MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL GROUP
AUGUSTA, MAINE

SUBSURFACE INVESTIGATION FOR RECONSTRUCTION OF ROUTE 17 TOWNSHIP D, MAINE

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Oxford County
PIN 8670.10

Soils Report No. 2010-13

Federal SB-ME-98(007)
May 20, 2010

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1.0 Introduction

1.1 Project Overview

Maine DOT proposes to rebuild a section of Route 17 in Township D. The project scope for this section of highway includes substantial horizontal and vertical realignment and full depth reconstruction. This report describes conditions from Station 1+00, 3.01 north of the Township D/Township E line and extends 1.11 miles northerly to Station 59+25. The section from Station 9+00 to Station 13+00 was built as a separate project. A scenic turnout will be constructed between Station 42+00 and 50+00 on the Left, below the highway. The Appalachian Trail crosses the highway at Station 36+80. Traffic volumes are light except during the fall leaf season.

1.2 Summary of Recommendations

- Where the roadway subgrade will consist of blasted rock, the subgrade should be fractured to a depth of 7 feet below the surface to ensure pavement structure drainage.

- The Contractor is likely to encounter groundwater seeps in cut soil slopes. A riprap downspout should be placed from any seep to the ditchline to allow drainage and prevent erosion of the slope.

- Existing pavement should be removed in all fill areas where the proposed subgrade elevation will be less than 7 feet below the existing pavement surface. This will minimize the problems of trapped water between the existing and new pavement sections.

- Large cobbles and boulders may be encountered in cuts at subgrade and in sideslopes. Cobbles and boulders should not be left projecting more than 6 inches from sideslopes or into the subbase soils.

- A shear key or heavy toe berm may be needed to hold the toe of slope in place at the Scenic Overlook between Stations 42+50 and 49+50.

- Existing culverts at Stations 32+31, 39+95 and 41+30 will be replaced as part of this project. Where areas of loose soils are encountered surrounding these culverts, the areas of loose soil should be replaced or compacted as needed to produce a strong, stable soil mass.

2.0 Site and Subsurface Conditions

2.1 General Site Conditions

This section of Route 17 winds around the slopes of Spruce Mountain. Land use along the project is undeveloped woodland crossed by the Appalachian Trail. The topography is steep and the existing centerline profile has grades on the order of 9% in the southern part of the project. Subsurface bedrock is shallow, there are many areas of exposed bedrock, and side slopes in most areas of the project are steep but not severe. Some areas have extremely steep, marginally stable slopes below the roadway and steep bedrock slopes above the roadway. Several drainage swales cross through culverts under the highway.

This road was constructed in the 1930's. No as-built plans are available for this area, but it appears that the roadway in the area of this project was built as a side-hill fill with cuts into the side of Spruce Mountain on the Right and steep fills on the Left.

The existing roadway is badly deformed near some existing culverts as a result of drainage and in areas where the bedrock is shallow and smooth due to ice action. Existing cross slopes are as much as 15% across the left lane and shoulder. This cross slope functions as an extreme reverse superelevation around a sharp curve. Existing ditches are inadequate, and subsurface drainage problems add to the pavement distress along this road. The existing pavement section is in poor condition.

Traffic volumes are low for most of the year, with projected 2029 AADT of 730 vehicles per day. Traffic volumes are anticipated to be higher during the fall tourist season and vehicle loadings are high for this traffic volume due to the estimated 24% heavy trucks. The existing Hot Mix Asphalt pavement is in poor condition.

2.2 Mapped Data

Geologic mapping by the National Wetlands Inventory indicates there are no significant areas of wetland soils adjacent to the highway in the area covered by this project. The NWI map of this area is included in Appendix B.

NRCS mapping indicates soils of the Hogback-Rawsonville Complex predominate along this project. These soils are described as silty sands with a high percentage of particles retained on a 10" sieve at the surface, and shallow bedrock. The unified classification for these soils is SM, ML and AASHTO classification is A-4 to A-5. The NRCS map and soils data for the area of this project are included in Appendix B.

