CIVIL ENGINEERING
ENVIRONMENTAL
SURVEYING
LANDSCAPE ARCHITECTURE
GEOTECHNICAL

ENVIRONMENTAL IMPACT STATEMENT

Puleo International, Inc.
Block 18, Lot 5
13 Moebus Place
Town of Clinton,
Hunterdon County, NJ

Prepared For:
Puleo International, Inc.
C/O Chris Puleo
3614 Kennedy Rd
South Plainfield, NJ
07080

October 19, 2020

Wayne J. Ingram, P.E.
New Jersey Professional Engineer
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Clinton | Asbury Park | Denville | Philadelphia

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1. INTRODUCTION

Engineering & Land Planning Associates, Inc. has prepared this Environmental Impact Statement (EIS) on behalf of Puleo International, LLC for the proposed development of the property known as Block 18 Lot 5 in the Town of Clinton, New Jersey. This EIS has been prepared in accordance with the requirements described in Chapter 88 Section 44.C of the Municipal Code. This EIS provides an inventory of existing natural resources, an assessment of the potential impacts to these resources and mitigation methods should the project be implemented.

In summary, it is anticipated that the proposed site improvements can be implemented without creating any appreciable adverse environmental impacts to the subject property or surrounding areas. If environmental impacts are incurred, appropriate mitigation measures will be implemented.

1.1 Project Description

The project proposes the construction of a 100,000 S.F. warehouse building with an office area and associated parking and loading docks. Stormwater management improvements will be constructed to meet state and local ordinance requirements. General site improvements in accordance with all state and local ordinance requirements will be implemented in the construction of the proposed development.

The Preliminary & Final Major Site Plan is included as Appendix A.

1.2 Site Description

The site is located at 13 Moebus Place in the Town of Clinton, Hunterdon County, New Jersey. The property is mostly a vacant lot, but contains a town utility building in the northwest corner with paved driveway accessing Moebus Place and an existing driveway opening along Route 31 North in the southeast corner. The utility building is utilized by the Town of Clinton Water as a Well House. The site consists of 573,519.38 S.F. (13.17 acres).

The site is located within the OB-4 Office Building District Zone, as shown on Figure 4. The Office Building District in the Town of Clinton is designated for office buildings for business, professional, executive and administrative purposes, scientific or research laboratories, data-processing facilities, medical and dental clinics and laboratories, child-care centers, funeral homes, art, music and dance studios, hotels, restaurants, and wireless telecommunications towers.

Land use surrounding the property consists of residential, commercial, and undeveloped use. Route 31 borders the southern property line of the site and Moebus Place borders the western property line. Two dentist offices and a financial office building are located on the other side of Moebus Place. Directly north of the site is a residential neighborhood and directly east of the site is another vacant undeveloped lot.

2. EXISTING ENVIRONMENTAL CONDITIONS

2.1 Topography

The topographic relief on the subject properties ranges from an elevation of 231 feet above MSL on the northern central portion of the property to 289 feet above MSL on the southeastern portion of the property near the access driveway opening. The slopes on site range from approximately 1.5% to 75%, which generally direct stormwater run-off flows from north to south. The majority of the site generally maintains a 12% slope across the property. The steeper slopes are found behind the existing building in the northwest corner, within the existing swale and behind a cluster of trees near the existing driveway entrance in the southeast corner.

2.2 Air Quality

There is a United States Environmental Protection air quality monitoring station in Hunterdon County. A 2019 Air Quality Index Report from this monitoring station shows the average Air Quality Index (AQI) to be at 39, which is in the range of “Good” quality. The Good Level of Health Concern considers the air quality to be satisfactory, with air pollution posing little or no risk.

Additionally, there is a NJDEP Bureau of Air Monitoring station located in the borough of Flemington, approximately 10 miles from the site. The pollutants monitored at this station used in the Air Quality Index include ozone and fine particulate matter with diameters of 2.5 micrometers or less. Ozone monitoring data generated on October 15, 2020 provided an 8-hour average of 27 ppb, which is in the range of “Good” quality. PM2.5 monitoring data generated on October 15, 2020 provided a 24-hour average of 8.5 Qg/m3, which is in the range of “Good” quality.

2.3 Water Quality

There are no lakes or ponds located on site. The South Branch Raritan River is located approximately 800 feet from the western property line of the site. According to NJDEP’s GeoWeb service, the South Branch is classified as FW2-TM, fresh water category one trout maintenance waters.

The property is part of the Raritan River SB (above Spruce Run) Watershed, within the sub-watershed known as Raritan R SB (Spruce Run-StoneMill gage). The property is within the North and South Branch Raritan Watershed Management Area (08). NJDEP GeoWeb indicates a Total Maximum Daily Load (TDML) Streamshed for this sub-watershed for Total Phosphorous and Total Suspended Solids Impairments, dated 2016.

There are no wetlands located on site.

The site contains an existing well and well pump utilized by the Town of Clinton Water, as shown on Sheet 3 of Appendix A. The water quality on the site is generally adequate with no known contamination existing within the property boundaries.

2.4 Noise Quality

The property is vacant and therefore characterized by low levels of sound produced from the property. However, the property is located adjacent to Route 31 and in close proximity to Interstate 78. Both of these highways produce significant vehicle noise levels at the project site.

2.5 Geology and Soil

The *USDA Soil Survey of Hunterdon County, New Jersey* as published by the *NRCS Web Soil Survey* indicates that the site is comprised of the following major soil series/phases, as shown on Figure 5:

- BhnB – Birdsboro Silt Loam (2 to 6 percent slopes);
- DufB – Duffield Silt Loam (2 to 6 percent slopes);
- DugCg – Duffield Silt Loam (0 to 12 percent slopes, rocky);
- GkcoC2 – Gladstone Gravelly Loam (8 to 15 percent slopes, eroded)

Birdsboro Silt Loam (2 to 6 percent slopes) is referred to as BhnB, as indicated on Figure 5. The Birdsboro series consists of deep, well-drained soils that have a stratified sandy or gravelly substratum. Birdsboro Silt Loam is derived from material weathered mainly from shale and sandstone. BhnB has a seasonal highwater table depth greater than 60 inches and a depth to a restrictive layer greater than 60 inches. This soil group is part of Hydrologic Soil Group B and does not meet hydric criteria. The capacity of the most limiting layer to transmit water is moderately high, ranging from 0.6 to 2 inches/hour.

Duffield Silt Loam is referred to as DufB for 2 to 6 percent slopes and as DugCg for 0 to 12 percent slopes. Duffield Silt Loam consists of well-drained soils derived from fine-loamy residuum weathered from limestone. The depth to lithic bedrock ranges from 48 to 60 inches and the depth to water table is more than 80 inches. Both are part of Hydrologic Soil Group B and neither meet hydric criteria. The capacity of the most limiting layer to transmit water is moderately high, ranging from 0.6 to 2 inches/hour.

Gladstone Gravelly Loam (8 to 15 percent slopes, eroded) is referred to as GkcoC2 and consists of well-drained soils derived from loamy colluvium from granite and gneiss and/or loamy residuum weathered from granite and gneiss. The depth to lithic bedrock ranges from 39 to 60 inches and the depth to water table is more than 80 inches. This soil group is part of Hydrologic Soil Group B and does not meet hydric criteria. The capacity of the most limiting layer to transmit water is moderately high, ranging from 0.6 to 2 inches/hour.

Previous on-site soil samples and soil investigation results can be found in Appendix C.

According to NJDEP GeoWeb, the bedrock geology beneath the site is known as Allentown Dolomite, aging to the Lower Ordovician and Upper Cambrian. Allentown Dolomite is categorized as dolomite and less abundant quartzite and shale. The majority of the site is underlain by surficial geology known as Pre-Illinoian Till, aging to the late Pliocene-early Pleistocene, categorized as clayey sandy silt to sandy silty clay with few to some pebbles and cobbles and very few boulders; reddish yellow, yellowish brown, reddish brown, as much as 30 feet thick. The northwestern corner and southeastern portion of the site are underlain by Weathered Carbonate Rock.

As shown on Figure 6, the subject property is underlain by carbonate rocks, falling within the Town's Carbonate Rock Area. Weathered Carbonate Rock can cause karstic conditions over time. Acidic groundwater seepage and runoff draining from the uplands can infiltrate and dissolve the carbonate rock. There are no folds, faults, or bedrock outcroppings on-site. Given the geologic conditions existing across the approximate 13 acres that make up the site, it is the professional opinion that the soils and geology at the site are suitable for the proposed warehouse and associated parking area construction. According the Phase II Investigation included in Appendix C, no voids or openings were encountered in the boreholes or test pits. No land subsidence related to fractures or cavities in bedrock is anticipated to result. The geology and soils at the site are determined to be competent to accept the proposed development shown in the Site Plans (Appendix A).

2.6 Vegetation

As part of the NJ Wildlife Action Plan, this site falls within the Skylands Landscape Region. NJDEP GeoWeb lists the vegetation along the edges of the site as old field with less than 25% shrub coverage. The majority of the site has vegetation listed as mixed deciduous/coniferous brush and shrubland. Locations of trees and shrubs can be seen on Sheet 3 of Appendix A.

2.7 Wildlife and Fish

A review of the NJDEP Landscape Project 3.3 Database indicates the site is listed as Rank 0, having no species of record. There are no vernal pools found on site. There are no Skylands Species Based Habitats found on site.

2.8 Hydrology

According to Federal Emergency Management Agency Flood Mapping, the site is within Zone X, Area of Minimal Flood Hazard.

Stormwater run-off follows the surface topography and generally flows to the south from the high point at the northern central portion of the site, conveyed by existing swales near the high point and moderate slopes. Stormwater run-off drains southwest to the existing inlets located in the existing paved driveway accessing Moebus Place before reaching the South Branch Raritan River, south to the existing inlets along Route 31, and southeast across the vacant Block 71.04 Lot 1, ultimately draining to the inlets along Grayrock Road and to the Beaver Brook tributary. Full analysis on the existing drainage patterns on site is included in the Stormwater Management Report, attached separately as Appendix B.

According to NJDEP GeoWeb, the bedrock aquifer beneath the site is known as the Jacksonburg Limestone, Kittatinny Supergroup, and Hardyston Quarzite. The rocks of this aquifer contain limestone and dolostone which is highly fractured and dissolvable in water. The abundance of fractures in the limestone gives it the ability to store and transmit large quantities of water making it a high yield aquifer. However, the cavernous nature of limestone and the very qualities can cause problems in well development where cavities are likely to contain large amounts of sediment and may require extensive treatment to clean the water. This aquifer is also sensitive to contamination due to the interconnection of various cavities.

2.9 Visual Character

The majority of the property contains undeveloped land with overgrown unkept vegetation that is beginning to encroach onto Moebus Place. Aerial mapping is provided as Figure 1.

2.10 History and Archaeology

There are no known archaeological findings on site. There are no historic features on site and the property is not within a historic district.

2.11 Traffic

Based on trip generation analysis rates and equations provided by the New Jersey Department of Transportation as of February 8, 2019, weekday and weekend daily trips calculated for the immediate surrounding properties of the subject property are as follows:

Land Use Description	Units	Weekday Daily Trips	Weekend Daily Trips
Single Family Detached Housing	7 Units	90	81
Dentist	9,593 S.F.	334	82
General Office Building	2,250 S.F.	28	5

2.12 Fill Quality and Subsurface Structures

According to NJDEP GeoWeb, there are no areas of historic fill on site.

As shown on Sheet 3 of Appendix A, an existing underground water service main line runs across the property, from the western property line to the northeast corner of the subject property. There is a 20-foot-wide water line easement around the service line. Other existing subsurface structures on-site include a storm sewer manhole, a well and well pump, water valves, and gas and electric utility connections.

Evidence of underground storage tanks was not observed at the subject property during the Phase I Investigation physical inspection, performed on June 23, 2020.

3. PROBABLE IMPACTS & MITIGATION

3.1 Topography and Drainage

The proposed development includes a proposed Grading & Drainage Plan, as shown on Sheet 5 of Appendix A. The proposed topography will provide stable slopes and conveyances for surface water runoff. Natural drainage patterns will be maintained to the extent possible while also utilizing the proposed retention system. The full stormwater management report and analysis have been attached separately as Appendix B. The site is not proposing to infiltrate stormwater under the recommendations provided in a report prepared by M2 Associates Inc. entitled "Phase II Investigation of Carbonate Rock Beneath Block 18 Lot 5 in the Town of Clinton" dated November 26, 2001. The proposed stormwater management system will convey water via closed pipe systems to the proposed Bioretention Basin. Details of this proposed stormwater management system, including locations and invert elevations of proposed inlets, the emergency spillway, headwalls and riprap apron locations are all included on the Grading & Drainage Plan. The recommended procedures for site preparation, structural fill materials and compacting testing, and storm sewer construction are also found on the Grading & Drainage Plan. The utility profiles for the proposed stormwater sewer pipe system are included as Sheets 7-9 of Appendix A.

The proposed runoff quality has achieved the required TSS removal, in accordance with NJDEP standards. Quality treatment has been provided for the proposed development through the use of a Bioretention Basin designed in accordance with the NJDEP BMP Manual for a water quality storm TSS removal rate of 80%. Soil Erosion and Sediment Control measures have been designed for the stormwater management system to ensure that water quality is maintained and that the system can safely and adequately control runoff from the property. Design calculations for the conduit outlet protection can be found in the Stormwater Management Report (Appendix B).

3.2 Air Quality

No substantial or adverse impacts are anticipated on the air quality on- or off-site. There is no air quality degradation associated with implementation of the warehouse facility, with no smoke or odors to be generated as a result.

3.3 Water Quality and Supply

The proposed development will not adversely impact the quality of natural water supply on- or off- site. Proposed water service connections to comply with state and township regulations are shown on Sheet 6 of the Site Plans (Appendix A), the Utility Plan. As shown, the proposed water service lateral will connect to the existing water service main along Moebus Place. A 6" Cement Lined Ductile Iron Pipe Water Service Main is proposed to run around the proposed warehouse building, connecting the proposed fire hydrant near the northwest corner of the proposed building and the proposed fire hydrant near the southeast corner of the proposed building. A 190' x 250' well easement is located in the northwest corner of the site, where the existing building and wells are, to separate these features from the proposed development.

3.4 Noise Quality

The proposed development will not result in any sources of noise or vibration levels in excess of State standards on- or off- site. It is anticipated that noise levels produced on-site will increase slightly post development, since the property is currently mostly unused. The resulting noise levels generated by the proposed warehouse are anticipated to be generally low with the exception of unloading and loading of vehicles in the proposed loading areas.

3.5 Geology and Soil

The proposed development will have minimal impact on site geology. Appendix D includes recommendations and precautionary options for development within the Town of Clinton Carbonate Area. If karstic conditions are encountered, such as unforeseen soil voids, soft pockets, or bedrock voids, mitigation procedures will be implemented. Flowable fill can be added to the areas should land subsidence occur to eliminate or reduce the soil migration into karstic rock and to restore subgrade integrity.

There is the potential for short term unavoidable impacts to soil erosion at the site during construction activities. Therefore, the proposed project will obtain Hunterdon County Soil Conservation District approval. All procedures set forth by the district will be followed to minimize soil erosion on and surrounding the site. Locations, notes and details of the soil erosion and sediment control methods are shown on Sheets 13-15 of the Site Plans (Appendix A). The Soil Erosion and Sediment Control Plan proposes silt fencing, temporary soil stockpiles, recommended soil compaction testing areas, stabilized construction accesses, tree protection fencing, inlet filter protection, sediment control bags, hay bale sediment barrier, soil stabilizing matting, and inlet sediment control devices.

3.6 Vegetation

The proposed development requires clearing of the site, including the removal of most trees on site. This tree removal will be mitigated in accordance with the Town's tree removal ordinance and on-site tree replacement requirements. No endangered or threatened species will be impacted as a result of the proposed project. The proposed development includes a Landscaping Plan, Sheet 11 of Appendix A, which provides the proposed plant schedule and locations of proposed shrubs, evergreen trees, ornamental trees, and shade trees. Planting details are included on Sheet 20 of Appendix A.

3.7 Wildlife and Fish

No wildlife or fish will be adversely impacted as a result of the proposed project.

3.8 Visual Character

The proposed development has been designed to be aesthetically pleasing and consistent with the surrounding areas. The proposed development will not adversely affect the visual character of the area. The proposed Landscaping Plan, included as Sheet 11 of Appendix A, will provide landscaping improvements to serve as appropriate buffering and to enhance the visual character of the site. The 75' Landscape Buffer Line is Shown on Sheet 4 of Appendix A, the Site Plan.

3.9 History and Archaeology

The proposed development will have no adverse impact on any historic resources or historically significant areas or archeological sites.

3.10 Traffic

Based on trip generation analysis rates and equations provided by the New Jersey Department of Transportation, estimated weekday and weekend daily trips calculated for the proposed use of the subject property are as follows:

Land Use Description	Units	Weekday Daily Trips	Weekend Daily Trips
Warehouse	100,000 S.F.	204	15

3.11 Wastewater Generation

The Town of Clinton Water & Sewer Department operates a 2.3 mgd wastewater treatment facility, providing sanitary sewer service to the Town. Based on NJAC 7:14A-23.3, projected wastewater flows generated by the proposed development on-site are determined based on the number of employees as follows:

Type of Establishment	Measurement Unit	Gallons Per Day
Factories/Warehouses (add process water)	Employee	25

As shown on Sheet 6 of Appendix A, the Utility Plan, construction of this warehouse facility requires a sanitary sewer main extension of the existing sanitary sewer main along Moebus Place to service the proposed building. The proposed warehouse facility is expected to have a maximum of 100 employees, requiring the construction of an 8-inch PVC pipe system to be connected to an existing manhole on Moebus Place. The proposed sanitary sewer main extension is to be constructed within the right-of-way of Moebus Place. The proposed sanitary lateral of the warehouse facility has been designed to exit the building along the west side of the building and to flow through a 6-inch PVC pipe section toward the proposed sanitary sewer main extension. The proposed utility profile of the proposed sanitary sewer pipe conveyance system to be connected to the existing stormwater sewer manhole is included as Sheet 10 of Appendix A.

The proposed warehouse facility is expected to generate an average projected flow of 25 gpd/employee x 100 employee = 2,500 GPD. In accordance with N.J.A.C. 7:14A-23.6: Sanitary Sewer Design, gravity sanitary sewers shall be designed to carry at least twice the estimated average projected flow when flowing half full. Therefore, the design peak flow used in the design of the proposed sanitary sewer main extension is 2,500 GPD x 2 = 5,000 GPD when flowing half full.

3.12 Solid and Hazardous Waste Generation

The proposed development anticipates the generation of solid waste resulting from the warehouse development. A dedicated refuse storage area with access for garbage collection is proposed, as shown on Sheet 4 of Appendix A. Garbage services in the Town of Clinton are provided by Republic Services. No hazardous waste will be generated as a result of the proposed project. Preventative dust control measures will be implemented during construction.

3.13 Lighting

The proposed development will result in an increase of artificial light produced on-site, given that the site is mostly vacant, with the Well House as the only existing structure. The proposed warehouse building and associated parking areas will be sufficiently lit as necessary. However, no adverse effects of the increase in light are anticipated for the surrounding areas. Block 71.04 Lot 1 remaining as a vacant lot will help control light spillage, as well as the proposed landscaping buffers. The Lighting Plan, included as Sheet 12 of Appendix A, identifies the proposed lighting levels across the site and provides lighting general notes, hours of the lights turned on, and locations of pole-mounted or building-mounted lights along with their mounting heights.

3.14 Economic Impact

The proposed development anticipates positive impacts as a result for the mostly vacant space as well as for the Town of Clinton. Since the property is mostly undeveloped, no displacement of people is required. The development of the proposed warehouse building and loading docks brings the potential to stimulate the local economy, introducing the space for new business and new jobs.

4. ALTERNATIVES ANALYSIS

4.1 No Build Option

A no build option was considered as part of this alternatives analysis. This would not allow the property owner to realize the economic potential of the property. There would be no impacts as a result of this option because there would no changes to the property and the lot would remain mostly vacant besides the existing Well House.

