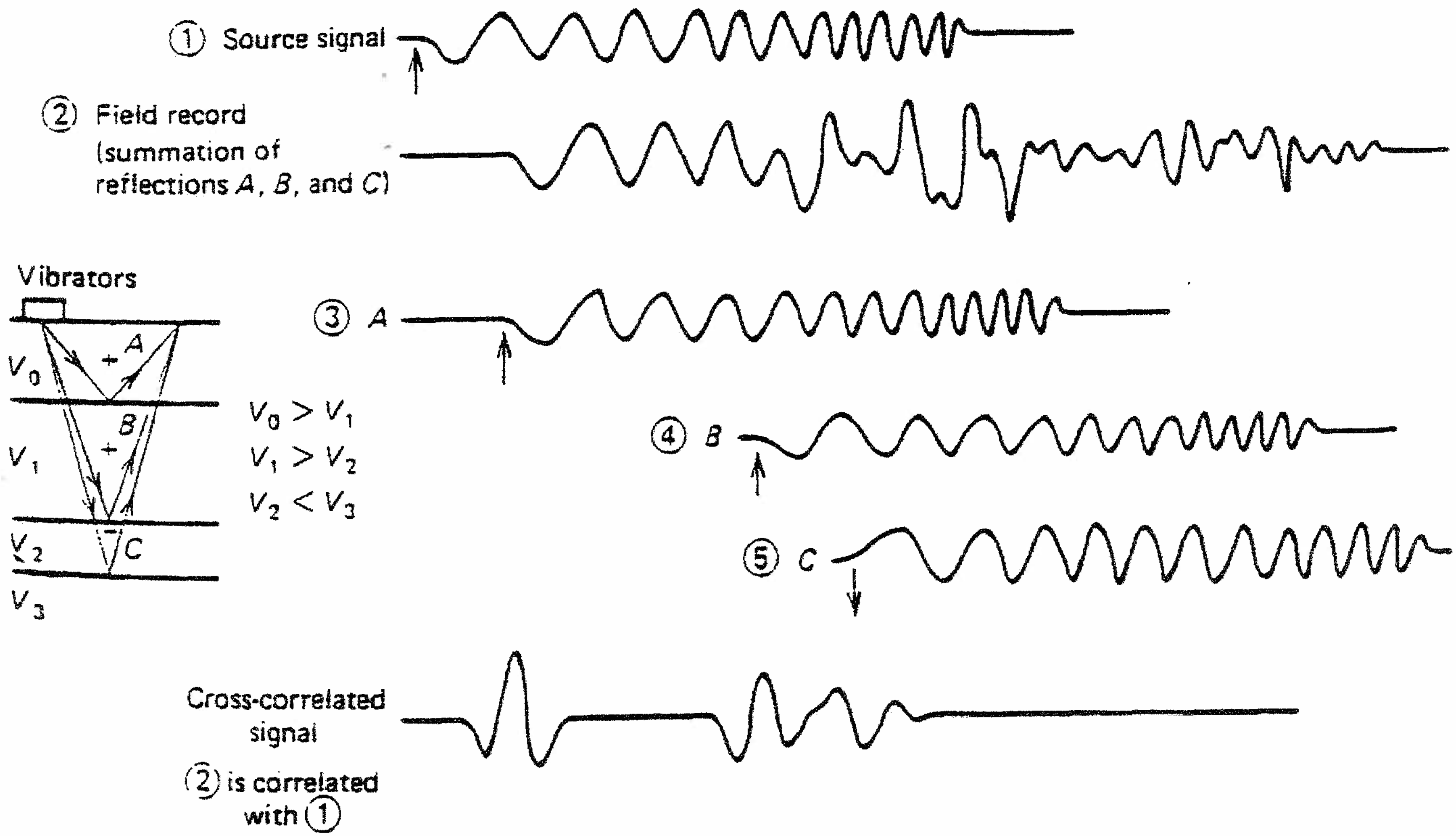


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Diagram of Vibroseis Cross-Correlation Operation

Figure 3-2

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Burke County, GA

Approved By: NMS

Date: 03/10/06

### *3.1.2.1.2 Parameter Testing*

The testing was performed along Line 1. The following parameters were tested:

- Sweep frequencies from 20 to 250 Hz.
- Sweep lengths of 6, 8 and 10 seconds.
- 4, 6 and 8 sweeps per station.