The Surficial Geology Map, Rangely area, by Maine Geologic Survey shows shallow bedrock and exposed rock outcrops surrounding this section of Route 17.

The bedrock Geologic Map of the Phillips and Rangely quadrangles, Map I-605, 1971, shows the bedrock in this area to be "gray, locally sulfidic metashale irregularly interbedded with subordinate amounts of arkosic metasandstone". A section of the Bedrock Geology map is included in Appendix A.

2.3 Subsurface Investigation

The subsurface investigation for this project was started in the fall of 2005. FWD testing, borings and probes were done. Seismic refraction and GPR studies were done in December, 2006, to determine depth to bedrock at the toes of slope, where drill rig

access was problematic and to obtain continuous sections in critical areas under the roadway. Logs from the borings and probes, lab test data and the geophysical report are included in Appendix C.

2.4 Native soils

The native soils encountered in our borings were a mixture of Sand, silty Sand, sandy Silt, and silt. A summary of the soils in shown in Table 1.

Table 1 – Subsurface Soils

Boring	Station	Offset	Refusal	NR	Soil Type	depth to H_2O
HB-TWPD-101	2+00	12.0 Rt		10.0 ft	SAND, little gravel, cobbles	6.0 ft
HB-TWPD-102	4+00	13.0 Rt		10.0 ft	SAND, little gravel, little silt	5.5 ft
HB-TWPD-103	8+00	5.0 Rt		10.0 ft	SAND, some silt, little gravel	3.5 ft
HB-TWPD-104	10+90	6.0 Rt		10.0 ft	SAND, some silt, little gravel	
HB-TWPD-105	17+55	6.5 Lt		10.0 ft	SILT, little gravel	
HB-TWPD-106	24+20	5.0 Rt		10.0 ft	sandy SILT, little gravel	
HB-TWPD-107	28+00	5.0 Rt	1.5 ft		sandy SILT, little gravel	
HB-TWPD-108	32+50	12.0 Rt	17.3 ft		SAND, some silt, little gravel	
HB-TWPD-109	38+90	16.0 Lt	3.6 ft		sandy SILT, little gravel	
HB-TWPD-110	41+50	22.0 Lt	5.5 ft		gravelly SAND, trace silt	
HB-TWPD-111	48+50	32.0 Lt	15.0 ft		Silty SAND, little gravel	
HB-TWPD-112	32+50	8.0 Lt	6.7 ft		SAND, some silt, little gravel	
HB-TWPD-113	32+75	6.0 Lt	11.5 ft		Sandy Gravel, some silt	8.5 ft

Boring logs and the power auger probe summary are included in Appendix C.
Lab test data for samples in these borings is in Appendix D.

2.5 Existing Pavement

The existing pavement is in poor condition with both transverse and lateral cracks. The shoulders are not paved, and drainage is inadequate. The soil materials under the pavement surface are generally sand. The pavement section is directly on bedrock on the inside of the curve in some places.

2.6 Subsurface Bedrock

Subsurface bedrock was encountered in many borings, and outcrops are common along this project. Some of the refusals in MaineDOT borings may be large boulders, but extensive areas of surface bedrock are visible along this project, and shallow subsurface bedrock may be encountered in areas other than those indicated in borings. A summary of bedrock data is shown in Table 2.