4.2 Less Intensive Option

A less intensive development was considered for the project. This alternative includes constructing a smaller warehouse structure and smaller associated parking area. This alternative would result in less traffic, a lower demand on utility services and a reduced footprint of development. However, the property and utility services can support the larger development and the reduction in size impacts the economic viability of the project.

4.3 More Intensive Option

A more intensive development was considered for the property. This alternative would include the construction of a larger warehouse building and larger associated parking area. This alternative would result in an increase in traffic, impervious surfaces, stormwater runoff, and land disturbance. This alternative was rejected due to the inability of the lot to easily support the increased footprint of development and the increase in costs associated.

5. LICENSES, PERMITS & APPROVALS

- Hunterdon County Planning Board Approval
- Hunterdon County Soil Conservation District Certification
- New Jersey Department of Environmental Protection Approval
- New Jersey Department of Transportation Approval

6. DOCUMENTATION

The Town of Clinton EIS Ordinance, 88-44 C, was reviewed as part of the preparation of this report. GIS mapping as provided by the NJDEP through its GeoWeb service was consulted during the preparation of the report as well as the US Environmental Protection Agency Outdoor Air Quality Data, the NJDEP Bureau of Air Monitoring Station Data and the New Jersey Administrative Code. Additionally, the applicant was consulted throughout the design process.

FIGURES

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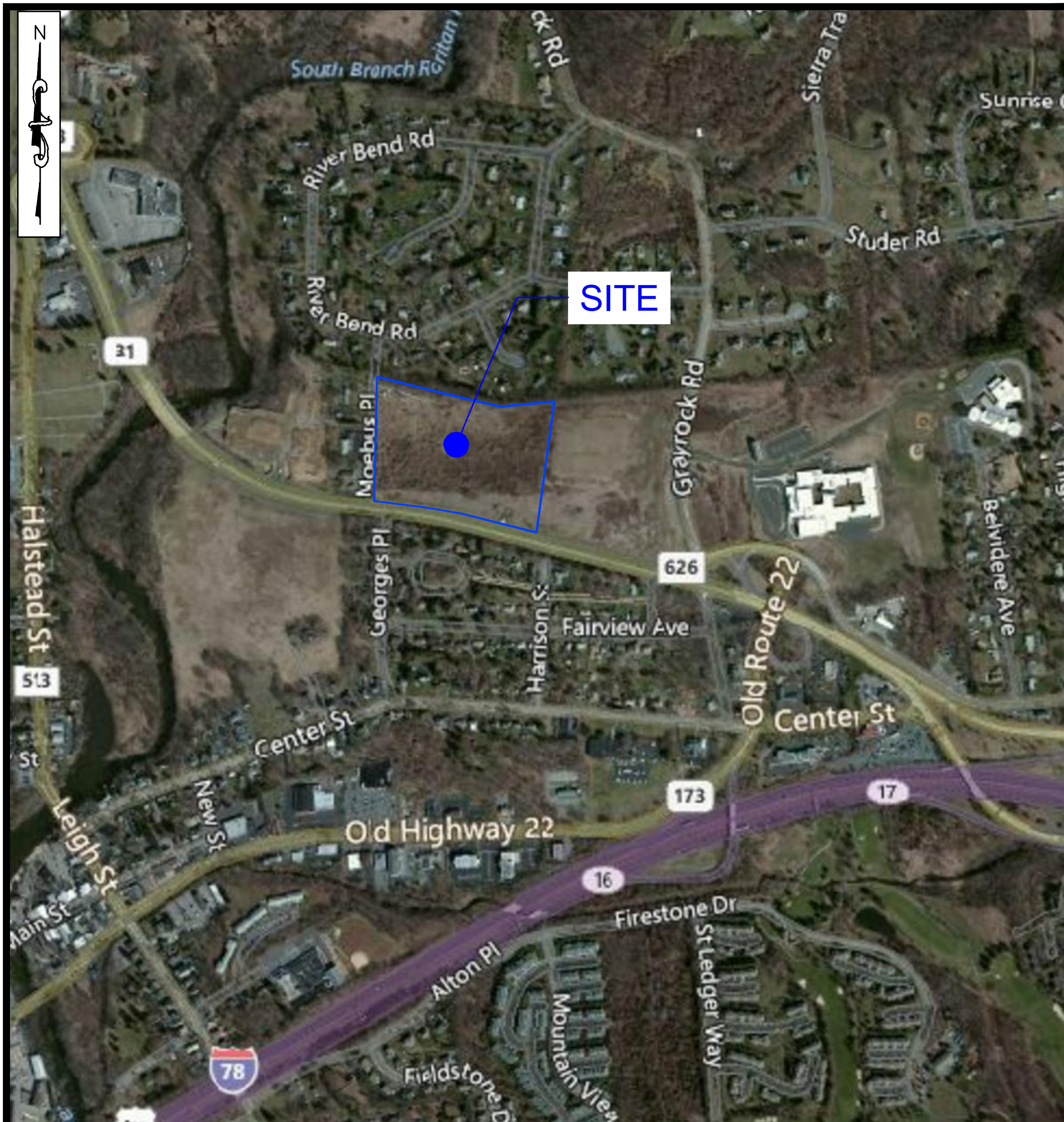

800 0 800

SCALE 1" = 800 FT

TITLE:

AERIAL MAP

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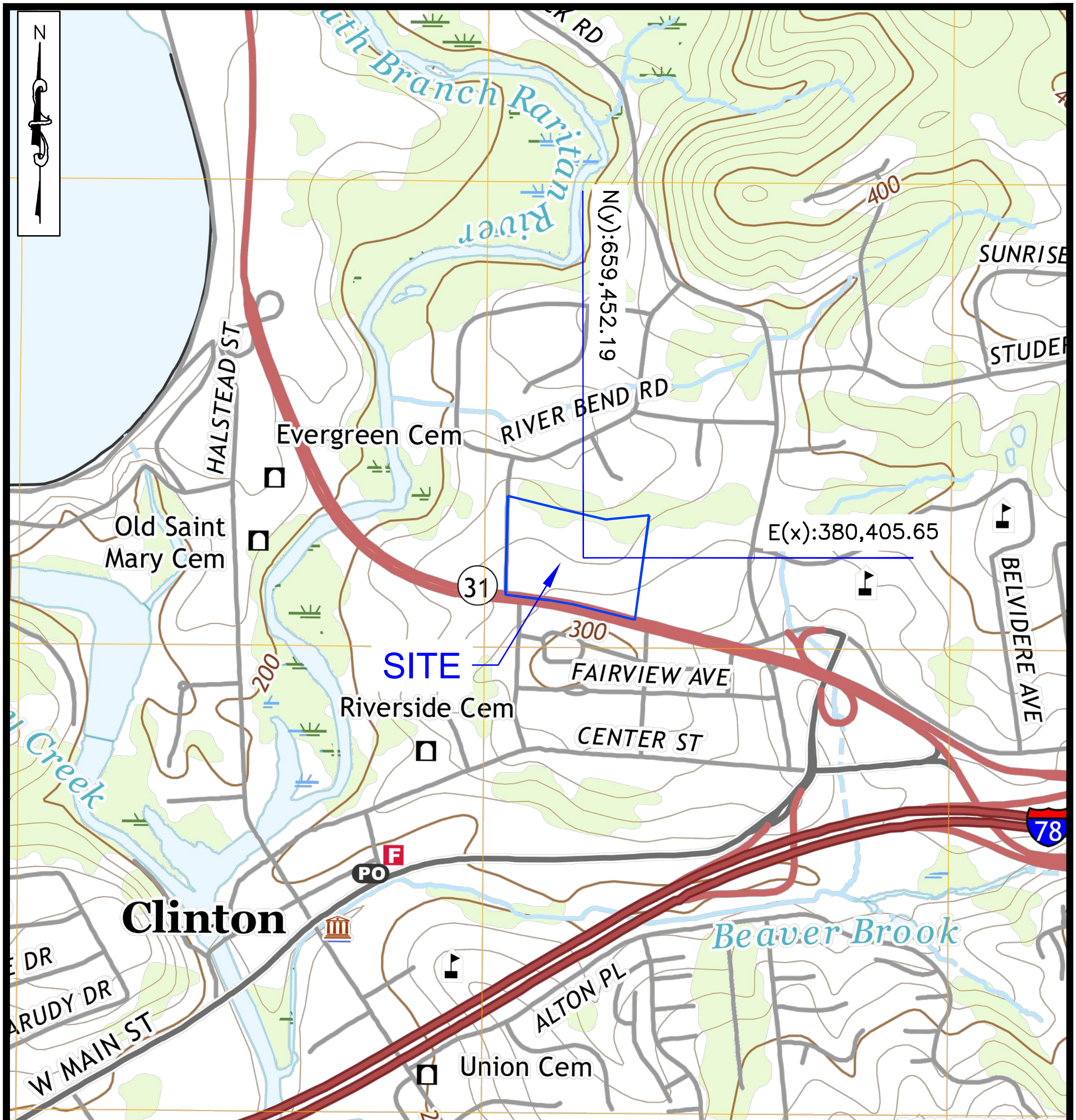
140 WEST MAIN STREET HIGH BRIDGE, NJ 08829
(908) 238-0544 FAX: (908)238-9572
C.O.A. #: 24GA28021500
A PROFESSIONAL ASSOCIATION

LOCATION:	DATE: 07/24/2020	FIGURE No.
PULEO INTERNATIONAL INC 13 MOEBUS PLACE (RT 31) BLOCK 18, LOT 5 TOWN OF CLINTON HUNTERDON COUNTY, NJ	PROJECT NO.: 0120176 FILENAME: AERIAL.DWG	1



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SCALE 1" = 1000 FT

REFERENCES:
USGS HIGH BIRDGE QUADRANGLE 2019

TITLE:

USGS MAP

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140 WEST MAIN STREET HIGH BRIDGE, NJ 08829
(908) 238-0544 FAX: (908)238-9572
C.O.A. #: 24GA28021500
A PROFESSIONAL ASSOCIATION

LOCATION:

PULEO INTERNATIONAL INC
13 MOEBUS PLACE (RT 31)
BLOCK 18, LOT 5
TOWN OF CLINTON
HUNTERDON COUNTY, NJ

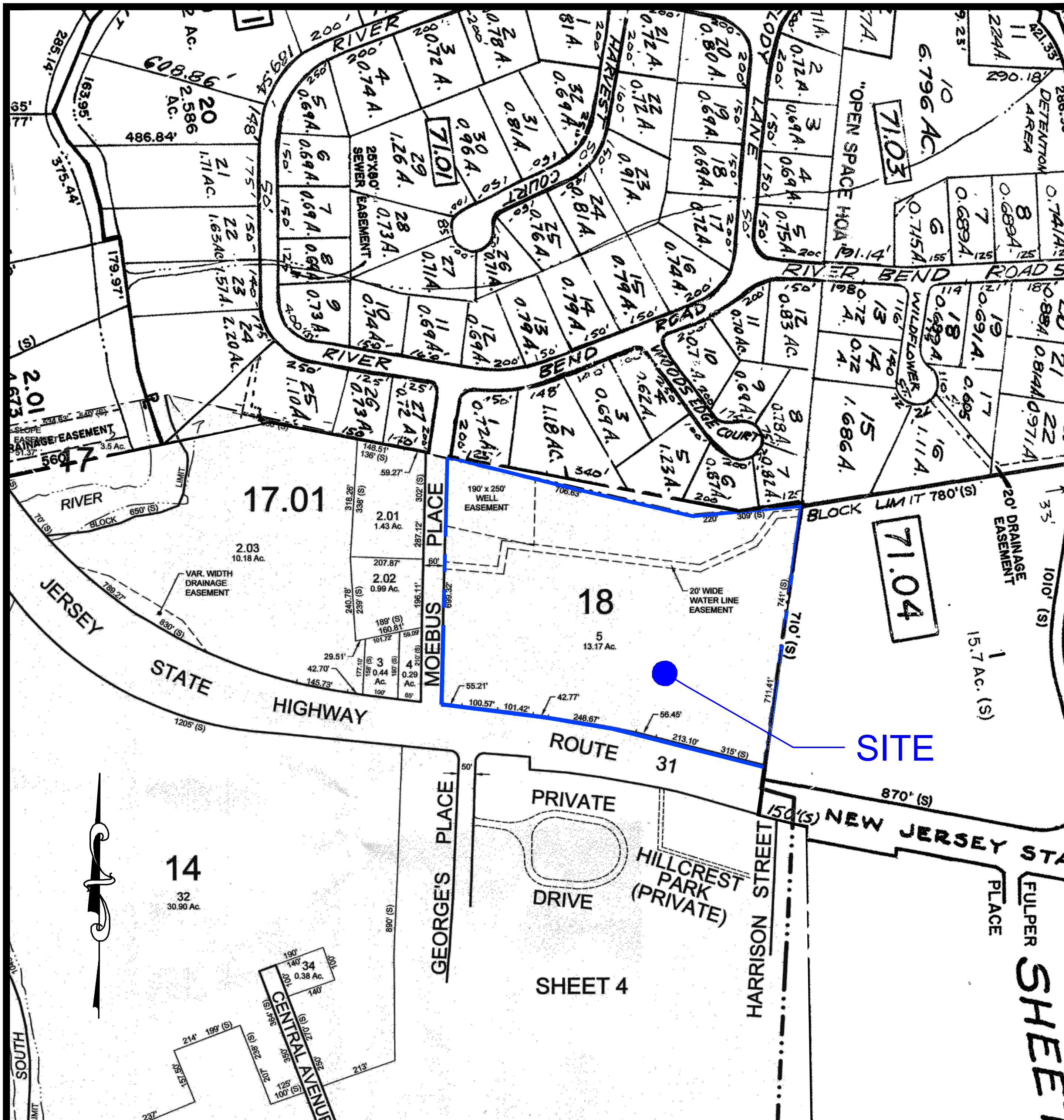
DATE: 07/24/2020

PROJECT NO.: 0120176

FILENAME: USGS.DWG

FIGURE No.

2



400 0 400

SCALE 1" = 400 FT

TITLE:

TAX MAP

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(908) 238-0544 FAX: (908)238-9572

C.O.A. #: 24GA28021500

A PROFESSIONAL ASSOCIATION

LOCATION:

PULEO INTERNATIONAL INC
13 MOEBUS PLACE (RT 31)
BLOCK 18, LOT 5
TOWN OF CLINTON
HUNTERDON COUNTY, NJ

DATE: 07/24/2020

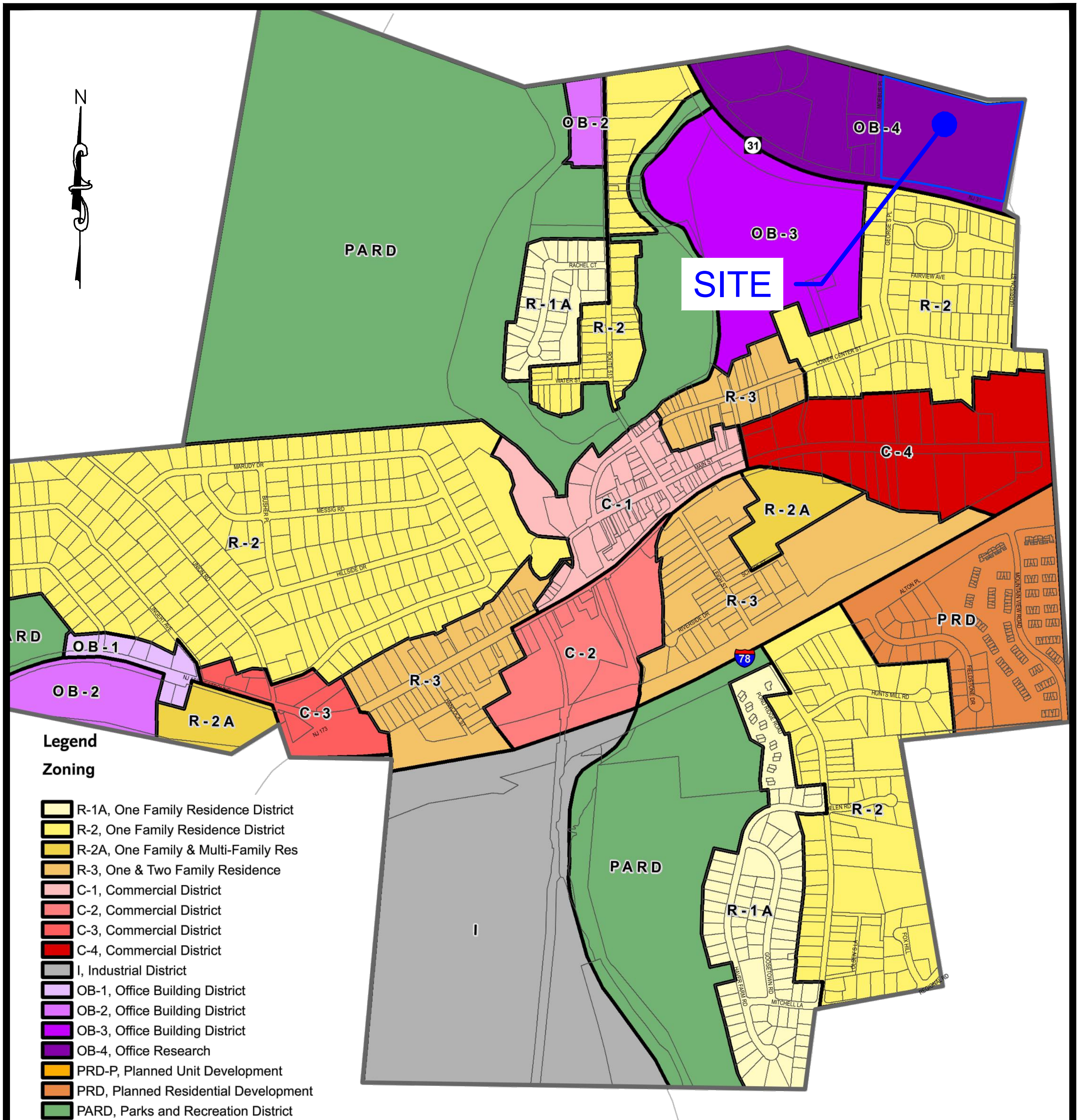
PROJECT NO.: 0120176

FILENAME: TAX.DWG

FIGURE No.