High-resolution reflection data may be recorded when geophones acquire a wide range of frequencies with a good signal-to-noise ratio. This is because the wider the range of frequencies in which there is good signal to noise, the better resolution there is to image the subsurface. The frequency content of the recorded signal is a function of several factors including the following:

- Frequencies generated by the seismic source. In the case of the vibrator source, the starting and ending frequencies in the sweep control the range of generated frequencies.
- Attenuation of the subsurface. The Earth tends to attenuate higher frequencies more rapidly than low frequency signals. This means that the Earth acts as a low-pass filter. The result of this is that even though high frequencies may be generated by the source, they may not be received at the geophones, because they have been attenuated by travel through the subsurface.

Another important objective in high-resolution seismic reflection is the minimization of ground roll energy. Ground roll energy is generated by the seismic source itself. Ground roll travels along the ground surface and is akin to the ripples observed on a pond when a pebble is dropped into the water. These surface waves interfere with the measurement of reflected energy from depth because they create vertical motion in the seismic transducers. In surveys for deeper objectives, typically ground roll energy is attenuated by the use of geophone arrays that can extend over 100 feet in length. This is not possible for high-resolution reflection, because these geophone arrays would result in an unacceptable degradation of the near-surface reflections. Therefore, a source that minimizes the amount of ground roll energy is important. The primary method of reducing ground roll is to reduce the amount of energy that is generated in the lower frequency bands, typically 60 Hz or less.

After initial seismic data analysis of field records on Line 1, it was determined that the useable frequency range was 25 to 220 Hz. This frequency range was used for the remainder of acquisition.

## 3.1.2.2 Recording System

### *3.1.2.2.1 Seismograph*

The recording system selected for this survey was the ARAM Aries manufactured by GEO-X Systems, LTD. The ARAM system is a modern engineering seismograph with the following features:

- 1000 plus channel recording
- A/D converter with 24 bit sigma-delta processor (high dynamic range)

- 1 millisecond sample interval
- Analog signal/noise ratio: Less than minus 100 dB, 96 channel
- Maximum samples per channel: 32,000
- Plotter: 6 inch 600 dpi thermal

#### *3.1.2.2.2 Geophones*

The geophones selected for this survey were Oyo Geospace 10 Hz geophones vertical 6 per station. The geophones were connected to Aries RAM boxes using specific seismic cable network (distributive) designed by GEO-X.