Table 2 - Bedrock data

Station	offset	Depth	Station	Offset	Depth
28+00	5 Rt	1.5 ft	36+00	11.5 Lt	2.8 ft
29+00	3.5 Rt	7.4 ft	36+00	1.5 Rt	Outcrop
29+00	16 Rt	outcrop	38+00	24 Lt	4.3 ft
31+00	5 Rt	3.4 ft	38+90	16.0 Lt	3.6 ft
31+00	18.5 Rt	outcrop	40+00	15 Lt	9.3 ft
32+50	12.0 Rt	17.3 ft	41+50	22.0 Lt	5.5 ft
32+50	8.0 Lt	6.7 ft	48+50	32.0 Lt	15.0 ft
32+75	6.0 Lt	11.5 ft	32+50	8.0 Lt	6.7 ft
34+00	4 Rt	2.1 ft	32+75	6.0 Lt	11.5 ft
34+00	12.6 Rt	outcrop			

Bedrock consists of metashales of the Rangeley Formation with sandstone and mudstone inclusions. Rock on the north or west side of Spruce Mountain was polished and on the south side of the mountain, blocks of rock were plucked from the side of the mountain as the glacier advanced. There appear to be well defined horizontal and vertical joint sets in the surface rock, however these may be a result of weathering rather than inherent characteristics of the rock.

2.7 Surface and Subsurface Drainage

In the area of Station 32+50, subsurface water drains the bedrock on the Right, approximately 7 feet below the roadway surface, dips down toward the culvert and washes fines out of the hillside on the Left. This has left a loose skeleton of soil particles surrounding the culvert at Station 32+31, with a pronounced slope on the roadway surface. Similar conditions may have caused the severe cross slopes at Stations 39+00 and 41+25. An additional problem at these culverts and other sections north of Station 38+00 is ice formation on the smooth, shallow bedrock slope below the roadway. It appears that the roadway may be sliding on ice that forms where water drains across the top of bedrock under the road in these areas.

3.0 Design Recommendations

3.1 Pavement Design

Very little of the new highway will be on the existing horizontal and vertical alignment, and complete reconstruction of the pavement structure is needed. FWD testing for this project indicates that a Resilient Modulus of 4000 psi is appropriate for this project. Although traffic volumes are low with an AADT of 520, the estimated heavy truck volumes are 24% of AADT. The higher modulus values on the FWD report are areas of shallow bedrock, and were not considered in determining the Modulus.

The pavement design for this project includes two gravel thicknesses to account for the differing subsurface soils conditions. Gravel southern portion of the project will be 18" thick, and for the remainder it will be 24" thick. A constant HMA thickness of 5 inches will be used for the project.

Fracture blasting will be required in all cuts where ledge will form the new highway subgrade to promote subsurface drainage and ensure that a surface of ice doesn't form beneath the roadway. Fracturing should be extended to a depth of 5 feet below the bottom of the subbase to prevent formation of trapped water pockets. After detonation, any rock extending into the subbase should be removed, and compaction will be needed to ensure that the fractured rock material forms a stable base for the roadway.

Transition zones will be required where the subgrade changes to and from pockets of frost susceptible soil, with a typical 20:1 transition. This transition will not be required for areas of bedrock subgrade where subgrade fracturing will be required.

If pockets of soft or loose soils are found at subgrade, a non-woven geotextile meeting MaineDOT Standard Specification 722, Stabilization/Reinforcement geotextile may be used to help support the subbase soils and construction traffic. This geotextile should be placed as shown in Standard Detail 620.03.

Existing pavement should be removed in all fill areas where the proposed subgrade elevation will be less than 5 feet above the existing pavement surface. This will

minimize the problems of trapped water between the existing and new pavement sections.

3.2 Embankment fills

The centerline will be raised in many parts of this project, and fill slopes will be required. Most fills are on the Left side of the highway, and existing slopes are steep. Many of these fills will be fairly narrow triangular sections to widen the shoulder and raise the centerline.

Surficial material on much of the existing side slope consists of small pieces of shale. These are not stable in the existing configuration. The depth of these materials is not known. The following picture shows shale covered sideslopes below the highway.

Subgrade soils encountered under the roadway were generally SAND with some silt, little gravel. A direct shear test on a representative sample indicated $\phi = 33^{o}$. Benching will be needed to ensure the stability of the constructed slope. Slope stability could become a problem in these fills if the existing slopes are not adequately prepared, and the embankments must be properly constructed. MDOT Standard Specification 203.10 should be carefully enforced to ensure adequate compaction of each lift as the work progresses. Computer modeling indicates that a properly constructed slope using will be stable at the design slopes.