3

REFERENCES:
- TOWN OF CLINTON TAX MAP SHEET 5
- CLINTON TOWNSHIP TAX MAP SHEET 13



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SCALE 1" = 1000 FT

REFERENCES: TOWN OF CLINTON ZONING MAP

TITLE:

ZONING MAP

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C.O.A. #: 24GA28021500
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LOCATION:

PULEO INTERNATIONAL INC
13 MOEBUS PLACE (RT 31)
BLOCK 18, LOT 5
TOWN OF CLINTON
HUNTERDON COUNTY, NJ

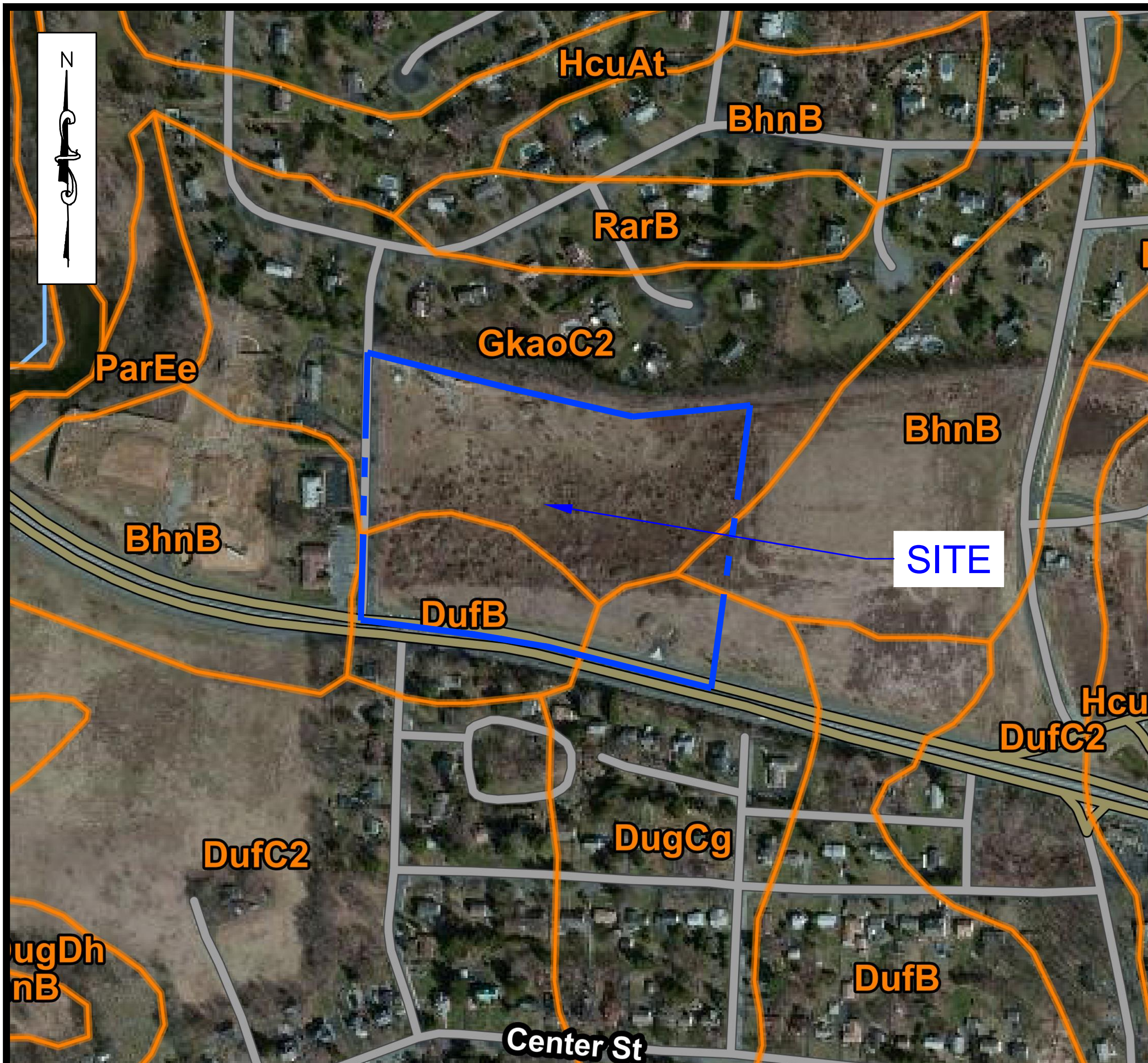
DATE: 07/24/2020

PROJECT NO.: 0120176

FILENAME: ZONING MAP.DWG

FIGURE No.

4



SOILS

GkcoC2: Gladstone Gravelly Loam, 8 t0 15 percent slopes, eroded;

DufB: Duffield Silt Loam, 2 to 6 percent slopes;

DugCg: Duffield Silt Loam, 0 to 12 percent slopes, rocky;

BhnB: Birdsboro Silt Loam, 2 to 6 percent slopes;

SOURCE:
NATURAL RESOURCES CONSERVATION SERVICE

400 0 400

Scale 1" = 400 ft

TITLE:

USDA SOIL MAP

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(908) 238-0544 FAX: (908)238-9572
C.O.A. #: 24GA28021500
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LOCATION:	DATE: 07/24/2020	FIGURE No.
PULEO INTERNATIONAL INC 13 MOEBUS PLACE (RT 31) BLOCK 18, LOT 5 TOWN OF CLINTON HUNTERDON COUNTY, NJ	PROJECT NO.: 0120176 FILENAME:SOIL MAP.dwg	5

LEGEND:

CARBONATE DISTRICT

CRD- CARBONATE ROCK DISTRICT

CDA- CARBONATE DRAINAGE AREA

400 0 400

Scale 1" = 400 ft

REFERENCES:
TOWN OF CLINTON CODE CHAPTER 88
LAND USE

TITLE:
MUNICIPAL CARBONATE AREA DISTRICT MAP

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(908) 238-0544 FAX: (908)238-9572
C.O.A. #: 24GA28021500
A PROFESSIONAL ASSOCIATION

LOCATION:
PULEO INTERNATIONAL INC
13 MOEBUS PLACE (RT 31)
BLOCK 18, LOT 5
TOWN OF CLINTON
HUNTERDON COUNTY, NJ

DATE: 07/24/2020

PROJECT NO.: 0120176

FILENAME: CARBONATE ROCK.dwg

FIGURE No.
6

APPENDIX A: PRELIMINARY & FINAL MAJOR SITE PLAN

(ATTACHED SEPARATELY)

APPENDIX B: STORMWATER MANAGEMENT REPORT
(ATTACHED SEPARATELY)

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APPENDIX C: ON-SITE SOIL TESTING

Biggs Engineering Associates, P.A.

113 East Washington Avenue
Washington, NJ 07882

Telephone (908) 689-1004
Fax (908) 689-7609

August 29, 2000

John Fallone
Fallone Organization
1117 Route 31 South
Lebanon, NJ 08833

Subject: Test Pits Bk 18 Lot 5
Clinton Township

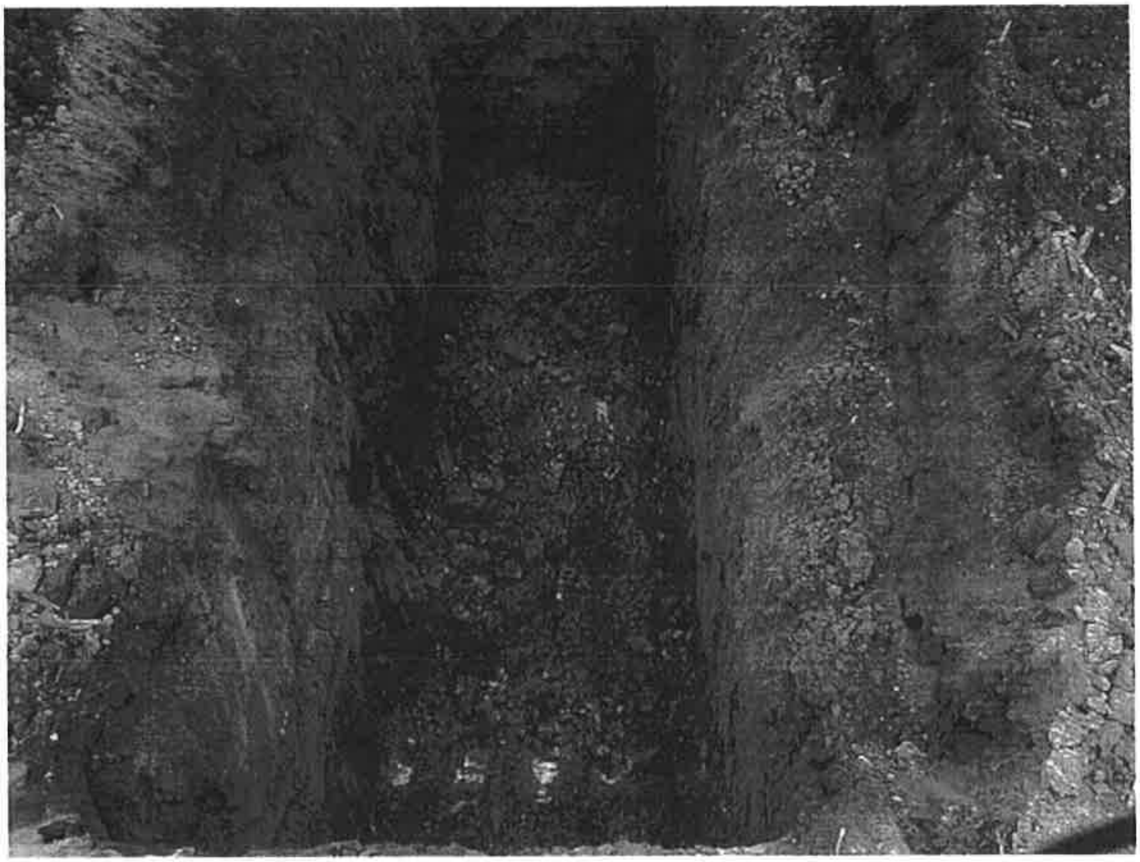
Dear John,

Enclosed are the results and approximate locations of the test pits preformed on May 10, 2000 on your Clinton site. We excavated 12 test pits on the southwestern portion of the site adjacent to Moebus Place. The depth to machine refusal varied from 72" to greater than 168". The high portion of the site adjacent to Moebus Place had the rock closest to the surface. There was no indications of sink hole activity in any of the test pits excavated. The underlaying rock appeared to be limestone, consistent with the report prepared by M² Associates. Our test pits are similar to borings 3, 4 and 5.

If you have any questions please call.

Sincerely,

Jess Symonds



Test Pit 2

Test Pit 5 at Low Point

Test Pit 7

Biggs Engineering Associates, P.A.

113 East Washington Avenue
Washington, NJ 07882

Telephone (908) 689-1004
Fax (908) 689-7609

6/29/00

Soil Logs

Fallone – Clinton Twp. Block 18, Lot 5

SL-1

0-8"	Topsoil
8-38"	Loam
38-105"	Loamy Sand, 10% Gravel, 5% Cobble
105-120"	Silt Loam
	Machine Refusal @ 120"

SL-2

0-12"	Topsoil
12-66"	Silt Loam, 10% Gravel
66-90"	Fractured Limestone
	Machine Refusal @ 90"

SL-3

0-10"	Topsoil
10-70"	Silt Loam, 10% Gravel
70-90"	Fractured Limestone
	Machine Refusal @ 90"

SL-4

0-12”	**Topsoil**
12-76”	**Silt Loam, 10% Gravel**
76-126”	**Silty Clay Loam, 15% Gravel, 15% Cobble, 15% Stones (All Limestone)**
	Machine Refusal @ 126+”

SL-5

(Low Point Photo #2)

0-24”	**Topsoil**
24-90”	**Silty Clay Loam**
90-144”	**Loamy Sand, 15% Gravel, 10% Cobble,**
144-168”	**Silt Loam,**
	No Rock

SL-6

0-15”	**Topsoil**
15-108”	**Silt Loam**
108-144”	**Fractured Limestone**
	Machine Refusal @ 144+”

SL-7

(High Point Photo #3)

0-8”	**Topsoil**
8-24”	**Silt Loam**
24-80”	**Fractured Limestone**
	Machine Refusal @ 80”

SL-8

0-12"	
12-54"	**Loamy Sand, 10% Gravel, 5% Cobble**
54-96"	**Silt Loam**
96-115"	**Fractured Limestone**
	Machine Refusal @ 115+"

SL-9

0-12"	**Topsoil**
12-54"	**Silt Loam**
54-84"	**Fractured Limestone**
	Machine Refusal @ 84"

SL-10

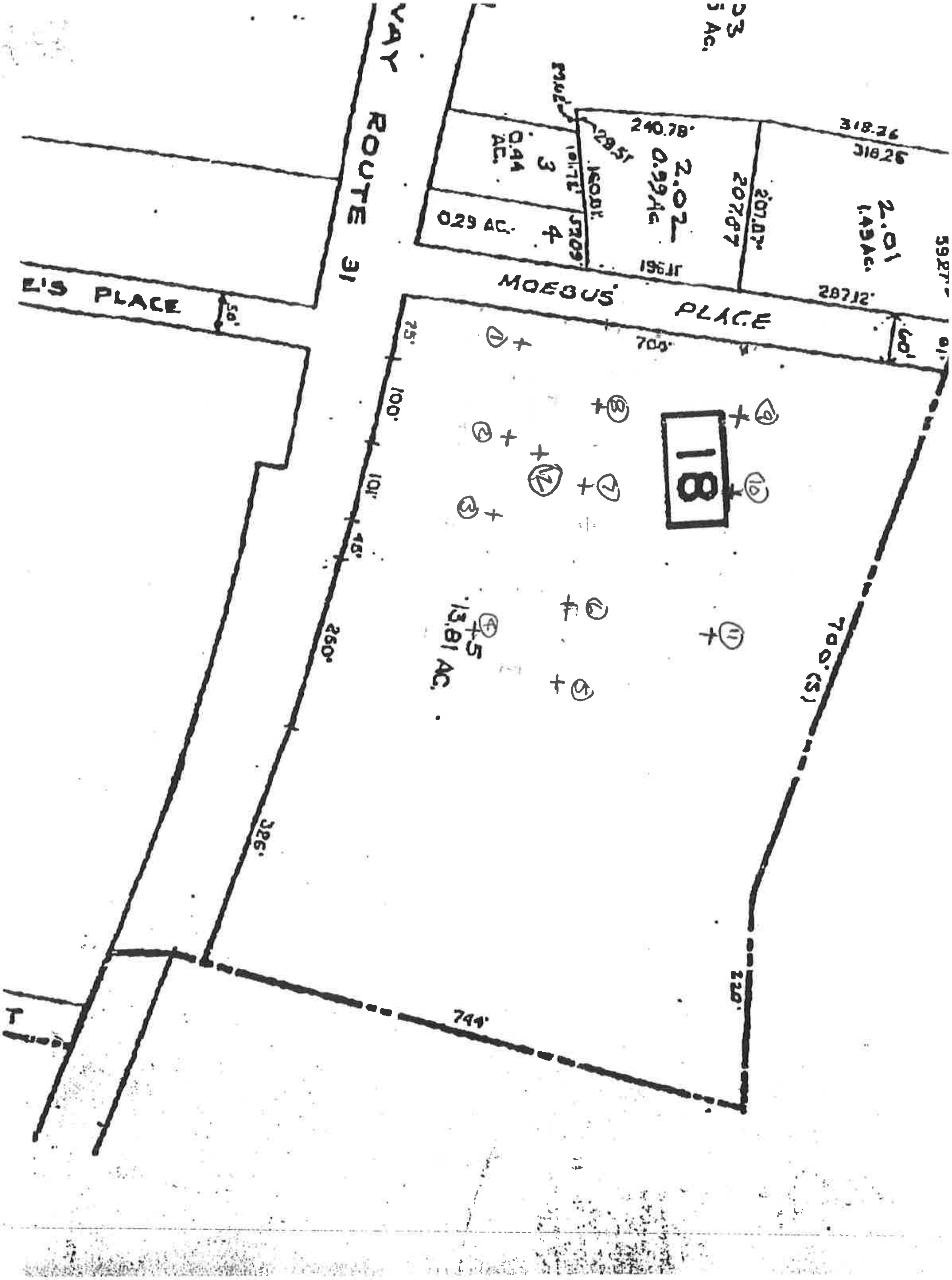
0-12"	**Topsoil**
12-36"	**Silt Loam**
36-80"	**Fractured Limestone**
	Machine Refusal @ 80"

SL-11

0-18"	**Topsoil**
18-70"	**Silty Clay Loam**
70-164"	**Silt Loam**

SL-12

0-16"	**Topsoil**
16-60"	**Silty Clay Loam**
60-72"	**Fractured Limestone**
	Machine Refusal @ 72"


ROUTE 31
MOEBUS PLACE
PLACE
18
13.81 AC.
5
2.02
0.99 Ac.
2.01
1.49 Ac.
3
0.44 AC.
4
0.29 AC.
240.78'
318.26
287.12'
207.87
700'
700' (3)
744'
260'
326'
100'
75'
50'
60'

M^2 Associates Inc

Providers of Geologic, Environmental, & Groundwater Consulting Services

Water: A Natural Renewable Resource

May 5, 1998

John Fallone
President
The Fallone Organization
1117 Route 31 South
Lebanon, NJ 08833

Re: Preliminary Geologic Evaluation of The Fallone Organization Site in Clinton Township, Hunterdon County, New Jersey.

Dear Mr. Fallone:

M^2 Associates Inc. was retained by The Fallone Organization to conduct a preliminary geologic evaluation in accordance with our November 11, 1997 proposal. This evaluation was conducted to assess bedrock geology at The Fallone Organization site on Gray Rock Road in Clinton Township, Hunterdon County, New Jersey.

SITE LOCATION

The Fallone Organization is proposing to develop the Gray Rock Road site, which is bounded by New Jersey State Highway 31 and Beaver Avenue to the south, Moebus Place to the west, a residential development to the north, and the Amerigas facility and GPU Energy easement to the east. Gray Rock road transects the property from north to south. The location of the site is shown on Figure 1.

The Gray Rock Road site encompasses approximately 60 acres and is currently used for farming. Based on information provided by the Clinton First Aid and Rescue Squad, The Fallone Organization will convey approximately 2.97 acres in the southeastern corner of the site to the Clinton First Aid and Rescue Squad for construction of a new facility.

The preliminary geologic evaluation reported herein encompasses the entire 60-acre site inclusive of the property planned for conveyance to the Clinton First Aid and Rescue Squad. Data obtained from the proposed Clinton First Aid and Rescue Squad site were instrumental in defining the bedrock geology of The Fallone Organization site.

M^2 Associates Inc • 24 Eighth Street • Frenchtown, New Jersey 08825-1102
Telephone: 908.996.3231 • Fax: 908.996.2142

GEOLOGY

GEOLOGIC MAPPING

The preliminary geologic evaluation was conducted to assess the potential presence of carbonate bedrock beneath the Gray Rock Road site. Many carbonate rock units are susceptible to the formation of solution features such as sinkholes and caverns. Collapse of one of these karst-type features could result in damage to buildings and harm to occupants.

In 1996, the United States Geological Survey (USGS) published a map entitled "Bedrock Geologic Map of Northern New Jersey". This map was used to preliminarily assess the geology of the Gray Rock Road site. This bedrock geologic information is shown on Figure 2.

FAULTS

As shown on Figure 2, a local thrust fault has been mapped approximately 800 feet west of site and transects the Allentown Formation. A regional fault has been mapped approximately 320 feet southeast of the site and has resulted in movement of several bedrock units. A small local fault has been mapped on the site and appears to parallel a straight section of the stream that transects the property. This local fault appears to have offset the Leithsville Formation, Hardyston Quartzite and microperthite alaskite near the northeast corner of the site. Movement along these faults may have resulted in fracturing of the bedrock beneath the Gray Rock Road site.

The presence of these three nearby faults indicates that the bedrock beneath the Gray Rock Road site is likely fractured. Fractures in bedrock serve as conduits and provide storage for groundwater. Groundwater movement along these preferred flow paths can enhance the dissolution of carbonate bedrock resulting in the formation of caverns, caves, and other karst features.

BEDROCK

Based on the USGS map, the Gray Rock Road site is underlain from west to east and youngest to oldest by the Ordovician-Cambrian age Allentown Formation and the Cambrian age Leithsville Formation and Hardyston Quartzite. A Precambrian age member of the Byram Intrusive Suite labeled as microperthite alaskite has been mapped near the eastern site boundary and intersects this boundary near the northeast property corner (see Figure 2). The following formation descriptions are based on the USGS' 1996 map.

Allentown Formation

The Allentown Formation is comprised of medium- to very light-gray, fine- to medium-grained, very thin- to very thick-bedded dolomite. This bedrock may contain orthoquartzite, shale, oolites, and stromatolites. The dolomite becomes increasingly shaly toward the lower conformable contact with the older Leithsville Formation. The thickness of Allentown ranges from 0 to 240 feet in New Jersey.

Leithsville Formation

The Leithsville Formation is comprised of light- to dark-gray and light-olive gray, medium- to fine-grained, thin- to medium-bedded dolomite. With continuing depth, this bedrock grades through a medium-gray, grayish-yellow, or pinkish-gray dolomite and dolomitic sandstone, siltstone, and shale toward a medium-gray, medium-grained, medium-bedded dolomite. Near the bottom of this formation, quartz sand stringers and lenses have been encountered. The Leithsville Formation, which ranges in thickness from 0 to approximately 185 feet, has a gradational conformable contact with the underlying Hardyston Quartzite.