## *3.1.3 Data Acquisition*

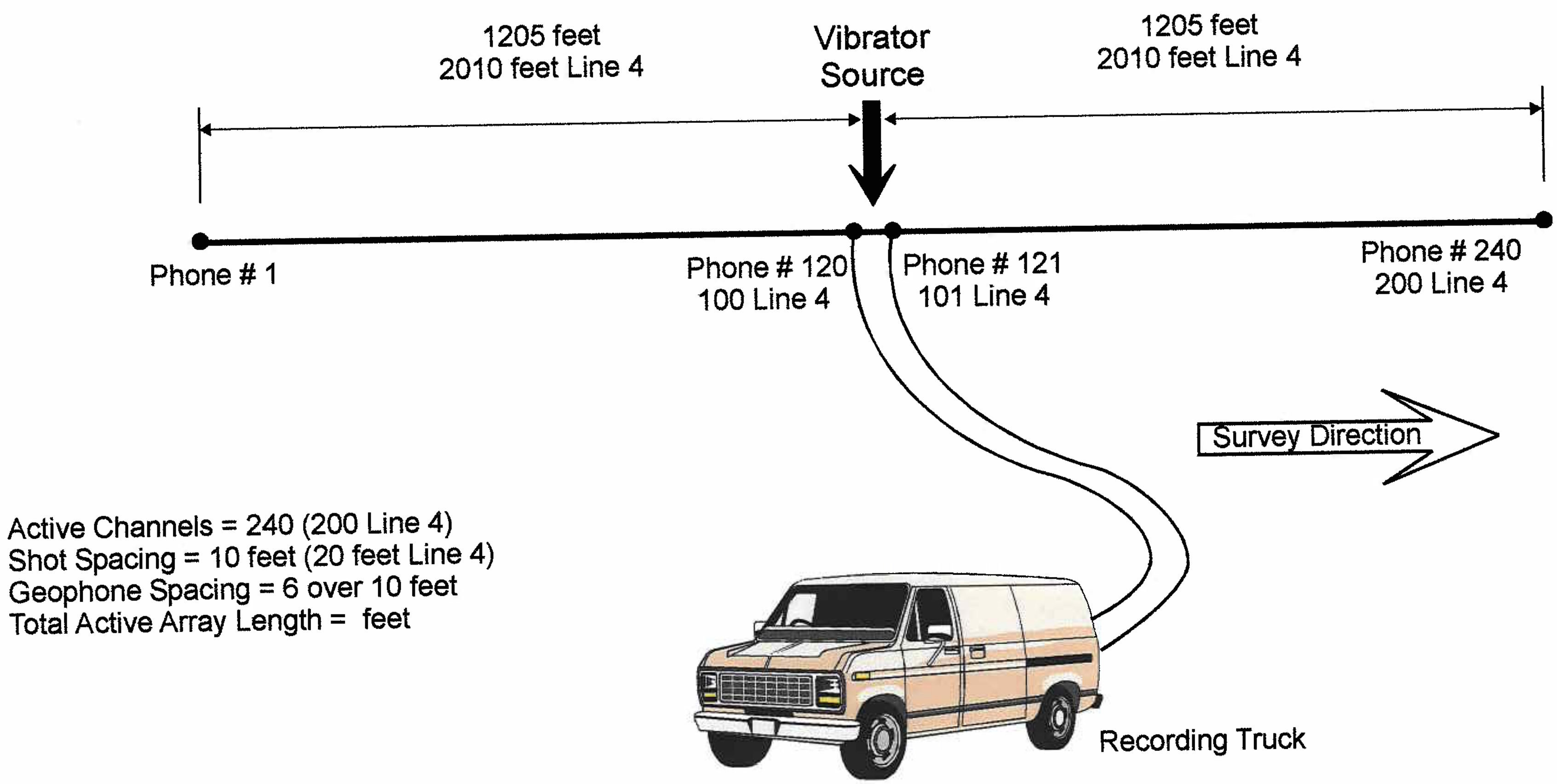
### 3.1.3.1 Data Acquisition Parameters

The seismic lines were acquired with the nominal acquisition parameters shown in Table 3.1.3.1. A diagram of the acquisition geometry is shown in Figure 3-3.

**Table 3.1.3.1**

**Nominal Reflection Acquisition Parameters**

| | |
|---|---|
| Source Interval | 10 feet (20 feet optional Line 4) |
| Receiver Interval | 10 feet (20 feet optional Line 4) |
| Number of Channels | 240, Lines 1, 2 and 3, Auxiliary Trace and Vibrator Signal Input<br>200, Line 4 |
| Nominal CDP Fold | 120, 100 Line 4 |
| Maximum Offset | 1205 feet, 2010 feet Line 4 |
| Minimum Offset | 5 feet, 10 feet Line 4 |
| Spread Geometry | Split Spread |
| Seismograph | GEO-X ARAM 24 |
| Record Length | 6 seconds, 2 second listen |
| Sample Interval | 1.0 ms |
| Seismic Source | Minibuggy<br>25-220 Hz, 6 second sweep, 6 sweeps/station |
| Vibrator Controller | Pelton Advanced System II |
| Geophones | 6 x 10 Hz Oyo |

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# Diagram of Nominal Acquisition Geometry

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Figure 3-3

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Burke County, GA

### 3.1.3.2 Data Quality

The observed frequency content of the seismic data was around 30 to 120 Hz. Depth to target, approximately 1000+ feet bsg, was achieved. The delineation of events below and above target depth was also achieved. The quality of the data is considered good, although there existed some site noise mentioned above and portions of the noisy areas may be attributed to localized geology.

#### *3.1.3.2.1 Coherent Noise*

Coherent noise was observed on the field records as ground roll but was minimal.

#### *3.1.3.2.2 Ambient Noise*

Minimal ambient noise was encountered due to road traffic along the county roads during acquisition. During heavier traffic on all roads, acquisition ceased until after the vehicles had passed. This could be achieved by watching the noise monitoring equipment during data acquisition and communication with the line crew.