Hardyston Quartzite

The older Hardyston Quartzite is comprised of light to medium-gray and bluish-gray conglomeratic sandstone. This type of sandstone is comprised of fine-sand to pebble-sized, sub-angular to sub-rounded dolomite and arkose rock fragments in a well to loosely cemented matrix. The thickness of this bedrock unit ranges from 0 to approximately 30 feet. The Hardyston Quartzite has an unconformable contact with underlying Precambrian age intrusive and metamorphic basement rocks such as microperthite alaskite of the Byram Intrusive Suite.

Microperthite Alaskite

Based on the USGS bedrock map, microperthite alaskite comprises the bedrock beneath properties located immediately east of The Fallone Organization site. The description for this type of bedrock ranges from pink- to buff-weathered, light-pinkish-gray or pinkish white, medium- to coarse-grained gneiss to granite with indistinct foliation. It is primarily composed of microcline microperthite, quartz, and oligoclase feldspar.

SINKHOLE SUSCEPTIBILITY

The Allentown and Leithsville Formations are carbonate rocks and are therefore, susceptible to the formation of karst features such as sinkholes and caverns. The Hardyston Quartzite and Precambrian microperthite alaskite are not carbonate rocks and therefore, not considered susceptible to the formation of karst features.

Although solution cavities may not form within the Hardyston Quartzite and microperthite alaskite, the contact between these rocks and the carbonates represents a zone of increased potential for solution cavities. Groundwater, after migrating through less permeable and sometimes more acidic rocks such as the quartzite and alaskite, has an increased capacity to dissolve carbonate minerals in more permeable limestones and dolomites.

Since the USGS map is based on regional data, site-specific data were required to accurately assess the presence of the Allentown and Leithsville dolomites beneath The Fallone Organization site. In addition, the site-specific information was necessary to assess the contact zone between the Hardyston Quartzite and Leithsville Formation.

BORINGS

LOCATIONS

A total of thirteen borings were drilled at The Fallone Organization site to obtain site-specific data regarding bedrock conditions. Borings labeled 1 through 9 were drilled on the 57-acre property proposed for development by The Fallone Organization. Borings A, B, C, and D were drilled on the approximately 3-acre parcel planned for conveyance to the Clinton First Aid and Rescue Squad. The boring locations are shown on Figure 3.

Borings 1 through 9 were drilled to depths ranging from 10 to 40 feet below ground surface with an air rotary/hammer rig on March 13, 1998. Borings A, B, C, and D were drilled to depths ranging from 38 to 40 feet below ground surface with an air rotary rig on March 13, 1998. Geologic logs were prepared of the materials removed from the boring and are presented in Attachment A.

WESTERN PORTION

The western portion of the site extends from Gray Rock Road to Moebus Place (see Figure 1) and is reportedly underlain entirely, by the Allentown and Leithsville Formations (see Figure 2). Borings 1 through 6 were drilled on this portion of the site.

Borings 1, 2, 3

Competent dolomite bedrock was encountered at shallow depths ranging from 5 to 12 feet below ground surface in Borings 1, 2, and 3. These three borings were drilled near the southern property boundary and extended to depths ranging from 10 to 25 feet below ground surface. Two small outcroppings of the Allentown dolomite were observed near Boring 2. Groundwater was not encountered in

Borings 1 and 3 but was present in the weathered bedrock at a depth of 3 feet below ground surface in Boring 2. In all three borings, the competent bedrock was dry and did not yield water.

The competent bedrock in Borings 1 through 3 was overlain by a thin layer of weathered dolomite that ranged in thickness from 0.5 to 1.5 feet. Yellow-brown silts with clay and a trace of very fine sand were encountered above the weathered bedrock. These stiff silts often contained sand- and gravel-sized weathered fragments of the underlying dolomite bedrock.

Borings 4, 5, 6

Bedrock was not encountered in Borings 4, 5, and 6, which were drilled nearer the northern property boundary and to depths ranging from 38 to 39 feet below ground surface. Groundwater was not encountered in these three borings.

Borings 4 and 5 were drilled within a topographic bowl-shaped area to assess if a sinkhole was responsible for the lowered elevations. The soils encountered in Borings 4 and 5 were comprised of yellow-brown silts with clay and a trace of very fine sand. Sand-, gravel-, and cobble-sized fragments of weathered dolomite were encountered within the stiff silts at depths exceeding 7 feet below ground surface. No voids were encountered during drilling. Air circulation was lost in Boring 4 within the depth intervals from 7 to 8 feet below ground surface and 20 to 21 feet below ground surface; and in Boring 5 within the depth intervals from 7 to 12 and 28 to 30 feet below ground surface.

The soils encountered in Boring 6 contained significantly more sand than encountered in Borings 1 through 5. Sand was the primary constituent of the materials encountered in this boring from 14.5 to 38 feet below ground surface. Weathered dolomite fragments were present in the sand matrix.

Summary

Based on the rock outcroppings, the competent bedrock materials encountered in Borings 1 through 3, the silt content and weathered bedrock fragments encountered in Borings 4 and 5, it appears that the western portion of the site is primarily underlain by the Allentown Formation. The presence of coarse to fine sands in Boring 6 indicates that the northeast corner of the western portion is underlain by the lower Leithsville Formation. Sand stringers and lenses are reportedly present in the Leithsville Formation near the contact with the Hardyston Quartzite.

EASTERN PORTION

The eastern portion of The Fallone Organization site extends from Gray Rock Road to the eastern property boundary and includes the proposed Clinton First Aid and Rescue Squad conveyance. Borings 7 through 9 and A through D were drilled within this portion of the site (see Figure 3).

Borings 8 and 9

Borings 8 and 9 were drilled near the two barns on the property. Competent bedrock was not encountered in either boring. Groundwater was encountered in Boring 8 at 23 feet below ground surface and in Boring 9 at 24 feet below ground surface. Both borings extended to 40 feet below ground surface.

Voids were encountered in Borings 8 and 9 at depth intervals 22 to 27 and 24 to 26 feet below ground surface, respectively. Similar to the borings in the western portion of the site, yellow-brown silts with clay and a trace of fine sand were encountered in Boring 9 both above and below the void. In contrast to the borings in the western portion, the silts encountered beneath the Boring 9 void were softer than the stiff silts encountered in Borings 1 through 6.

The soils encountered in Boring 8 above the void were comprised of red-brown silts and/or coarse to fine sands with a trace of clay; soils similar to these were not encountered elsewhere at the site. Beneath the void, stiff yellow-brown silts with coarse to fine sand and traces of clay were encountered. The silts and sands encountered below the void in Boring 8 were similar to the materials encountered in the four borings (Borings A through D) drilled to the southeast of Boring 8.

Borings 7 and A through D

In Borings A, B, and C, yellow-brown silts with clay and a trace of sand were encountered from ground surface to depths ranging from 4.5 to 9 feet below ground surface. Below this silt layer and from ground surface in Boring D, the percentage of sand increased from less than 10 percent to more than 90 percent of the materials encountered. In addition, gravel- and cobble-sized materials and quartzite fragments were encountered at some locations and depths. Bedrock was not encountered in any of the four borings. Groundwater was encountered in one boring (A) at a depth of 37 feet below ground surface. This boring was located at the lowest elevation in comparison to the three other borings.

Yellow-brown silts and coarse to fine sands with clays were encountered to 3 feet below ground surface in Boring 7. From 3 to the completed depth of the boring at 40 feet below ground surface, tan to white medium to fine sands with only a trace of silt and a few quartzite fragments were encountered. Groundwater was not encountered in this boring.

The silts encountered at shallow depths in Borings 7 and D and to greater depths in Borings A, B, C, 8, and 9 are probably derived from weathering of dolomitic portions of the Leithsville Formation. The sands encountered beneath the silts are most likely derived from the weathering of the lowermost portions of the Leithsville Formation, which contained some sand stringers and lenses, and the Hardyston Quartzite. The quartzite fragments and well–sorted sands encountered in Borings 7 and D and near the base of Borings A, B, and C are indications of the Hardyston Quartzite.

Summary

Based on the materials encountered in Borings 7, A, B, C, and D, the Leithsville Formation has been eroded from the easternmost portion of the site leaving behind a thin shallow residual silt layer. Competent Hardyston Quartzite bedrock is likely present beneath the residual sands derived from the weathering of this bedrock. Based on the USGS bedrock map (see Figure 2), Precambrian intrusives and metamorphics would be encountered beneath the Hardyston Quartzite, which this map indicates, may extend only to 130 feet below ground surface.

The lowermost sections of the Leithsville may continue to be present beneath the silts and sands encountered in Borings 6, 8, and 9. The voids encountered in Borings 8 and 9 may be indicative of the contact between the Hardyston Quartzite and Leithsville Formation. Solution features can form near the contact between a less permeable geologic formation such as the Hardyston Quartzite and more permeable carbonate rocks such as the Leithsville dolomite. If these voids indicate the contact between the formations, then this contact may be approximately 650 feet west of the contact shown on the USGS map.

CONCLUSIONS

Based on the results of the preliminary geologic evaluation and the thirteen borings the following conclusions are made:

1. The western portion of The Fallone Organization site as defined by Borings 1 through 5, is apparently underlain by the Allentown Formation. Competent bedrock was encountered at shallow depths in Borings 1 through 3. Two bedrock outcroppings were observed near Boring 2.

2. The Leithsville Formation dolomites may underlie the central portion of the site near Gray Rock Road as defined by Borings 6, 8, and 9. Competent bedrock was not encountered in these borings. The high percentages of sands encountered in these borings indicate that the uppermost portions of this formation have been eroded and only the lower sections containing sand stringers and lenses may continue to exist beneath the site.

3. The easternmost portion of the site as defined by Borings 7, A, B, C, and D appears to be underlain by Hardyston Quartzite. In general, these borings encountered stiff silts at shallow depths. Dense sands underlay these silts.

4. Voids were encountered in Borings 8 and 9 and groundwater was present in these voids. The voids may be indicative of the contact between the Hardyston Quartzite and Leithsville Formations.

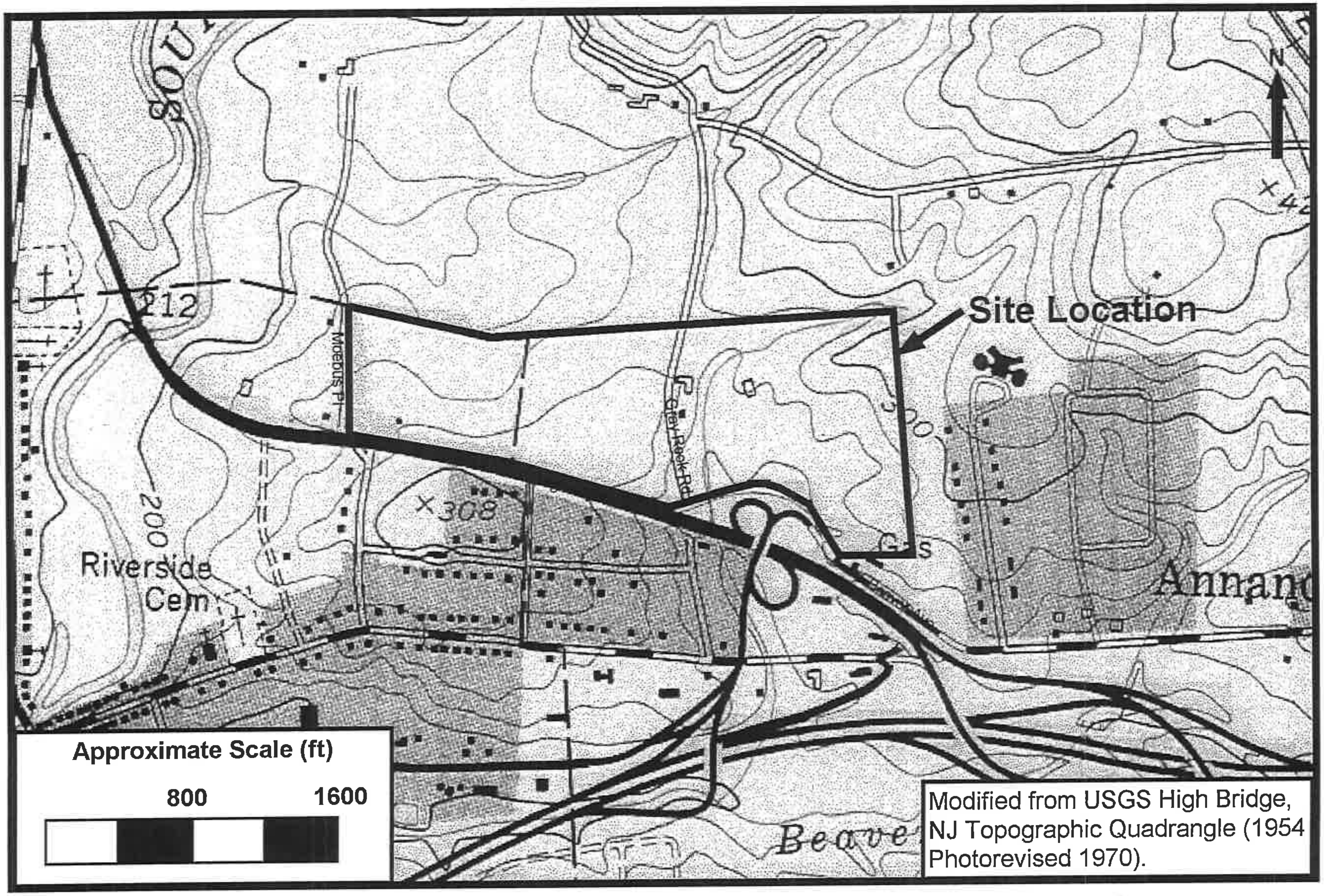
M^2 Associates appreciates the opportunity afforded by The Fallone Organization to conduct the preliminary geologic evaluation of the Gray Rock Road site in Clinton Township. If you have any questions, please call Matt Mulhall at (908) 996-3231.

Respectfully submitted,
M^2 Associates Inc.

Matthew J. Mulhall, P.G.

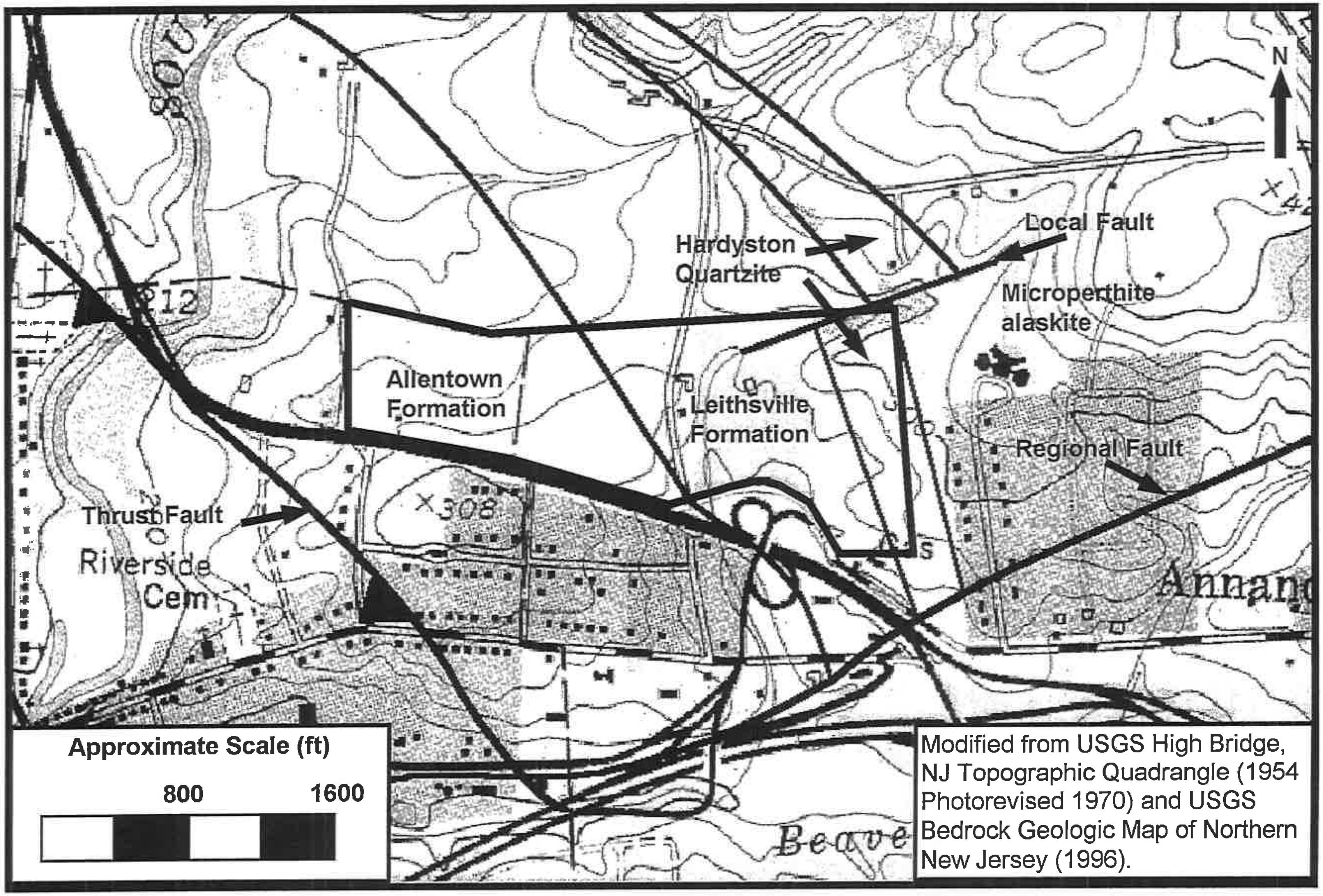
Water: A Natural Renewable Resource

Figure 1: Location of The Fallone Organization Site
Clinton Township, Hunterdon County, New Jersey



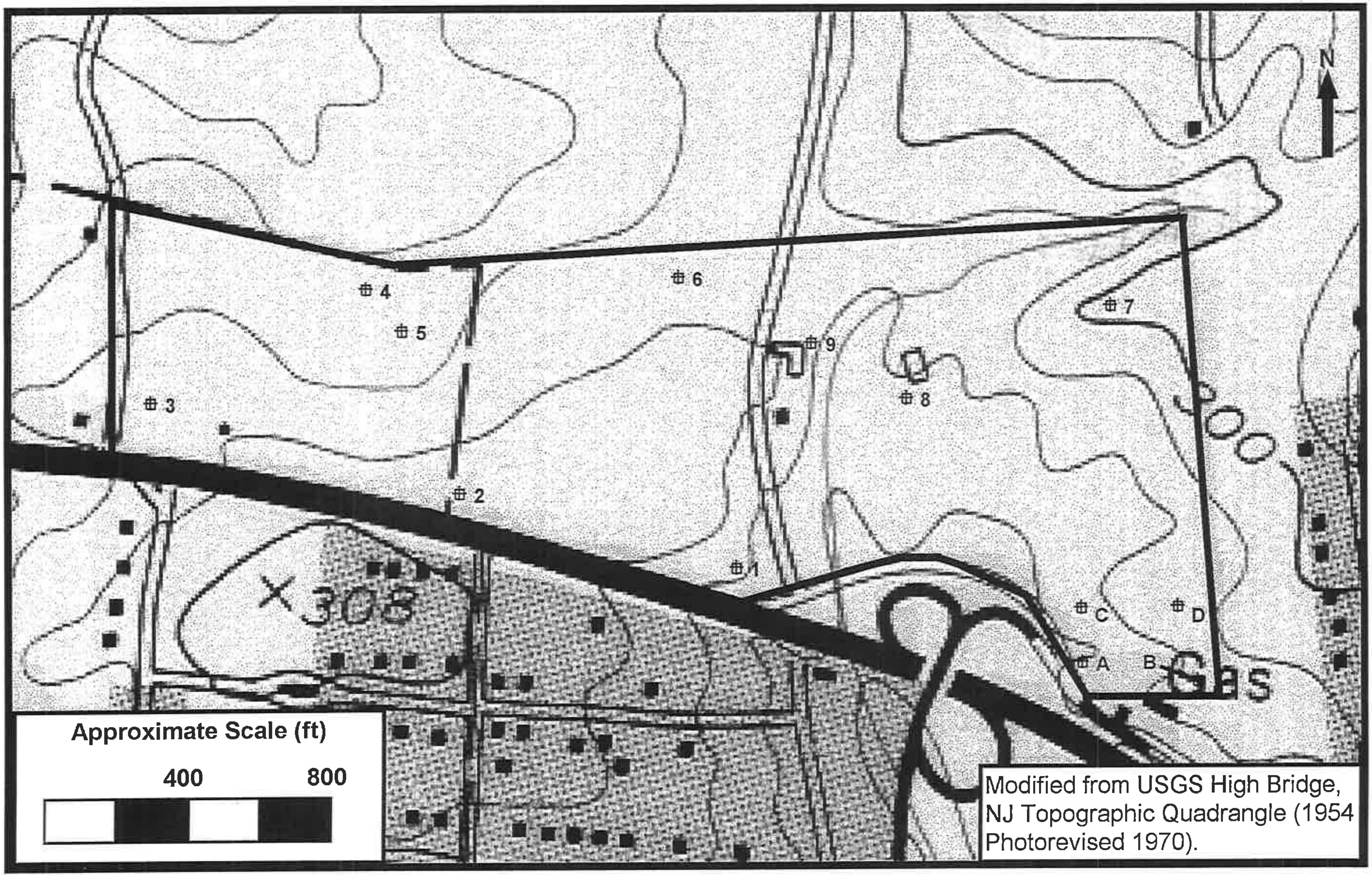
Water: A Natural Renewable Resource

Figure 2: Geology of The Fallone Organization Site
Clinton Township, Hunterdon County, New Jersey



Water: A Natural Renewable Resource

Figure 3: Boring Locations at The Fallone Organization Site
Clinton Township, Hunterdon County, New Jersey



Water: A Natural Renewable Resource

ATTACHMENT A:
SOIL BORING LOGS

Boring Log

Name: Matt Mulhall　　Date: 13-Mar-98　　Page 1 of 1

Water: A Natural Renewable Resource

Site: Fallone-Clinton　　Weather Clear 35^0

Boring No. 1　　Total Depth: 10 feet below ground surface

Time Drilling Started: ______ AM/PM　　Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings　　Device Diameter: 4-inch　　Sampling Interval: ______

Drilling Method: Air Rotary　　Type of Drilling Fluid: Air　　Contractor: Plainfield Well

Driller's Name: Mark O'Dell　　Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	2		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
2	3.5		ML	Yellow-brown Silt, little clay with frequent sand and gravel sized weathered residual dolomite fragments. Stiff. Residual soils and rock fragments from Allentown Formation.	
4	5			Light gray weathered dolomite. Allentown Formation.	
5	10			Competent dolomite bedrock. Very dry. Allentown Formation.	Groundwater not encountered in boring. End of boring at 8 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall Date: 13-Mar-98 Page 1 of 1

Site: Fallone-Clinton Weather Clear 35^0

Boring No. 2 Total Depth: 13 feet below ground surface

Time Drilling Started: ______ AM/PM Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings Device Diameter: 4-inch Sampling Interval: ______

Drilling Method: Air Rotary Type of Drilling Fluid: Air Contractor: Plainfield Well

Driller's Name: Mark O'Dell Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
0	2.5		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
2.5	7.5		ML	Yellow-brown Silt, little clay with frequent sand and gravel sized weathered residual dolomite fragments. Fragment size increases with depth. Residual soils and rock fragments from Allentown Formation. Moist. Very stiff.	
7.5	8			Light gray weathered dolomite. Allentown Formation. Wet.	
8	13			Competent dolomite bedrock. Very dry. Allentown Formation.	Bedrock outcrop nearby is comprised of dolomite. Groundwater encountered at 3 feet below ground surface in boring. End of boring at 13 feet below ground surface.

Boring Log

Name: Matt Mulhall	Date: 13-Mar-98	

Water: A Natural Renewable Resource

Site: Fallone-Clinton	Weather Clear 35^0

Boring No. 4	Total Depth: 39 feet below ground surface

Time Drilling Started: ____ AM/PM	Time Drilling Completed: ____ AM/PM

Type of Sampling Device: Cuttings	Device Diameter: 4-inch	Sampling Interval: ____

Drilling Method: Air Rotary	Type of Drilling Fluid: Air	Contractor: Plainfield Well

Driller's Name: Mark O'Dell	Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	7		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
7	8		ML	Yellow-brown Silt, little clay with frequent sand, gravel, and cobble sized weathered residual dolomite fragments. Residual soils and rock fragments from Allentown Formation. Slightly moist. Stiff. Some loss of air circulation.	
8	20		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
20	21		ML	Yellow-brown Silt, little clay with frequent sand, gravel, and cobble sized weathered residual dolomite fragments. Residual soils and rock fragments from Allentown Formation. Slightly moist. Very stiff. Some loss of air circulation.	

Boring Log Continued

Name: Matt Mulhall   Date: 13-Mar-98   Page 2 of 2

Site: Fallone-Clinton   Weather Clear 35^0

Boring No. 4   Total Depth: 39 feet below ground surface

Water: A Natural Renewable Resource

Sampling Interval (Depth in feet below ground surface)					
From:	To:	Core Recovery	Time/Hydraulic Pressure or Blows per Inch	Sample/Core Description	Comments
21	39		CL	Yellow-brown Clay, some silt. Moderate plasticity. Medium consistency. Residual soils weathered from Allentown Formation.	Groundwater and competent bedrock not encountered in boring. End of boring at 39 feet below ground surface.

Boring Log

Name: Matt Mulhall   Date: 13-Mar-98   Page 1 of 2

Site: Fallone-Clinton   Weather Clear 35^0

Water: A Natural Renewable Resource

Boring No. 5   Total Depth: 39 feet below ground surface

Time Drilling Started: ____ AM/PM   Time Drilling Completed: ____ AM/PM

Type of Sampling Device: Cuttings   Device Diameter: 4-inch   Sampling Interval: ____

Drilling Method: Air Rotary   Type of Drilling Fluid: Air   Contractor: Plainfield Well

Driller's Name: Mark O'Dell   Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	7		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
7	12		ML	Yellow-brown Silt, little clay with frequent sand, gravel, and cobble sized weathered residual dolomite fragments. Residual soils and rock fragments from Allentown Formation. Slightly moist. Stiff. Slight loss of air circulation.	
12	28		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
28	30		ML	Yellow-brown Silt, little clay with few sand, gravel, and cobble sized weathered residual dolomite fragments. Residual soils and rock fragments from Allentown Formation. Slightly moist. Very stiff. Slight loss of air circulation.	

Boring Log Continued

Name: Matt Mulhall Date: 13-Mar-98

Site: Fallone-Clinton Weather Clear 35^0

Boring No. 5 Total Depth: 39 feet below ground surface

Water: A Natural Renewable Resource

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Time/Hydraulic Pressure or Blows per Inch	Sample/Core Description	Comments
30	34.5		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from Allentown Formation.	
34.5	39		ML	Yellow-brown Silt, little clay with few sand, gravel, and cobble sized weathered residual dolomite fragments. Residual soils and rock fragments from Allentown Formation. Slightly moist. Very stiff. No loss of air circulation.	Groundwater and competent bedrock not encountered in boring. End of boring at 39 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall

Date: 13-Mar-98

Site: Fallone-Clinton

Weather Clear 35^0

Boring No. 6

Total Depth: 38 feet below ground surface

Time Drilling Started: ______ AM/PM

Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings

Device Diameter: 4-inch

Sampling Interval: ______

Drilling Method: Air Rotary

Type of Drilling Fluid: Air

Contractor: Plainfield Well

Driller's Name: Mark O'Dell

Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	14.5		ML	Yellow-brown Silt, some coarse to fine sand, little clay. Little plasticity. Stiff. Residual soils weathered from lower Leithsville Formation.	
14.5	38		SM	Yellow-brown coarse to fine Sand, some silt, little clay, few gravel and pebble sized weathered dolomite fragments. Dense. Residual soils weathered from lower Leithsville Formation.	
					Groundwater and competent bedrock not encountered in boring.
					End of boring at 38 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall   Date: 13-Mar-98   Page 1 of 1

Site: Fallone-Clinton   Weather Clear 35^0

Boring No. 7   Total Depth: 40 feet below ground surface

Time Drilling Started: ______ AM/PM   Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings   Device Diameter: 4-inch   Sampling Interval: ______

Drilling Method: Air Rotary   Type of Drilling Fluid: Air   Contractor: Plainfield Well

Driller's Name: Mike Assante   Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	1		OL	Topsoil. Brown Clay, some silt. Soft. Organic.	
1	3		ML	Yellow-brown Silt, some coarse to fine sand, little clay.Little plasticity. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
3	40		SW	Tan to white medium to fine Sand, trace silt. Few coarse quartzite fragments. Dense. Residual soils weathered from underlying Hardyston Quartzite.	Groundwater and competent bedrock not encountered in boring. End of boring at 40 feet below ground surface.

Boring Log

Name: Matt Mulhall Date: 13-Mar-98 Page 1 of 2

Site: Fallone-Clinton Weather Clear 35^0

Water: A Natural Renewable Resource

Boring No. 8 Total Depth: 40 feet below ground surface

Time Drilling Started: ____ AM/PM Time Drilling Completed: ____ AM/PM

Type of Sampling Device: Cuttings Device Diameter: 4-inch Sampling Interval: ____

Drilling Method: Air Rotary Type of Drilling Fluid: Air Contractor: Plainfield Well

Driller's Name: Mike Assante Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	1		OL	Topsoil. Brown Clay, some silt. Soft. Organic.	
1	9		ML	Red-brown Silt, and coarse to fine sand, trace clay. Little plasticity. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
9	22		SP	Red-brown coarse to fine Sand, some silt, trace clay.Dense. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
22	27			Void. Loss of air circulation. No recovery.	
27	30.5		ML	Yellow-brown Silt, some coarse to fine sand, little clay. Slightly plastic. Moist. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	

Boring Log Continued

Name: Matt Mulhall Date: 13-Mar-98 Page 2 of 2

Site: Fallone-Clinton Weather Clear 35^0

Boring No. 8 Total Depth: 40 feet below ground surface

Water: A Natural Renewable Resource

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Time/Hydraulic Pressure or Blows per Inch	Sample/Core Description	Comments
From:	To:				
30.5	40		ML	Yellow-brown Silt, some coarse to fine sand, little clay. Few gravel to cobble sized rock fragments. Slightly plastic. Stiff. Moist. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	Groundwater encountered at 23 feet below ground surface in boring. Competent bedrock not encountered in boring. End of boring at 40 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall   Date: 13-Mar-98   Page 1 of 1

Site: Fallone-Clinton   Weather Clear 35°

Boring No. 9   Total Depth: 40 feet below ground surface

Time Drilling Started: ____ AM/PM   Time Drilling Completed: ____ AM/PM

Type of Sampling Device: Cuttings   Device Diameter: 4-inch   Sampling Interval: ____

Drilling Method: Air Rotary   Type of Drilling Fluid: Air   Contractor: Plainfield Well

Driller's Name: Mike Assante   Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
0	1		OL	Topsoil. Brown Clay, some silt. Soft. Organic.	
1	24		ML	Yellow-brown Silt, little clay, trace fine sand. Slightly plasticity. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
24	26			Void. Loss of air circulation. No recovery.	
26	40		ML	Yellow-brown Silt, little clay, trace coarse to fine sand. Slightly plastic. Wet. Medium consistency. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	Groundwater encountered at 24 feet below ground surface in boring. Competent bedrock not encountered in boring. End of boring at 40 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall   Date: 13-Mar-98   Page 1 of 1

Site: Clinton Rescue Squad   Weather Clear 35^0

Boring No. A   Total Depth: 40 feet below ground surface

Time Drilling Started: ______ AM/PM   Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings   Device Diameter: 4-inch   Sampling Interval: ______

Drilling Method: Air Rotary   Type of Drilling Fluid: Air   Contractor: Plainfield Well

Driller's Name: Mike Assante   Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	2		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
2	9		ML	Yellow-brown Silt, little clay, trace very fine sand. Very slight plasticity. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
9	40		SM	Yellow-brown coarse to fine Sand, some silt, trace clay, few quartzite fragments. Dense. Residual soils weathered from underlying Hardyston Quartzite.	Groundwater encountered at 37 feet below ground surface. Competent bedrock was not encountered in boring End of boring at 40 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall | Date: 13-Mar-98 | Page 1 of 1

Site: Clinton Rescue Squad | Weather Clear 35^0

Boring No. B | Total Depth: 38 feet below ground surface

Time Drilling Started: ______ AM/PM | Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings | Device Diameter: 4-inch | Sampling Interval: ______

Drilling Method: Air Rotary | Type of Drilling Fluid: Air | Contractor: Plainfield Well

Driller's Name: Mike Assante | Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
0	4.5		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
4.5	6		SP	Yellow-brown coarse to fine Sand, some coarse to fine gravel, trace silt, few cobbles. Very dense. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
6	30		ML	Yellow-brown Silt, little clay, trace fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Quartzite.	
30	38		SW	Yellow-brown coarse to fine Sand, trace silt. Dense. Residual soils weathered from underlying Hardyston Quartzite.	Groundwater and competent bedrock not encountered in boring. End of boring at 38 feet below ground surface.

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall　Date: 13-Mar-98　

Site: Clinton Rescue Squad　Weather Clear 35^0

Boring No. C　Total Depth: 38 feet below ground surface

Time Drilling Started: ______ AM/PM　Time Drilling Completed: ______ AM/PM

Type of Sampling Device: Cuttings　Device Diameter: 4-inch　Sampling Interval: ______

Drilling Method: Air Rotary　Type of Drilling Fluid: Air　Contractor: Plainfield Well

Driller's Name: Mike Assante　Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
0	5		ML	Yellow-brown Silt, little clay, trace very fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
5	9		ML	Yellow-brown Silt, little clay, little coarse to fine sand, few cobbles and weathered quartzite fragments.Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
9	23		ML	Yellow-brown Silt, little clay, trace fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Quartzite.	Moisture present in soils at 22 feet below ground surface.
23	38		SW	Yellow-brown medium to fine Sand, trace silt. Dense. Residual soils weathered from underlying Hardyston Quartzite.	Groundwater and competent bedrock not encountered in boring. End of boring at 38 feet below ground surface.

Boring Log

Name: Matt Mulhall | Date: 13-Mar-98 | Page 1 of 1

Water: A Natural Renewable Resource

Site: Clinton Rescue Squad | Weather Clear 35^0

Boring No. D | Total Depth: 38 feet below ground surface

Time Drilling Started: ____ AM/PM | Time Drilling Completed: ____ AM/PM

Type of Sampling Device: Cuttings | Device Diameter: 4-inch | Sampling Interval: ____

Drilling Method: Air Rotary | Type of Drilling Fluid: Air | Contractor: Plainfield Well

Driller's Name: Mike Assante | Helper's Name: Oscar Argueta

Sampling Interval (Depth in feet below ground surface)		Core Recovery	Unified Soil Classification System Symbol	Sample/Core Description	Comments
From:	To:				
0	10		ML	Yellow-brown Silt, little clay, little coarse to fine sand, few cobbles and weathered quartzite fragments.Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Formations.	
10	12		ML	Yellow-brown Silt, little clay, trace fine sand. Slightly plastic. Stiff. Residual soils weathered from eroded lower Leithsville or upper Hardyston Quartzite.	
12	14		ML	Light gray Silt, little clay. Slightly plastic. Stiff. Moist. Residual soils weathered from eroded lower Leithsville or upper Hardyston Quartzite.	
14	38		SW	Tan-white medium to fine Sand. Trace silt. Dense. Dry. Residual soils weathered from underlying Hardyston Quartzite.	Groundwater and competent bedrock not encountered in boring. End of boring at 38 feet below ground surface.

Water: A Natural Renewable Resource

PHASE II INVESTIGATION OF CARBONATE ROCK BENEATH BLOCK 18 LOT 5 IN THE TOWN OF CLINTON, HUNTERDON COUNTY, NEW JERSEY

NOVEMBER 26, 2001

Prepared for:

~~John Fallone~~
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Water: A Natural Renewable Resource

PHASE II INVESTIGATION OF CARBONATE ROCK BENEATH BLOCK 18 LOT 5 IN THE TOWN OF CLINTON, HUNTERDON COUNTY, NEW JERSEY

DRAFT

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2. Locations of Borings and Test Pits at the Proposed Z&F, LLC Office Building Complex Block 18 Lot 5 in the Town of Clinton, Hunterdon County, New Jersey.

APPENDIX

A. Appendix A: Phase II Investigation Boring Logs for Block 18 Lot 5 in Town of Clinton, Hunterdon County, New Jersey.

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PHASE II INVESTIGATION OF CARBONATE ROCK BENEATH BLOCK 18 LOT 5 IN THE TOWN OF CLINTON, HUNTERDON COUNTY, NEW JERSEY

INTRODUCTION

M² Associates recently completed Phase II of the carbonate rock evaluation of Block 18 Lot 5 in the Town of Clinton, New Jersey. A preliminary geologic evaluation was conducted at the site in March 1998 and M² Associates summarized the results of this first phase in a May 5, 1998 report.

SITE CONDITIONS

LOCATION

Block 18 Lot 5 is bounded to the west by Moebus Place and to the south by New Jersey State Highway 31 in the Town of Clinton. The northern and eastern property boundaries coincide with the municipal boundary between the Town of Clinton and the Township of Clinton. The site location is shown on Figure 1.

DEVELOPMENT PLANS

Z&F have presented plans prepared by Studer and McEldowney to the Town of Clinton Planning Board to construct two office buildings and associated parking lots on this 13.166-acre lot. These plans have received preliminary site plan approval from the Town of Clinton Planning Board.

Each building will have a footprint of approximately 150 feet by 110 feet with a building height of approximately 40 feet. A courtyard will be located between the two buildings and parking lots will be located on all sides. Driveway entrances to the property will be from New Jersey State Highway 31 and Moebus Place.

A stormwater detention basin will be located near the northern property boundary and will receive runoff from impervious surfaces. The discharge from this basin will be to an unnamed tributary to the South Branch of the Raritan River.

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BEDROCK GEOLOGY

As shown on Figure 1, the entire Z&F site is underlain by Cambrian-Ordovician Allentown Formation. The presence of the Allentown Formation beneath the site was confirmed during the preliminary geologic evaluation conducted in 1998. The Allentown Formation is described by the United States Geological Survey (USGS) as medium- to very light-gray, fine- to medium-grained, very thin to very thick-bedded dolomite. Oolites and algal stromatolites characterize this bedrock formation. The thickness of the formation in New Jersey ranges from 0 to 240 feet.

The Allentown Formation becomes increasingly shaly toward the lower conformable contact with the underlying Leithsville Formation. The USGS and New Jersey Geological Survey (NJGS) have mapped the Leithsville Formation immediately northeast of the site (see Figure 1).

The Allentown dolomite is comprised of carbonate minerals, which when exposed to acidic water can slowly dissolve. Over long periods of time, openings such as cavities, caves, and caverns can form in the bedrock and become conduits for subsurface erosion of soils. The erosion of overlying soils into an underlying solution opening in the bedrock can result in the formation of a sinkhole.

Since solution openings may be present in the subsurface bedrock and sinkholes can form on a site underlain by dolomite, a Phase II investigation was conducted to assess the potential for sinkholes to form primarily beneath the buildings and detention basin proposed for construction at the site.

PHASE II INVESTIGATION

WORKPLAN

During the preliminary geologic evaluation, four borings (labeled 2,3,4, and 5 in the May 5, 1998 report) were drilled on or immediately adjacent to the site. In two borings (2 and 3) completed along the southern portion of the property, dense competent dolomite was encountered within 8 to 12 feet of ground surface. In two borings (4 and 5) completed in the northwestern portion of the site, competent bedrock was not encountered to a depth of 39 feet below ground surface.