### 3.1.3.3 Data Acquisition and Quality Control Procedures

Typical field operations were as follows:

1. At the beginning of each day, a printout was made of a record for an uncorrelated vibrator sweep to ensure that seismograph triggering and vibrator operation was normal. System tests were run at the beginning of each day. These tests include:
    - Channel Test: this is to ensure that each RAM box is working within a specified window and that the gain, harmonic distortion, dynamic range and other parameters are relatively equal for all channels. Channels are flagged individually if any parameter is out of range. If so, the RAM box is immediately replaced. If either of these parameters is out of range during acquisition, the system flags the RAM box as an error so that that particular box can be checked or replaced. An example of this test is provided in Appendix B. The remainder of the tests is on the CDROM labeled TESTS.
    - Internal Automatic Test: This test is to observe the recorder (ARAM) is operating within specific tolerances and basically tests the communications between the recorder and the RAM boxes. An example of this test is provided in Appendix B. The remainder of the tests is on the CDROM labeled Daily Tests.
    - Vibrator Controller Test: This test is to ensure the encoder of the vibrator controller (located in the vibrator) is functioning properly. These tests could not be written to CDROM, therefore copies are provided in Appendix B.
    - Vibrator Controller Observer's Screen: This is not a test. Primarily, this display is viewed during acquisition with specific settings to observe the function of the vibrator. This display shows Total Distortion, Vibrator Output Force (in pounds) and Reference verses Vibrator signal. The later makes sure the vibrator is in phase with the controller. Preset values are entered into this system to alarm the observer of errors in either of these categories. One screen capture per day is provided in Appendix B

2. The noise levels were monitored for the live geophone spread to ensure that the levels were acceptable and that the number of dead channels was at a minimum (zero).
3. Prior to beginning the acquisition of each field record, a check was made of the vibrator position, file number on the seismograph, and status of the seismograph. Any anomalies were noted on the observer's notes. The vibrator operator at every vibrator point checked the vibrator position. Skips, re-acquisitions and offsets were noted on the observer notes.
4. The vibrator was triggered from the recording doghouse, and a sweep is initiated. The record can be correlated using ARAM software, displayed on the screen (every shot location) and printed out at a predetermined interval. The uncorrelated record was stored to hard disk and 8mm DAT tape drive in real time. The first and last file on the tape was played back after move-ups and at the end of the line to ensure no tape errors. The correlated record was also analyzed on screen and checked for proper equipment operation and number of, if any, dead channels.
5. A cable and geophone continuity check to the geophone was performed before the beginning of and during acquisition each day.

#### 3.1.3.4 Processing

The processing flow for the data is based on a standard common depth point reflection processing flow with several enhancements due to the high resolution required for the survey and specific conditions at the site. The processed shot records (or CDP gathers) from each location along the survey line were then stacked to form the trace record. A sample processing flow is provided in Appendix E.

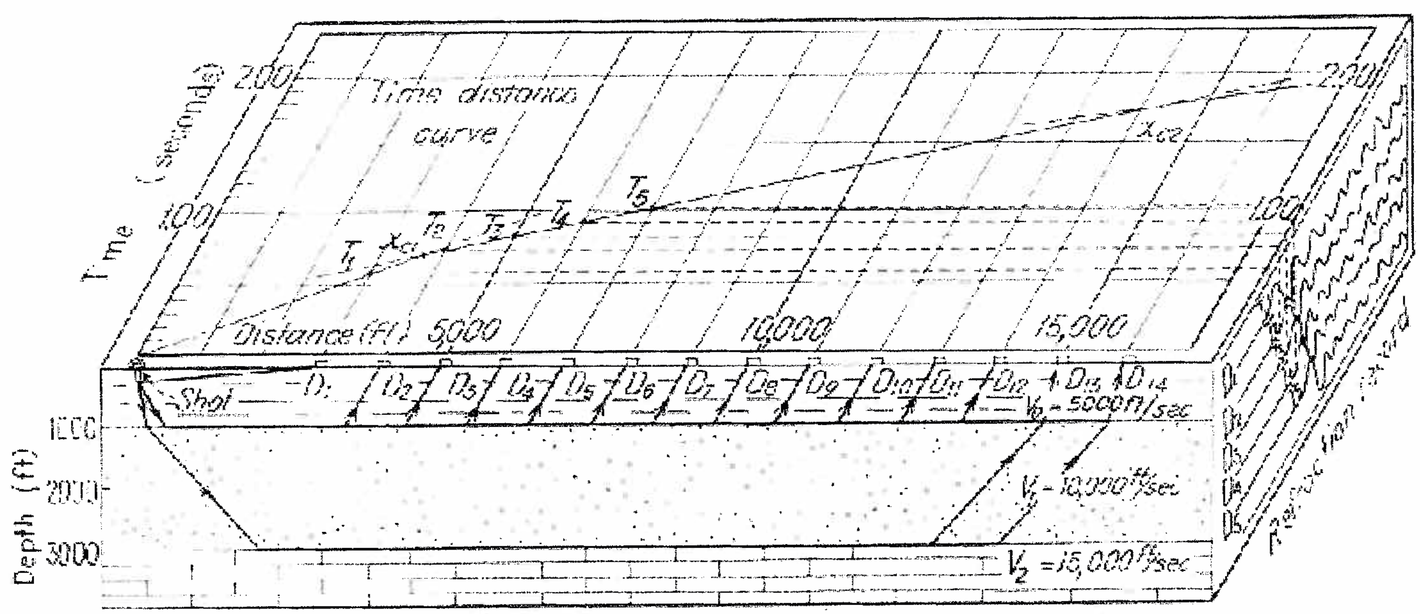
The noise from the Vogtle Plant made it difficult for refraction analysis. This noise overrides refraction, or first break picks, especially near the plant. Therefore, refraction statics were not applied to Lines 1, 2 and 3 for the reflection lines. Only elevation statics were applied to the final stack data. Line 4 had no noise issues and therefore refraction statics and elevation statics were applied to this line.