The geologic logs of these borings and the May 5, 1998 report were submitted to the Town of Clinton Planning Board, which in turn submitted a copy of the report to Raymond J. Tully, P.E. of Melick-Tully and Associates (MTA) for his review and comment. Mr. Tully summarized the results of his review in an August 24, 2001 letter to the Planning Board. Based on this letter and discussions regarding site conditions between Mr. Tully and Matthew J. Mulhall of M^2 Associates, a workplan for a detailed geologic evaluation of site foundation conditions was outlined. This workplan included the following:

1. Six soil/bedrock borings along the centerline of the buildings, with three borings per building. These borings were to be drilled through soils using the Standard Penetration Method to assess soil conditions with respect to foundation support. If rock were encountered at a depth less than 40 feet, a 10-foot core sample would be collected. Z&F's engineer would use the data from these borings to prepare final foundation designs for the buildings and retaining walls. In addition, the data from these borings would be used to assess the actual and potential presence of solution openings, soil voids, and sinkhole features beneath the proposed buildings.

2. Two test pits would be excavated within the proposed detention basin to a depth of 12 feet below ground surface. A soil boring would also be drilled within this detention basin to a depth of 25 feet below ground surface. The data from this boring and the test pits would be used to assess soil composition; the presence of a seasonal water table; and the actual and potential presence of solution openings, soil voids, and sinkhole features beneath the proposed basin.

3. If borings drilled near the buildings and/or within the detention basin indicated potential solution openings and/or sinkhole features, then additional borings would be drilled as necessary to define these openings and/or features.

4. Grouting the borings after completion with a cement-bentonite grout mix prepared as per New Jersey Department of Environmental Protection (NJDEP) regulations (N.J.A.C. 7:9-9.1). The volume of grout used to fill the borings was to be measured and compared to the theoretical volume of grout needed to fill the boring. The data from the grout measurements is useful in assessing the competency of the bedrock and the potential size and presence of openings in rock or soil.

RESULTS

Boring Locations

Six borings, three per building, were drilled along an east to west centerline through the proposed buildings. Two borings were drilled within the detention basin. Two test pits were also completed within the detention basin. The locations of the borings and test pits are shown on Figure 2.

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Sampling

Split-spoon samples were collected continuously in two-foot intervals from approximately 1.5 to 2 feet below ground surface to the top of bedrock or 40 feet below ground surface, which ever was encountered first. The split-spoon samples were collected using the Standard Penetration Test as outlined in ASTM Test D-1586. The 2-inch diameter split-spoons were driven using a 140-pound hammer dropping 30-inches per blow and the blow counts were recorded in 6-inch intervals.

The blow counts for the last 12-inch interval of each split-spoon sample were summed and used to estimate preliminary bearing pressures for soils near each building. The preliminary bearing pressure estimates were made using results summarized by George F. Sowers in the fourth edition of "Introductory Soil Mechanics and Foundations: Geotechnical Engineering" as summarized on Page 147 in the 1983 text entitled "Structural System Design" by Robert A. Coleman.

The preliminary bearing pressures were estimated to assess potential soft zones in soils or weak points in rock that may be susceptible to differential settlement and/or sinkhole formation. We have not designed foundations. Z&F will retain a qualified professional engineer to prepare appropriate foundation designs.

In addition to the split-spoon samples, bedrock cores were obtained from one boring beneath the east building and all three borings beneath the west building. In all four of these borings, bedrock was encountered within 40 feet of ground surface. These 2-inch diameter rock samples were collected in 5 to 10 foot continuous cores using a standard 10-foot long NX-sized core. The rock cores were inspected for rock-type, recovery, and Rock Quality Designation (RQD), which is the ratio of the length of intact core sections longer than 4-inches to the length of the core run. Similar to the split-spoon blow counts, the RQD results were used to estimate bearing pressures for the underlying bedrock.

In the two borings completed in the detention basin, rock cores were not obtained. The air hammer bit on the drilling rig was used similar to a percussion rig to assess the depth to bedrock and the relative hardness of this rock. Split-spoon samples were collected in one of these two borings. Two test pits were completed in the detention basin to inspect soil profiles for composition, the presence of soil voids and/or solution openings, and the potential presence of a seasonal water table beneath the proposed basin. The data from these detention basin borings and test pits were used to evaluate the competency of the bedrock, the potential for groundwater mounding, and the potential presence of solution openings.

The borings were drilled by a New Jersey-licensed driller in the employ of Plainfield Well Drilling of Martinsville, New Jersey. The test pits were excavated with a Hitachi EX150 by an operator employed by Somerset Excavating. A professional geologist employed by M^2 Associates logged all borings and test pits. A professional geologist employed by MTA was also on site and inspected the test pits and samples from the borings.

Grouting

All borings were grouted in accordance with N.J.A.C. 7:9-9.1 by mixing three 94-pound bags of Portland Cement with approximately 15 to 20 pounds of bentonite and 7 gallons of water per batch. The mixer capacity is 40 gallons and each batch filled the mixer. After a batch was completely mixed, the grouting machine pumped the grout through a tremie pipe to the bottom of the boring. Additional batches were mixed as necessary to completely fill each boring. The borings were inspected on the day following grouting to assess grout settlement.

East Building

Borings

Three borings were drilled along the centerline of the east building starting from east to west (see Figure 2). Detailed results from these borings are provided on the geologic logs included in Attachment A. The soils encountered along the east side of the building are primarily medium to hard, plastic, brown-yellow clays with some silt and few to frequent sand- to gravel-sized weathered rock fragments. To a depth of approximately 9.7 feet below ground surface, the soils were till deposits associated with pre-Illinoian glaciation. From 9.7 to 29 feet below ground surface, residual clays with few weathered sand- to gravel-sized dolomite fragments derived from the underlying dolomitic bedrock were encountered.

A small void was encountered in Boring EB-1 between 14.5 and 14.7 feet below ground surface and a slightly larger void was encountered immediately below a 2-foot thick section of competent dolomite from 31 to 32 feet below ground surface. A layer of weathered dolomite and residual yellow-brown to red-brown clays was encountered from 32 to 37 feet below ground surface and this layer of stiff clays was in turn underlain by competent dolomite to approximately 40 feet below ground surface. As this first boring was nearing completion, a larger void was encountered from approximately 40 to 44.5 feet below ground surface. Competent bedrock was encountered beneath the void to the completed boring depth of 46 feet below ground surface. Of the eight borings completed at the site, the EB-1 boring was the only one in which voids were encountered either in soils or bedrock.

Bearing Capacity Estimates

The bearing capacity estimates for the materials encountered in this first boring ranged from approximately 3,000 to 25,000 pounds per square foot. If a thin layer of clay and silt is removed from 5.5 to 7.5 feet below current ground surface or 3.5 to 5.5 feet below ground surface after first floor grade is achieved, the soils above the first void have an estimated bearing capacity of 8,000 pounds per square foot.

The first void and the two other voids encountered in the EB-1 boring do not appear laterally extensive as they were readily filled with grout. The theoretical grout capacity of this boring based on the size of the borehole was approximately 68 gallons. A total of 80 gallons of grout were necessary to fill this borehole and the voids. There was slight (less than 0.5-foot) settlement of the grout in this borehole observed 24 and 48 hours after grouting was complete.

Boring EB-2 was drilled near the anticipated center of this building and glacial till deposits primarily comprised of loose to medium, coarse to fine sands with some medium to fine gravel were encountered to a depth of approximately 14.8 feet below ground surface. These shallow soils have an estimated bearing capacity ranging from 3,000 to 5,500 pounds per square foot. Residual yellow-brown and light gray plastic clays with some silt and few to frequent sand- to gravel-sized dolomite fragments were encountered from 14.8 to 24 feet below ground surface. The estimated bearing pressures for these soils range from 2,500 to 7,000 pounds per square foot.

The residual soils beneath the center of the East Building were underlain by highly fractured dense dolomite bedrock from 24 feet below ground surface to the completed depth of 38 feet below ground surface. No voids were encountered in the soils or bedrock in this boring. Given the highly fractured nature of this dolomite and a RQD of 8 percent for the core from this boring, the estimated bearing capacity of the bedrock from 24 to 38 feet below ground surface is 25,000 pounds per square foot. Although the rock in this boring appeared highly fractured, little extra grout was needed to seal the boring. The theoretical grout capacity of this boring based on the size of the borehole was approximately 46 gallons. A total of 80 gallons of grout were necessary to fill this borehole and there was no settlement of the grout in this borehole observed 24 and 48 hours after grouting was complete.

The third boring for the East Building, EB-3, encountered stiff to hard, very slightly plastic clays underlain by medium-dense brown-yellow to tan, coarse- to fine-grained sand with little silt, which were in turn underlain by highly decomposed gneissic rock. These till deposits extended from ground surface to a depth of 17 feet below ground surface and based on the blow counts, have an estimated bearing pressure range from 3,500 to 6,500 pounds per square foot.

Residual stiff to hard, plastic to slightly plastic, yellow-brown to light gray, clay with some silt, and few to frequent highly weathered sand- to gravel-sized dolomite fragments were encountered from 17 to 37.25 feet below ground surface. These residual clays, which have an estimated bearing pressure range from 3,500 to 8,000 pounds per square foot were interlayered with layers of less weathered dolomite, which have an estimated bearing pressure of approximately 25,000 pounds per square foot. A hard layer of dolomite was encountered from 26.5 to 32 feet below ground surface and a second layer was encountered from 37.25 feet below ground surface to the completed depth of 40 feet below ground surface. Although there was some loss of air circulation when drilling through these layers, no voids or solution openings were encountered.

The theoretical grout capacity of Boring EB-3 based on the 6-inch diameter and depth of 40 feet is approximately 59 gallons. A total of 80 gallons of grout were necessary to fill this borehole. There was approximately 0.5-foot of grout settlement in this borehole 24 after grouting was complete. There was no additional settlement 48 hours after grouting was complete.

SUMMARY

The results of the three borings drilled for the East Building indicate that foundations can be designed and supported by the soils and bedrock beneath this building. Based on first floor elevations and the boring elevations, it appears that slight cuts of 1 to 2 feet will be needed near the center and east side of the building and a fill of approximately 4 feet will be needed near the west side of the building and courtyard. Some of the less dense or softer soils encountered at shallow depths in EB-1 and EB-2 will most likely be removed as part of grading operations. The shallow soils near the center and/or east side of the building most likely are not appropriate for a controlled/engineered fill along the west side of the building and/or courtyard. However, coarse sands and gravels in the detention basin area, if installed in appropriate sized lifts and properly compacted, should provided adequate soils support for the west side of the building and courtyard.

Although voids/solution openings were only encountered along the east side of this proposed building, as in all areas underlain by carbonate rock, no investigation can fully characterize or identify all solution openings and/or potential sinkhole areas. Therefore, inclusion within the building footings/foundation of sufficient steel reinforcing to maintain structural integrity in the event a sinkhole forms, is recommended.

West Building

BORINGS

Three borings were drilled along the centerline of the west building starting from east to west (see Figure 2). Detailed results from these borings are provided on the geologic logs included in Attachment A. The soils encountered were primarily comprised of coarse- to fine-grained sands and some coarse- to fine-grained gravel and silt till deposits associated with pre-Illinoian glaciation. Unlike the East Building, bedrock was encountered at shallow depths beneath the West Building. No voids or solution openings were encountered in these three borings.

BEARING CAPACITY ESTIMATES

In Boring WB-1, a soft and/or loose zone of till deposits and residual soils comprised of sand, clay, and silt was encountered to a depth of approximately 9 feet below ground surface. These soils have low resistance to the Standard Penetration Test and therefore, have a low estimated bearing pressure range from 1,500 to 2,500 pounds per square foot. These soils are most likely inadequate for foundation support and may need to be replaced if conventional footings are used. Beneath the soft and/or loose zone, the residual soils increased in hardness. These stiff to hard, light to medium gray clays and highly weathered dolomite fragments from 9 to 14.75 feet below ground surface have an estimated bearing pressure range from 5,500 to 8,000 pounds per square foot.

Dense, light to dark gray, very fine-grained dolomite was present beneath the residual soils in Boring WB-1. A core sample from 18 to 26.5 feet below ground surface in this boring indicated a highly brecciated and re-calcified fractured dolomite with a RQD of 35 percent. Water was lost during coring, which also indicates that the rock was highly fractured. The core bit was blocked by large irregular shaped dolomite fragment making coring difficult and core recovery was approximately 56 percent. No voids or solution openings were encountered. The borehole volume of Boring WB-1 was approximately 31 gallons and 40 gallons were necessary to seal this boring. There was slight (less than 0.5-foot) settlement of the grout in this borehole observed 24 and 48 hours after grouting was complete.

Boring WB-2, drilled in the center of the proposed West Building, encountered loose to medium, brown-red and yellow-brown coarse to fine sands, with little to some medium to fine gravel, and trace silt to a depth of 16.25 feet below ground surface. These till and/or glacial outwash deposits have an estimated bearing pressure range from 3,000 to 5,500 pounds per square foot.

The glacial deposits beneath the center of the West Building were underlain by a 1.25-foot layer of highly decomposed dolomite and hard, plastic clay, which has an estimated bearing pressure of 8,000 pounds per square foot. This thin layer of residual soils was underlain by very dense, light to dark gray, medium to fine grained dolomite. The recovery was 100 percent and the RQD equal to 72 percent for a core taken from 20 to 30 feet below ground surface in this boring. The high rock quality designation indicates that the bedrock in this boring has an estimated bearing pressure of 50,000 pounds per square foot. Little extra grout was necessary to seal Boring WB-2, which had a theoretical borehole volume of 34 gallons and was filled with 40 gallons. There was slight (less than 0.5-foot) settlement of the grout in this borehole observed 24 and 48 hours after grouting was complete.

Bedrock was encountered within 6 feet of ground surface in Boring WB-3. The dolomite in this boring was overlain by medium-stiff, golden-brown and red-brown residual silt with little clay and frequent decomposed dolomite fragments. A core sample was collected in two attempts because the bit became blocked with a rock fragment at approximately 11 feet below ground surface. The first core sample was collected from 6 to 11 feet below ground surface and recovery was 100 percent. This interval of rock was comprised of highly fractured light to dark gray, fine to very-fine grained dolomite with a RQD of 26 percent. The fractured nature of the dolomite from 6 to 11 feet below ground surface indicates an estimated bearing pressure of 20,000 pounds per square foot.

The bedrock encountered in WB-3 from 11 to 16 feet below ground surface was also light to dark gray, medium to fine grained dolomite. This interval appeared to be slightly less fractured than the overlying 5-foot interval and had a RQD of 50 percent. Recovery was 100 percent. The slightly less fractured nature of the core from 11 to 16 feet indicates an estimated bearing pressure of 30,000 pounds per square foot. Boring WB-3 had a borehole volume of 14 gallons but because of some loss to the fractures needed 27 gallons of grout for sealing. There was no settlement of the grout in this borehole observed 24 and 48 hours after grouting was complete.

SUMMARY

The three borings drilled for the West Building indicate that foundations can be designed and supported by the soils and bedrock beneath this building. Based on first floor elevations and the boring elevations, it appears that a controlled fill will be needed in the eastern portion of this building and that cuts of 1 to 7 feet will be needed near the center and west side of the building. Some of the less dense or softer soils encountered to 9 feet below ground surface in WB-1 should be removed prior to installing a controlled fill in this area.

A cut of one to two feet to reach final grade near the center of the West Building may not be sufficient to remove the loose sands in this area. As a result, mechanical compaction and/or replacement of the loose soils with a controlled/engineered fill may be necessary beneath the center of this building.

Along the west side of the West Building, it may be necessary to construct footings on shallow bedrock. Appropriate precautions should be included in the foundation design to minimize potential deflection and/or differential settlement at locations where the foundation support is transferred from bedrock to controlled/engineered fill or soils.

Although no voids or solution openings were encountered in any of the West Building borings, given the fractured nature of the bedrock and the presence of carbonate rock, it is recommended that sufficient steel reinforcing be included in any foundation designs to ensure structural support is maintained in the event a sinkhole forms.

Detention Basin

Location

Two borings (DB-1 and DB-2) and two test pits (DB-A and DB-B) were completed within the detention basin and the locations are shown on Figure 2. In the two borings completed in the detention basin, rock cores were not obtained. The air hammer bit on the drilling rig was used similar to a percussion rig to assess the depth to bedrock and the relative hardness of this rock. Split-spoon samples were collected in one of these two borings. Two test pits were completed in the detention basin to inspect soil profiles for composition, the presence of soil voids and/or solution openings, and the potential presence of a seasonal water table beneath the proposed basin. These detention basin borings and test pits were used to evaluate the competency of the bedrock, the potential for groundwater mounding, and the potential presence of solution openings beneath the basin.

Test Pits

The test pits were excavated within the detention basin prior to the borings. The first test pit (DB-A) was excavated in the western portion of the basin within the area where approximately 10 feet of soil will be removed to achieve final grade. Evidence of a seasonal water table was not present in this test pit; the water level in a nearby well was approximately 44.8 feet below ground surface or at a site elevation of approximately 195 feet. The proposed base of the detention basin will be 234 feet in elevation.

Soils in DB-A were comprised of red-brown and yellow-brown coarse to fine sand with some silt and coarse to fine gravel. These dense, pre-Illinoian glacial deposits will be excavated during construction of the detention basin and could be used to replace some soils beneath the proposed buildings or other areas of the site.

Test Pit DB-B was excavated in the eastern portion of the detention basin and there was no evidence of a seasonal water table apparent in this test pit. The water level in a nearby well was approximately 39.8 feet below ground surface or at a site elevation of approximately 195 feet. The bottom of the proposed basin in this area will be completed at an elevation of 234 feet. Soils comprised of red-brown and yellow-brown coarse to fine sand with some silt and coarse to fine gravel. These pre-Illinoian glacial deposits will be excavated during construction of the detention basin and could be used to replace some soils beneath the proposed buildings or other areas of the site.

Soils were encountered in the eastern half of DB-B to the completed depth of 14.5 feet below ground surface. Light to medium gray weathered dolomite was encountered in the western half of this test pit at a depth of 5 feet below ground surface and extended to the completed depth of this half of the test pit at 7 feet below ground surface.

BORINGS

Borings DB-1 and DB-2 were drilled in between Test Pits DB-A and DB-B. In both of these borings, dense, dry, weathered dolomite was encountered within 4 to 8 feet below ground surface. The dense, competent bedrock extended to the completed depths of the borings and no voids or solution openings were encountered. The presence of shallow bedrock in these two borings and in the western half of Test Pit DB-B indicates a laterally extensive pinnacle is present beneath this portion of the site. Approximately 4 to 6 feet of the top of this pinnacle will need to be removed as part of the detention basin construction.

Soils encountered in the borings were similar to the soils encountered in the test pits. A seasonal water table was not evident in either boring. The coarse to fine-grained glacial deposits are competent for a detention basin. Given the nearly 40 feet to groundwater beneath the proposed detention basin and the coarse-grained glacial deposits, it is highly unlikely that groundwater mounding beneath this basin would result in seeps and/or subsurface flooding of downgradient properties.

Although groundwater-mounding problems are highly unlikely, the presence of a pinnacle beneath the detention basin is an indication of differential weathering and possible solution openings in bedrock. Since clays and silts are present beneath the site, especially near the eastern building, these materials could be excavated and used to prepare a low permeability liner in the detention basin. This liner would minimize and slow infiltration of water collected in the basin and should therefore, minimize the potential for subsurface erosion beneath the basin. A 2-foot thick clay liner properly installed in the bottom of the basin in 1-foot lifts and properly compacted to achieve 95 percent of maximum density as determined with the ASTM D 1557 Method should be sufficient to minimize the potential for subsurface infiltration and drainage.

GENERAL KARST CONSTRUCTION ELEMENTS

In carbonate rock environments, extra precautions are often included in construction plans to minimize the potential for sinkhole formation. Given the variable nature of these rocks and the potential for solution openings, it is highly unlikely that any Phase II investigation will identify all solution openings and/or potential sinkholes. Since subsurface erosion causes sinkholes to form, minimizing water velocities and volumes resulting from construction will minimize the potential for sinkholes to form as a result of these man-made activities. As a result there are several general construction elements listed below that are recommended for inclusion in site construction plans. These elements are as follows:

1. Prior to commencement of construction, contractors should review all geotechnical reports including but not limited to the May 5, 1998 M^2 Associates report entitled "Preliminary Geologic Evaluation of the Fallone Organization Site in Clinton Township, Hunterdon County, New Jersey"; the August 24, 2001 Melick-Tully report entitled "Geologic Review, Application for Preliminary Site Plan-Lot 5, Block 18, The Fallone Organization, Town of Clinton, Hunterdon County, New Jersey"; and this November 21, 2001 M^2 Associates report entitled "Phase II Investigation of Carbonate Rock beneath Block 18 Lot 5 in the Town of Clinton, Hunterdon County, New Jersey".

2. Any voids and/or sinkholes encountered during construction should be quickly cordoned off and inspected by a geologist or geotechnical engineer experienced in karst geology. All sinkholes and/or solution openings encountered during construction or after all construction is complete should be remediated.

3. No construction (roadways, structures, underground utilities, etc.) should occur in an area of a non-remediated sinkhole and/or solution opening. Vehicle traffic and all construction equipment should be directed away from the sinkhole and/or void until this karst feature can be remediated.

4. Rubber "O"-ring gaskets are to be used on all storm drainage piping and piping should be water tight to prevent leakage.

5. Utility line backfill should be of native material free of cobbles or boulders, compacted to a minimum of 90 percent of the maximum obtainable density through ASTM D1557 Methods in open areas and 95 percent of ASTM D1557 maximum density in structure or paved areas. If a clean granular backfill is used in any portion of a utility trench, a minimum of 12 inches of low permeability backfill should be placed atop the trench and compacted as previously noted. In all

instances, proper bedding and controlled backfill are important. Technical inspection and testing of bedding and filling operations are required.

6. In any utility excavation where non-native soils are emplaced adjacent to all or part of the utility structure, water dams should be installed in the base of the trench at intervals of 20 to 30 feet and should extend the full width of the excavation.

7. Rock excavation should be performed by heavy construction equipment or hydraulic-hammer wherever possible. Blasting materials should only be used as a last resort when mechanical means are incapable of fracturing rock.

8. Although it is unlikely based on the Phase II investigation, it is prudent in carbonate rock terranes to assume that a sinkhole could form beneath a portion of a building. Therefore, all foundation designs should include appropriate steel reinforcement to bridge an opening and maintain structural support.

9. After all topsoil is removed and/or final base grade achieved but prior to excavation of any utilities or footing trenches, the areas of the parking lots, driveways, and building should be proof rolled to identify any potential weak areas for structural support. A geologist or geotechnical engineer experienced in karst geology should inspect the proof rolling operations.

10. Any weak areas identified during the proof rolling process should be excavated to remove soft soils and to inspect for potential solution openings. Soils that are appropriate for backfill should be installed in the excavation(s) in 1-foot lifts and properly compacted to achieve 95 percent of maximum density as determined with the ASTM D 1557 Method. An engineer experienced in soils testing and compaction requirements should complete all soil compaction and density testing.

11. After heavy precipitation events (greater than 1-inch), all exposed areas in which topsoil has been removed should at a minimum, be visually inspected for indications of subsidence, vertical erosion, and/or sinkholes. A geologist or geotechnical engineer experienced in karst geology should further evaluate any areas of potential concern identified during this inspection.

12. During the excavation of any utility or foundation trenches, soils should be bermed along the perimeter of the trench to prevent stormwater from flowing into the trench.

13. A geologist or geotechnical engineer experienced in karst environments and carbonate bedrock should inspect all excavations for evidence of potential sinkholes.

14. A vibratory roller should be used to compact subgrade soils approximately 2 feet below the base of the detention basin to achieve 90 percent of maximum density as determined with the ASTM D 1557 Method. Clays and silts derived from the site should be placed in lifts a maximum 1-foot thick, above these subgrade soils to the final grade of the detention basin. A sheep's-foot roller should be used to compact this basin liner to achieve 95 percent of maximum density as determined with the ASTM D 1557 Method. An engineer experienced in soils testing and compaction requirements should complete all soil compaction and density testing.

15. A geologist or geotechnical engineer experienced in karst geology should inspect any sinkholes, solution openings, and/or soil voids found during or after construction. These openings should be overexcavated and/or flushed with potable water to locate the solution cavity or competent bedrock. A flowable fill or appropriate dental grout will be emplaced in the bedrock opening to minimize continued subsurface erosion.

CONCLUSIONS

Based on the data collected during the Phase II site investigation, the following conclusions are made:

1. Block 18 Lot 5 in the Town of Clinton is underlain by Allentown Formation dolomite. The borings completed in early 1998 indicate that dolomitic bedrock is encountered within 7.5 to 10.5 feet of current ground surface in the southern portion of the site proposed for parking lots. The Phase II borings indicate that bedrock is present beneath the proposed eastern and western buildings at depths ranging from 28 to 38 feet below ground surface and 6 to 20 feet below ground surface, respectively. Beneath the center of the proposed detention basin, bedrock was encountered between 4 and 6 feet below ground surface.

2. Voids were only encountered in Boring EB-1 completed near the eastern side of the eastern building. These voids, which had vertical extents ranging from 0.2 to 4.5 feet, apparently were not horizontally extensive since the grout uptake in this boring was only slightly greater than the borehole volume.

3. As expected in northern New Jersey for carbonate rocks of the Cambrian-Ordovician periods, the dolomites beneath the site were fractured. Rock quality was generally poor to moderate.

4. Given the presence of carbonate rock beneath the site, the presence of small voids in one boring, and the degree of bedrock fracturing, foundation designs should include sufficient steel reinforcement to support structures in the event of sinkhole formation.

5. Shallow soils beneath the site were generally pre-Illinoian glacial till deposits comprised of coarse- to fine-grained sands with some coarse- to fine-grained gravels and silts. Along the eastern portion of the site, hard plastic clays with some silt and frequent sand to gravel-sized weathered dolomite fragments were encountered. These soils in combination with some residual clays and silts derived from weathering of the underlying dolomitic rock could be excavated and used to line the detention basin. The coarse-grained till deposits from the detention basin could be used to replace the clays and silts and if properly compacted, could be used as needed for controlled fills beneath the buildings, parking lots, and retaining walls.

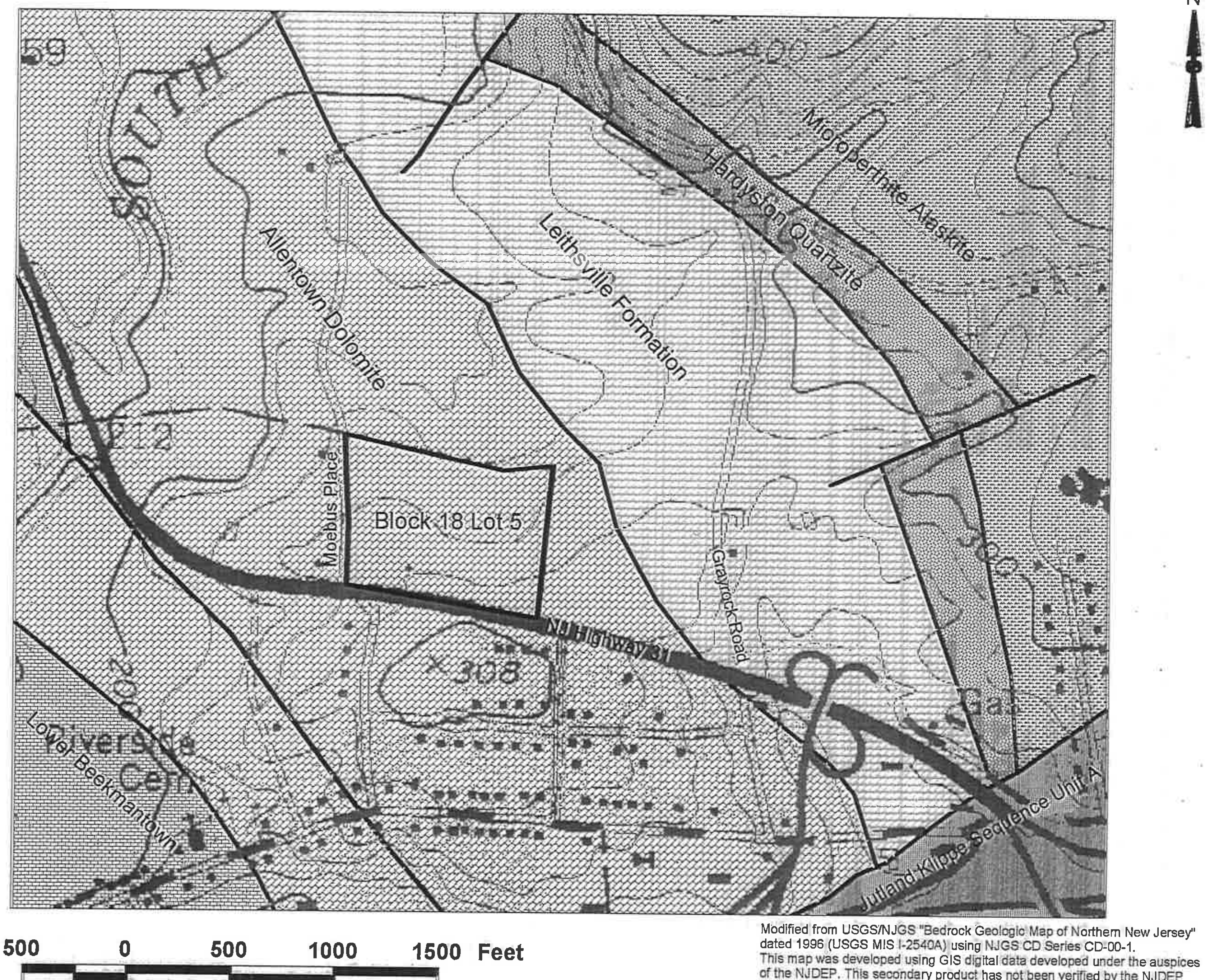
6. Given the coarse-grained till deposits encountered beneath the detention basin, groundwater mounding is unlikely to result in seeps and/or subsurface flooding of downgradient properties. The presence of a dolomite pinnacle beneath this basin indicates differential weathering, which suggests a possibility of solution openings. Although no solution openings were encountered during the Phase II investigation of this basin, a liner constructed of fine-grained site soils is recommended to slow water velocities and to minimize potential vertical infiltration and/or subsurface erosion.

7. The Phase II investigation did not identify any karst features that would prevent and/or alter the site plans preliminarily approved by the Town of Clinton Planning Board.

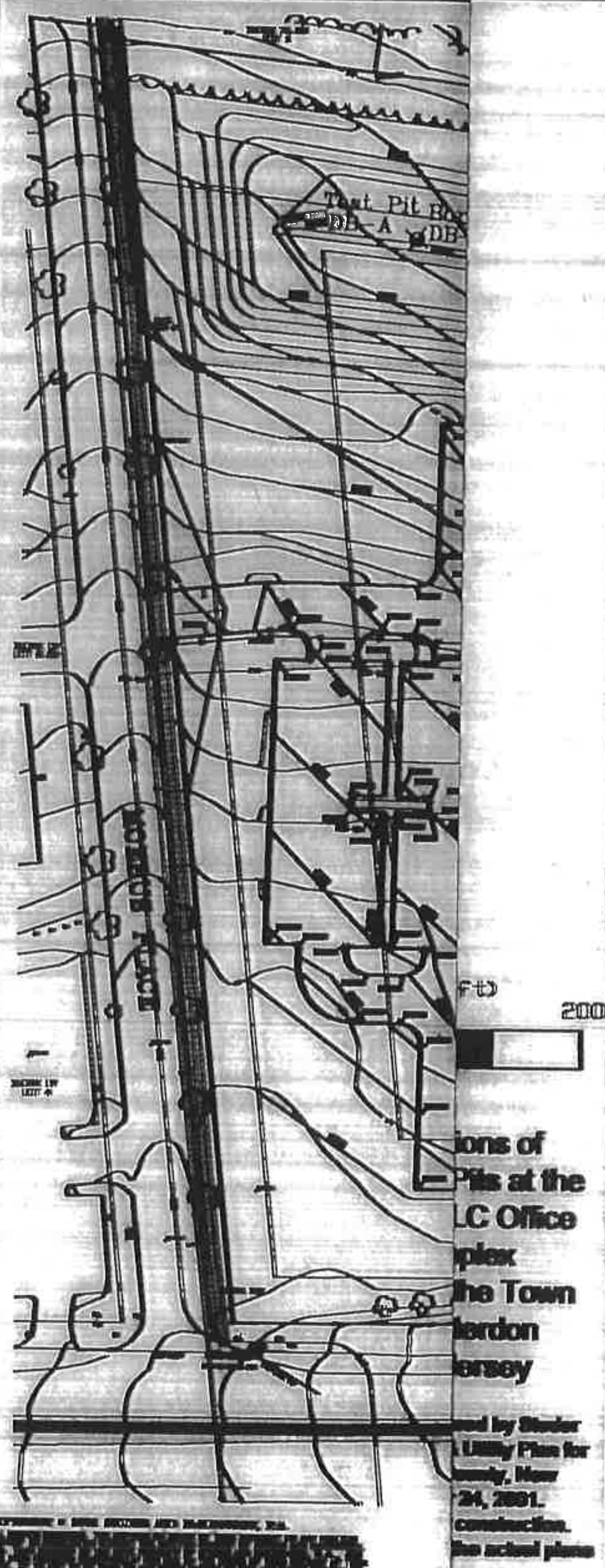
LIMITATIONS

The exact occurrence of sinkholes, subsidence activity, or karst features is not always predictable even after extensive surface and subsurface investigation. Therefore, neither this report nor any surface/subsurface investigation will serve as a guarantee, warranty, or assurance against the formation of sinkholes or land subsidence. M^2 Associates cannot and does not provide a guarantee or warranty to Z&F LLC or the Town of Clinton against the formation of sinkholes or land subsidence at the proposed site.

Figure 1: Site Location and Bedrock Geology of the Z&F LLC Property in Clinton, New Jersey



Modified from USGS/NJGS "Bedrock Geologic Map of Northern New Jersey" dated 1996 (USGS MIS I-2540A) using NJGS CD Series CD-00-1.
This map was developed using GIS digital data developed under the auspices of the NJDEP. This secondary product has not been verified by the NJDEP and is not state authorized.



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Water: A Natural Renewable Resource

APPENDIX A:
PHASE II INVESTIGATION
BORING LOGS FOR
BLOCK 18 LOT 5 IN
TOWN OF CLINTON,
HUNTERDON COUNTY, NEW JERSEY

Boring Log

Name: Matt Mulhall　　Date: 4-Sep-01　　

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 1　　Total Depth: 46 feet below ground surface

Type of Sampling Device: Split Spoon-2 ft　　Device Diameter: 2 inch　　Sampling Interval Continuous

Drilling Method: Rotary　　Type of Drilling Fluid: Air　　Hammer Weight: 140 lbs.

Driller's Name: Mike Assante　　Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface)		Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
From:	To:				
0	1.5			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
1.5	3.5	1.5	6,8,8,10	Brown-yellow clay, some silt. Frequent coarse to fine sand and gravel-sized rock fragments. Plastic, moist. Till deposits.	CL
3.5	5.5	1.5	15,15,15,16	Same to 4.5 ft// 4.5 to 4.8 ft -Tan coarse to fine sand, some gravel, little silt. Highly weathered rock fragments. Dry. Till.	SP
5.5	7.5	1.9	4,6,5,6	4.8 to 6.2 ft - Brown-yellow, clay, some silt. Few sand to gravel sized rock fragments. Plastic, moist. Till.	CL
7.5	9.5	2	8,8,12,20	6.2 to 8 ft - Brown-yellow, clay, some silt. Few to very few san to gravel sized rock fragments. Plastic, dry. Till.	CL
				8 to 9.7 ft - Yellow-brown, clay, trace silt. Very few sand to gravel sized rock fragments. Plastic, dry. Till.	CL
9.5	11.5	2	15,15,25,25	9.7 to 14.2 ft - Yellow-brown and light gray clay, some silt. Very few sand to gravel sized rock fragments. Plastic, dry. Residual soils.	CL
11.5	13.5	2	5,10,15,15		
13.5	15.5	1 of 1	15,50/6"	14.2 to 14.5 ft - Light to medium gray weathered dolomite. Residual. Hammer refusal at 14.5 ft. Void from 14.5 to 14.7 during drilling.	
15.5	17.5	2	3,5,4,5	14.7 to 18.5 ft - Yellow-brown, clay, some silt. Frequent sand to gravel sized dolomite rock fragments. Plastic, dry.	CL
17.5	19.5	2	7,10,10,14	18.5 to 19.5 ft - Red-brown, clay, trace silt. Few sand to gravel sized dolomite rock fragments. Plastic, dry.	CL
19.5	21.5	1.9	10,10,10,13	19.5 to 21.5 ft - Yellow-brown, clay, little silt. Frequent sand to gravel sized dolomite rock fragments. Plastic, dry.	CL

Boring Log Continued

Water: A Natural Renewable Resource

Name: Matt Mulhall   Date: 4-Sep-01   Page 2 of 2.

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 1   Total Depth: 46 feet below ground surface

Sampling Interval (Depth in feet below ground surface)					
From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
21.5	23.5	1.8	10,9,11,10	21.5 to 25.8 ft - Red-brown, clay, trace silt. Few to very few sand to gravel sized dolomite rock fragments. Plastic, dry.	CL
23.5	25.5	2	3,4,8.12		
				25.8 to 26 ft - Tan coarse to fine sand, some coarse to fine gravel, trace silt. Wet.	SW
25.5	27.5	1.8	12,10,12,15	26 to 27.5 ft - Red-brown, clay, trace silt. Few to very few sand to gravel sized dolomite rock fragments. Plastic, dry.	CL
27.5	29.5	1.5/1.6	15,15,18,50/1"	27.5 to 29 ft - Yellow-brown and red-brown, clay, some silt. Frequent sand to gravel sized dolomite rock fragments. Plastic, dry.	CL
				29 to 31 ft - Light to medium gray, fine to medium grained dolomite.	
31	32			Void	
32	34	2	10,7,8,13	32 to 32.5 ft - Dolomite, weathered to fine-grained sand. Wet. 32.5 to 37 ft - Yellow-brown and red-brown clay, little silt. Few to frequent rock fragments. Plastic, moist.	CL
34	36	0.7	8,8,10,12		
36	38	0.5	10,30,50/0"	37 to 40 ft - Light gray dolomite. Dense.	
40	44.5			Void	
44.5	46			Light to medium gray, medium to fine grained dolomite.	
				Notes: 1. Groundwater measured at 26 feet below ground surface. 2. Borehole grouted with six 94-pound bags of Portland Cement, 40 lbs. Bentonite, and 42 gallons of water. 3. Borehole volume equals 68 gallons. 4. Grout mix equals 80 gallons.	

Boring Log

Name: Matt Mulhall   Date: 4-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 2   Total Depth: 38 feet below ground surface

Sampling Device: Split Spoon-2 ft/Core Barrel-10 ft.   Device Diameter: 2 inch   Sampling Interval: Continuous

Drilling Method: Rotary   Type of Drilling Fluid: Air   Hammer Weight: 140 lbs.