## 3.2 Seismic Refraction

### *3.2.1 Introduction*

The refraction technique is based on Snell's law: a propagating wave impinging upon an interface between two materials of differing propagation velocities will, at the correct angle of incidence, travel along the interface at the higher of the two propagation velocities. Huygen's principle states that every point along this interface will act as an independent source of acoustic energy as the wave passes. Typically, this method has been used to map depths to interfaces where the propagation velocity of the surface to be mapped is appreciably higher than that of the materials above. Only the onset of the acoustic energy (the time of arrival) is used in a typical refraction mapping application.

Figure 3-4 (Dobrin, 1976) illustrates the wave paths, travel times and a seismic record for a typical application of the refraction seismic method. In the typical refraction seismic method, the slope of arrivals at adjacent receivers is utilized to determine the




# Refraction Schematic, 3 Layer Case

(Dobrin, 1976)

Approved By: NAS

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Figure 3-4

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propagation velocity of that material. The typical application of the seismic refraction method implicitly assumes that the propagation velocity of layered materials in the sub-surface increases with depth.

Seismic refraction techniques are typically employed to determine the thickness and depth of subsurface stratigraphic layers and the velocities of seismic waves within these layers. Simplified, the seismic waves generated at the surface travel at different velocities in various types of soil and rock and are refracted at the interfaces between these layers. The density and elastic properties of the subsurface layers determine the speed or velocity that the seismic wave (in this case, the compressional or P-wave) will travel through the layer. The greater the difference in density and elastic properties between layers the better and more accurate mapping. To successfully map the near-subsurface layer using refraction techniques, preceding concepts then are based on the fundamental assumptions onsite:

1. Seismic velocities of the geologic layers must increase with depth.
2. The geologic layers must be of sufficient thickness to allow detection as defined by the geophone station interval.
3. The seismic velocities of the geologic layers must be sufficiently different to allow the resolution of the individual layers.

### 3.2.2 Seismic Refraction Data Acquisition

The seismic survey parameter testing was initiated on January 27th on Line 1. Basically, the acquisition of the seismic refraction data was the same as the reflection acquisition including the following:

- The geophone group was changed to 50 feet to allow longer offsets, source to geophone. The source interval was also increased to 100 feet.
- Offend source locations are required to build target depth redundancy at the ends of the seismic lines.
- The entire line(s) were live during acquisition. That is, every geophone at 50 feet was recorded regardless of the position of the vibrator source.

Geophones and related equipment were laid out at 50 foot receiver intervals along Line 1 and energy source testing began on station 301. The sweep parameters remained the same. Source interval progressed down Line 1 at 100 foot intervals, including twenty 100 foot intervals off each end to increase redundancy at the beginning and ends of the line. Off-end stacks could not be acquired beyond the ends of Line 1 due to private property to the west and the plant on the east. Lines 3 and 4 had adequate space for offend acquisition.

Since refraction information was compromised due to plant generated noise observed during seismic reflection acquisition, it was decided by an SNOC representative that refraction acquisition not be conducted along Line 2 that runs close to the west end of the generating plant.