Driller's Name: Mike Assante   Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface)		Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
From:	To:				
0	1.5			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4	1.2	6-5-5-4	Brown-yellow, black coarse to fine sand, some medium to fine gravel, trace silt. Dense, dry. Till deposits.	SP
4	6	1.8	3-4-3-5	Same	SP
6	8	1.1	4-4-4-7	Same	SP
8	10	1.3	5-5-6-9	Same with little silt.	SP
10	12	1.7	4-7-8-10	Same to 11 ft.	SP
12	14	1.9	5-5-7-10	11 to 14.8 ft.- Yellow-brown, tan medium to fine sand, trace silt. Dense, dry. Till deposits.	SP
14	16	1.7	5-3-4-5	14.8 to 22 ft- Yellow-brown, light gray clay, some silt. Few to frequent highly weathered dolomite fragments. Plastic, moist. Residual soils.	CL
16	18	1.7	4-4-4-4		CL
18	20	1.4	6-7-6-8		CL
20	22	1.8	10-10-8-11		CL
22	24	1.8	14-10-13-13	22 to 24 ft - Yellow-brown, light gray clay, some silt. Frequent weathered dolomite fragments. Plastic, moist. Residual soils.	CL
24	26	.25/.25	50/3"	24 to 28 ft. - Weathered light gray dolomite.	

Boring Log Continued

Name: Matt Mulhall Date: 4-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 2 Total Depth: 38 feet below ground surface

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
28	33	5/5'		Very light gray, fine to very fine-grained, thick bedded dolomite. Allentown Formation. High angle cleavage apparent.	
33	38	3.2/5'		RQD = 8 percent. Core sample is highly fractured. Lost water circulation at 32.5 feet. Mechanical break at 33 feet because core barrel plugged. No voids encountered during coring. Average coring speed was 4.5 minutes per foot to 33 feet, 2.5 minutes per foot from 33 to 36 feet, and 32 minutes from 36 to 38 feet. Notes: 1. No voids or openings encountered in borehole. 2. Groundwater measured at 27.3 feet below ground surface. 3. Borehole grouted with mix of six 94-pound bags of Portland Cement, 40 lbs. Bentonite, and 42 gallons of water. 4. Borehole volume equals 46 gallons. 5. Grout mix equals 80 gallons.	

Boring Log

Name: Matt Mulhall Date: 5-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 3 Total Depth: 40 feet below ground surface

Type of Sampling Device: Split Spoon-2 ft Device Diameter: 2 inch Sampling Interval Continuous

Drilling Method: Rotary Type of Drilling Fluid: Air Hammer Weight: 140 lbs.

Driller's Name: Mike Assante Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface)		Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
From:	To:				
0	1.5			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
1.5	3.5	1.7	5-5-8-16	Brown-yellow silt, little clay. Few sand and gravel-sized rock fragments. Very slightly plastic, dry. Till deposits.	ML
3.5	4.5	0.9/1'	16-40	Same to 4.5 ft with large gneiss cobble blocking end of spoon.	ML
				Drill to 5 feet	
5	7	1.7	18-14-10-14	Brown coarse to fine sand, little silt, trace clay. Frequent weathered gneiss rock fragments. Plastic, dry. Till.	SP
7	9	1.5	12-12-14-10	Same	SP
9	11	1.8	10-7-7-10	Brown-yellow to tan, coarse to fine sand, little silt. Dense, dry. Till.	SP
11	13	1.9	5,5,4,6	Same to 11.25 ft. 11.25 to 15 ft - Highly decomposed rock. Yellow-brown and gray-white clay, some silt. Plastic, moist. Till.	CL
13	15	1.6	4-4-8-7		
15	17	1.2	11-8-11-8	Decomposed rock. Coarse to fine sand, little fine gravel, little silt, trace clay. Dense, dry. Till.	SP
17	19	2	6-6-5-6	Yellow-brown clay, some silt. Few weathered dolomite fragments. Plastic, moist. Residual soils.	CL
19	21	1.4	7-9-10-13	Yellow-brown and light gray clay, some silt. Highly decomposed dolomite. Plastic, moist. Residual soils.	CL
21	23	1.4	8-12-8-8	Same	CL

Boring Log Continued

Name: Matt Mulhall Date: 5-Sep-01 Page 2 of 2.

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. East Building 3 Total Depth: 40 feet below ground surface

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
23	25	1.9	7-9-10-13	Same with large fragment of light gray dolomite at end of spoon.	CL
25	27	1.5/1.5	12-15-30-R	Yellow-brown to light gray clay, some silt. Highly decomposed dolomite to 26.5 ft.	
				Drill to 31 feet. Attempts to collect split spoon samples from 27 to 31 encounter refusal. Cuttings are light gray competent dolomite. No voids encountered.	
31	32	0/0	R	Refusal to split-spoon. Resume drilling and lose circulation fro 31 to 32. Cuttings indicate thin layer of clay at 31 but dolomite beneath to 32 feet. No voids encountered during drilling.	
32	34	2	2-2-3-7	Yellow-brown to light gray clay, some silt. Highly decomposed dolomite. Slightly plastic, moist. Residual.	CL
34	36	1.5	25-13-10-20	Same	CL
36	38	0.9	10-10-30/3"	Same to 37.25 feet. Dolomite fragment in end of spoon.	CL
38	40			Drill to 40 feet. Dolomite encountered. Lost most air circulation but no voids encountered. Very dense rock.	
				Notes: 1. No voids or openings encountered in borehole. 2. Groundwater was not encountered in borehole; borehole wall settlement prevented measurement. 3. Borehole grouted with six 94-pound bags of Portland Cement, 40 lbs. Bentonite, and 42 gallons of water. 4. Borehole volume equals 59 gallons. 5. Grout mix equals 80 gallons.	

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall | Date: 6-Sep-01 |

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 1 | Total Depth: 26.5 feet below ground surface

Sampling Device: Split Spoon-2 ft/Core Barrel-10 ft. | Device Diameter: 2 inch | Sampling Interval Continuous

Drilling Method: Rotary | Type of Drilling Fluid: Air | Hammer Weight: 140 lbs.

Driller's Name: Mike Assante | Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface) From:	To:	Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
0	1			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4	0.8	5-4-3-4	Brown coarse to fine sand, some fine gravel, trace silt. Dense, dry. Till deposits.	SP
4	6	0.8	4-3-3-2	Brown clay, little silt. Few weathered rock fragments. Plastic, dry. Till	CL
6	8	0.3	3-4-3-3	Same with few more rock fragments.	CL
8	10	0.7	4-4-5-8	Light to medium gray clay, some silt. Highly decomposed dolomite. Slightly plastic, dry. Residual soils.	CL
10	12	1.6	5-7-10-10	Same	CL
12	14	1	7-10-15-12	Same	CL
14	16	0.75/.75	30-30/3"	Same to 14.75 ft. Light gray dolomite beneath.	CL
				Drill to 18 feet. Encounter clay filled fracture from 15.75 to 16. Rock very dense from 16 to 18. Set up to core 18 to 28 feet.	

Boring Log Continued

Name: Matt Mulhall Date: 6-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 1 Total Depth: 26.5 feet below ground surface

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
18	26.5	4.8/8.5'		Light to dark gray, very fine grained, thick bedded dolomite. Allentown Formation. High angle cleavage and fractures apparent. Highly brecciated and recalcified. RQD = 35 percent. Core sample is fractured and broken in several zones. Lost water circulation at 18 feet and 25.5 feet. Stopped coring at 26.5 feet because barrel blocked by large fragment. Average coring speeds approximately 4.5 minutes per foot. Notes: 1. No voids or openings encountered in borehole. 2. Groundwater not encountered. 3. Borehole grouted with mix of three 94-pound bags of Portland Cement, 20 lbs. Bentonite, and 21 gallons of water. 4. Borehole volume equals 31 gallons. 5. Grout mix equals 40 gallons.	

Boring Log

Name: Matt Mulhall   Date: 6-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 2   Total Depth: 30 feet below ground surface

Sampling Device: Split Spoon-2 ft/Core Barrel-10 ft.   Device Diameter: 2 inch   Sampling Interval Continuous

Drilling Method: Rotary   Type of Drilling Fluid: Air   Hammer Weight: 140 lbs.

Driller's Name: Mike Assante   Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface)		Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
From:	To:				
0	1			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4	1	3-4-7-3	Brown-red coarse to fine sand, some medium to fine gravel, trace silt. Dense, dry. Till or outwash deposits.	SW
4	6	0.7	2-5-9-9	Same	SW
6	8	1.3	7-5-4-6	Yellow-brown coarse to fine sand, little medium to fine gravel, little silt. Dense, dry. Till or outwash deposits.	SW
8	10	1.8	7-8-6-9	Same with increased grain size with depth.	SW
10	12	1.8	10-9-6-9	Yellow-brown coarse to fine sand, some coarse to fine gravel, little silt. Dense, dry. Till or outwash deposits.	SW
12	14	1.2	2-7-9-9	Same	SW
14	16	1	4-8-8-8	Yellow-brown coarse to fine sand, and coarse to fine gravel, little silt. Dense, dry. Till or outwash deposits.	SW
16	18	1.8	5-5-5-50/1"	Same to 16.25 feet. 16.25 to 17.5 feet - Highly decomposed rock. Yellow-brown and light gray clay, some silt. Few weathered dolomite fragments. Plastic, moist. Residual soils Light gray dolomite in tip of spoon.	CL
				Drill to 20 feet. Rock very dense from 17.5 to 20. Set up to core 20 to 30 feet.	

Boring Log Continued

Name: Matt Mulhall　Date: 6-Sep-01　

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 2　Total Depth: 30 feet below ground surface

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
20	30	10/10'		Light to dark gray, medium to fine grained, thick to thin bedded dolomite. Allentown Formation. High angle cleavage apparent. RQD = 72 percent. Core sample is very competent with slight fracturing between 25 and 27 feet below ground surface. No loss of water circulation. Average coring speeds approximately 7 minutes per foot from 20 to 23 feet and 3.5 minutes per foot from 23 to 30 feet. Notes: 1. No voids or openings encountered in borehole. 2. Groundwater could not be measured because borehole retained water used in coring. 3. Borehole grouted with mix of three 94-pound bags of Portland Cement, 20 lbs. Bentonite, and 21 gallons of water. 4. Borehole volume equals 34 gallons. 5. Grout mix equals 40 gallons.	

Boring Log

Water: A Natural Renewable Resource

Name: Matt Mulhall Date: 7-Sep-01

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 3 Total Depth: 16 feet below ground surface

Sampling Device: Split Spoon-2 ft/Core Barrel-10 ft. Device Diameter: 2 inch Sampling Interval Continuous

Drilling Method: Rotary Type of Drilling Fluid: Air Hammer Weight: 140 lbs.

Driller's Name: Mike Assante Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface)		Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
From:	To:				
0	1			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4	1.8	4-5-5-6	Golden brown and red-brown silt, little clay. Highly decomposed rock. Slightly plastic, dry. Residual soils	ML
4	6	1/1'	5-8-50/0"	Decomposed dolomite with large light gray fragment in tip.	
				Drill to 6 feet and set up to core from 6 to 16. Core barrel blocked with fragment at 11 feet. Core collected in two 5 foot intervals.	
6	11	5/5'		Light gray to dark gray, fine to very fine-grained, thick bedded dolomite. Allentown Formation. High angle cleavage apparent. RQD = 26 percent. Core sample is fractured but well cemented No loss of water circulation. Mechanical break at 11 feet because core barrel plugged. No voids encountered during coring. Average coring speed was 3 minutes per foot .	

Boring Log Continued

Name: Matt Mulhall   Date: 7-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. West Building 3   Total Depth: 16 feet below ground surface

Sampling Interval (Depth in feet below ground surface) From:	To:	Core Recovery	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
11	16	5/5'		Light to dark gray, medium to fine grained, thick to thin bedded dolomite. Allentown Formation. High angle cleavage apparent. RQD = 50 percent. Core sample is competent but fractured. No loss of water circulation. . Average coring speeds approximately 3 minutes per foot . Notes: 1. No voids or openings encountered in borehole. 2. Groundwater was not encountered in borehole. 3. Borehole grouted with mix of two 94-pound bags of Portland Cement, 10 lbs. Bentonite, and 14 gallons of water. 4. Borehole volume equals 14 gallons. 5. Grout mix equals 27 gallons.	

Boring Log

Name: Matt Mulhall Date: 10-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. Detention Basin 1 Total Depth: 13 feet below ground surface

Type of Sampling Device: Split Spoon-2 ft Device Diameter: 2 inch Sampling Interval Continuous

Drilling Method: Rotary Type of Drilling Fluid: Air Hammer Weight: 140 lbs.

Driller's Name: Mike Assante Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface) From:	To:	Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
0	1			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4	1	3-3-3-3	Red-brown and yellow-brown silt. Few weathered rock fragments. Not plastic, dry. Soft. Outwash or till deposits.	ML
4	6	1.8	5-7-7-6	Red-brown and yellow-brown coarse to fine sand, some silt an medium to fine gravel. Dense, dry. Outwash or till deposits.	SP
6	8	1/1.75'	4-4-25-25/3	Gray fine sand and silt. Decomposed dolomite. Dense, dry. Residual soils.	SP
				Drill to 13 feet to assess rock.	
8	13			Competent dolomite. Light to medium gray, fine to medium grained dolomite.	
				Notes: 1. No voids or openings encountered in borehole. 2. Groundwater was not encountered in borehole. 3. Borehole grouted with mix of three 94-pound bags of Portland Cement, 20 lbs. Bentonite, and 21 gallons of water. 4. Borehole volume equals 19 gallons. 5. Grout mix equals 40 gallons.	

Boring Log

Name: Matt Mulhall Date: 10-Sep-01

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Boring No. Detention Basin 2 Total Depth: 23.5 feet below ground surface

Type of Sampling Device: Cuttings Device Diameter: ______ Sampling Interval Continuous

Drilling Method: Rotary Type of Drilling Fluid: Air Hammer Weight: 140 lbs.

Driller's Name: Mike Assante Contractor: Assante Bros. Plainfield Well Drilling

Sampling Interval (Depth in feet below ground surface) From:	To:	Spoon Recovery (feet)	Hammer Blows per 6-Inch Interval	Sample/Core Description	Unified Soil Classification System Symbol
0	1			Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
2	4			Red-brown and yellow-brown coarse to fine sand, some silt an medium to fine gravel. Dense, dry. Outwash or till deposits.	SP
8	13			Encounter dolomite at 4 feet. Drill to 23.5 feet to assess rock. Competent dolomite. Light to medium gray, fine to medium grained dolomite.	
				Notes: 1. No voids or openings encountered in borehole. 2. Groundwater was not encountered in borehole. 3. Borehole grouted with mix of five 94-pound bags of Portland Cement, 50 lbs. Bentonite, and 35 gallons of water. 4. Borehole volume equals 35 gallons. 5. Grout mix equals 55 gallons.	

Test Pit Log

Name: Matt Mulhall   Date: 6-Sep-01   Page 1 of 1.

Water: A Natural Renewable Resource

Site: Town of Clinton Block 18 Lot 5

Test Pit No. Detention Basin A   Total Depth: 14.6 feet below ground surface

Type of Excavator: Hitachi EX150   Contractor: Somerset Excavating

Sampling Interval (Depth in feet below ground surface) From:	To:	Unified Soil Classification System Symbol	Sample/Interval Description	Comments
0	1		Topsoil: Light brown, organic, silt, trace clay. Few rock fragments.	
1	5.6	SP	Red-brown and yellow-brown coarse to fine sand, some silt and medium to fine gravel. Few pebbles. Dense, dry. Outwash or till deposits.	
5.6	11.4	SP	Red-brown and yellow-brown coarse to fine sand, some silt and coarse to fine gravel. Frequent pebbles, cobbles, and boulders. Highly weathered and decomposed. Dense, dry. Outwash or till deposits.	
11.4	14.6	SP	Yellow-brown coarse to fine sand, some silt. Dense, dry. Till deposits.	
			Notes: 1. No voids or openings encountered in test pit. No slumping of soils observed. 2. Groundwater was not encountered in test pit. 3. No seasonal mottling or other indicators of groundwater.	

APPENDIX D: DESIGN ELEMENTS, RISKS, TESTING REQUIREMENTS, PERFORMANCE STANDARDS, PREFERRED DESIGN ELEMENTS AND REMEDIAL PLAN ELEMENTS FOR DEVELOPMENT IN KARST TERRAIN

E&LP

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Town of Clinton

Carbonate Area District
Table 1
Design Element, Risks, Testing Requirements, Performances Standards, Preferred Design Element and Remedial Plan Elements for Development in Karst Terrain
[Added 8-26-2008 by Ord. No. 08-12]

Design Element	Risks	Testing Requirements	Performance Standards	Preferred Design Element and Remedial Plan Elements
High-load and broad-load structures (high-rise buildings, parking decks, warehouses, water towers, etc.)	Settlement Structural damage/loss Personal injury/death	Evaluate available data Reconnaissance – prior to design Test pits – to confirm shallow bedrock where suspected Borings – 1 per 5,000 square foot area of building footprint; depth based on column/slab load proposed Geophysics – at foundation elements Conceptual failure model – discretionary Bridging analysis – discretionary Inspection of footings – intermittent during construction	Optimal layout Redundancy of support elements Pre-drill foundation sites, depths determined by proposed loads High-tensile strength slabs, with load transfer capability Use pile tips Drill caisson sites, depths determined by proposed loads Pre-construction grouting	Inspection Evaluation plan Remedial grouting plan Remedial designs
Low-load structures (single-family homes, small offices, stores, etc.)	Settlement Collapse Property damage Personal injury	Evaluate available data Inspection of footings – during installation of trench or footing	Foundation areas show no evidence of creep or settlement Drainage directed away from foundation	Foundation reinforcement Occasional inspection by owner
Bridges	Settlement Collapse Embankment failure	Test pits – to competent bedrock Borings – 5 to 10 feet into competent bedrock	Piles, caissons to competent bedrock Redundancy Footing with bridging of anticipated failure Pre-construction grouting	Alternate route Abutment reinforcement modifications Evacuation plans Escrow to recover repair
Underground tanks	Settlement/failure Undermining/failure Undetected leaks	Test pits – in excavation Borings – in or near excavation, 10 feet into competent bedrock	Soil and rock void-free Voids grouted Aboveground tanks	

Design Element	Risks	Testing Requirements	Performance Standards	Preferred Design Element and Remedial Plan Elements
Roads and parking areas	Settlement Undermining Collapse Contaminated runoff	Analysis of existing data Reconnaissance of route Test pits or borings – installed in depressions, or other likely karst features Geophysics – where warranted, and to link boring/test pit data	Layout to avoid karst features Minimize paved areas Control drainage under pavement Controls on blasting Use of ripping Compaction of roadbase Reinforced roadbed	Alternative route Evacuation route Repair procedures Subsidence monitoring Bridging over sinkholes
Drainage features: Conduits Swales Catch basins Detention basins Ponds Injection pits	Settlement Leaks Collapse Undermining of adjacent areas Injection of pollutants to groundwater	Analysis of existing data Reconnaissance of route – prior to design Test pits, probes at select catch basin sites Inspection schedule – continuous during construction Borings into bedrock – locations and depth based on geology, and practical considerations, ± 2 per acre Permeability lasting – for injection sites	Route consistent with site evaluation results Swales/lined swales Watertight joints Impermeable backfill Layout to avoid karst features Liners/compacted substrate Velocity reducers Ponds at water table elevation On-stream ponds Facilities remote from structures	Inspection schedule Repair proposal/escrow Reserve area Grouting specifications Repair escrow Abandonment plan
Utility conduits	Leaks Conduit failure Pollution/explosion/fire Property damage	Reconnaissance of route – prior to design Inspection schedule – continuous during construction Test pits, borings, probes – at key locations to identify possible areas of undermining	Route consistent with site evaluation results Backfill with native soils Geotextiles Piers, where appropriate Strong, flexible conduit Proper backfill procedures	Evacuation plan Shutoffs in key locations Alternate routes
Subsurface sewage disposal systems	Groundwater contamination Structural failure	Test pits – one per 1,000 square feet, 2 at a minimum	Pressure-closed disposal beds Beds not located next to rock pinnacles, nor in natural depressions	Alternate sites Closed systems (holding tanks)
Wells	Washed-out subsidence during drilling Subsidence due to dewatering Excessive grout needs Turbidity Natural water-quality hardness, metals, radium, radon	Careful oversight Intermittent reconnaissance, monitoring Sampling of parameters of concern	Well screen and gravel pack Minimize well loss Reconnaissance/monitoring of subsidence	Alternate site Grout modifications Pumpage modifications Casing off of mud zones Well screen and gravel pack