## 4.0 DELIVERABLES

All deliverables are provided in the Appendix portion of this field report. The deliverables, as stated in the proposal, are of the following and a brief description of the deliverable is described separately below.

### 4.1 Appendix A Observer's Logs

Observer's logs are a means by which the observer can identify which channels are live on the ground, the source position, the file number that is being recorded, the time in which the file was recorded, all parameters pertaining to the specific line that is being acquired and any comments that relate to acquisition, field conditions, etc. These items are necessary to assist the seismic data processor during front end input of the data called geometries. The files are in Excel ® spreadsheet format.

### 4.2 Appendix B Daily Tests

Daily tests, as mentioned before, were run to ensure proper function of the recording system. Included are:

- Channel Tests: individual channel testing
- Auto Tests: seismic recorder testing, communications with the seismic line
- Vibrator Status: checking the encoder of the seismic controller
- Vibrator Functionality: observe the vibrator sweep is during acquisition

The channel tests and auto tests could be written to disc and are therefore provided on CDROM in this appendix. They are ASCII files and can be read with any word processing program.

### 4.3 Appendix C Survey Data

The survey data was acquired by Georgia Power. After completion of the surveys, the data was provided in ASCII format of eastings, northings, elevations and station numbers to be sent to the seismic processors.

The 10-ft and 20-ft prefixed *.txt files are the seismic reflection line coordinates. The 50-ft and 100-ft prefixed *.txt files are the seismic refraction coordinates.

## 4.4 Appendix D Field Data for Reflection and Refraction

The raw field records are provided in SEG standard SEGY format for both the reflection and refraction data are provided on DVD. The reflection data are raw uncorrelated field files and the refraction data are both correlated and uncorrelated.

## 4.5 Appendix E Paper Plots and SEGYs of Reflection Data

All four seismic reflection lines are plotted in trace amplitude. Only the first version, Stack 1 is plotted but all subsequent process is provided on CDROM. The processes are:

- Stack 1: Normal stack of the seismic reflection data
- Stack 1 FX: FX decon applied to the stack
- Stack 1 WHTFX: FX decon and spectral whitening applied to the stack
- Stack 1 WHTFX MIGR: FX decon, spectral whitening and migration applied to the stack
- VEL RMS: These are the stacking velocities used to process the data. Instead of time amplitude pairs, these data are time velocity pairs.
- The final static for each reflection line CDP is provided in ASCII format. These files are Line number totstat.a_db.

A data input loading form and example processing side label is also included in this section. This loading form tells where the easting and northing information is located in the trace headers.

## 4.6 Appendix F Paper Plots and Refraction Data and Depth Migration Data

The three refraction and depth migration profiles for Lines 1, 3 and 4 are plotted and included in this appendix. The plots are also provided in Adobe® .PDF format on the CDROM in this appendix. Also included in this appendix are:

- A text or ASCII file that provides all the output X, Z and Vp values used to render the 2-D Vp models in a graphic format. This is a .txt file and .vel file.
- A file containing or otherwise documenting the first-arrival picks used in the velocity inversions. This is a *.brk file.
- Pre Stack Depth Migration seismic profiles in .PDF and SEGY format.
- Report on the seismic refraction and depth migration technique and procedures.

A letter report describing the specific processing flow used to produce the depth-migrated images was not available at the time of this report. This report will be provided once the depth migration portion of this analysis is complete.

## 4.7 Appendix G Miscellaneous Information

This appendix exhibits other pertinent information used to justify checking of the geophones prior to mobilization, daily logs, variance logs and crew sign in sheets. Specifically they are:

- Daily logs showing day to day activities during acquisition.
- Variance logs show that tests were run during acquisition to improve data quality. These logs primarily describe the issue at hand, what change was made to improve the issue (variance) and that a field representative has concurred.
- Geophone check sheet by Cadillac Geophysical Services. These checks include measuring the resistance of the geophone string and making sure they fall in within a specified tolerance in ohms. This is to ensure that all geophones are hooked up in the string. An impulse check is to make sure that all geophones have the same response as the reference string. This includes amplitude and phase of the response.
- Crew sign in sheets are to discuss field activities each morning prior to going to the field. These meetings are similar to tailgate safety meetings to discuss any activities prior to the morning that my pose as a safety issue so that all hazards are addressed and to promote safety. No occurrence of injuries was discovered during seismic data acquisition activities at the Vogtle facility.

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