The soils used in embankment construction are anticipated to be primarily sand with moderate to low fines content, from excavation on or near this project. It would be

difficult to get vegetation established on the native soils in this climate, and riprap is proposed for surface cover. These soils will be quite erodible, and the slopes must be stabilized during construction. Riprap should be placed as fill construction progresses rather than end-dumped over the whole slope length at the end of construction to ensure that the stones are stable as placed.

Existing culverts at Stations 32+31, 39+95 and 41+30 will be replaced as part of this project. Where areas of loose soils are encountered surrounding these culverts, the areas of loose soil should be replaced or compacted as needed to produce a strong, stable soil mass.

3.4 Soil Cut Slopes

Deep cuts will be required on the Right side of the highway for construction of this project. Much of the cut volume will be in exposed and subsurface bedrock, but there are cut areas with significant overburden soils. Soil cut slopes are generally 1v:3h or flatter, although slopes are steeper in some sections. Estimated depth of overburden on the sideslopes was established with a minimum number of test pits, and may vary from what is shown on the plans.

Rounded stones should not be used as riprap on cut slopes, due to the length of the slopes, the possibility of ice action surrounding groundwater seeps, and large amounts of spring runoff in this area. A Special Provision for large stone materials is included in the appendices to better define the materials that will be acceptable. All cut slopes must receive temporary stabilization during construction.

3.5 Rock Cut Slopes

Rock cuts will be required for this project. In general, the steep rock cuts along this project will have a maximum height of approximately 18 feet. Rock excavation in the area of the Appalachian Trail will be done in such a manner that the final appearance of the corridor is similar to the condition of the rocks when the glacier retreated. Well defined horizontal and vertical joint sets are clearly visible in this area, and where possible, excavation should follow these joint sets. If the orientation of existing joint sets will produce an overhanging slope, small steps should be left in the slope rather than allowing tall overhangs. The final slope at the Appalachian Trail must be navigable by hikers, with a maximum overall slope of not more than 40% and firm footing.

Controlled blasting should be considered for other rock slopes where the height of the cut exceeds 8 feet and/or the overburden will have a slope greater than 3h:1v, but a natural appearance is preferred if a stable slope with no overhanging bedrock can be produced without presplit or cushion blasting. Slopes of 1h:4v should be stable for the bedrock along this roadway unless adverse joint sets are encountered. If it appears that existing fractures in the bedrock will lead to unstable slopes, the Geotechnical Engineer should be called in to work with the blaster; the final slope may need to be altered to promote stability.

Blasting must be accomplished to minimize risk to adjacent marginally stable slopes, and to ensure the safety of hikers on the Appalachian Trail and in nearby woods.

3.6 Surface Water Drainage

Surface water on the Right will be collected in ditches in all areas of the project. Stone ditch and riprap should be used to stabilize the ditches and culvert inlets and outlets, to prevent undermining in these areas.

The steep culverts at Stations 32+31, 39+95 and 41+30 will be replaced with flatter pipes. The culverts will drain to riprap downspouts to minimize erosion, and well defined inlets will be provided.

3.7 Groundwater

Groundwater seeps are difficult to detect during a subsurface investigation program. If seeps are encountered in cut slopes during construction, downspouts should be constructed as needed to carry the water to the ditch without damage to the underlying slope.

3.8 Frost Action

The design freezing index of Township D is 2000. Mean depth of frost penetration for granular soils in this area is not well defined, but estimated as 7 feet, with a design frost depth of 8 feet under plowed surfaces.

Soils in this area are generally granular materials with low to moderate fines content, and are slightly frost susceptible. Pockets of soils with higher fines may be encountered

during construction. Any water trapped in the upper subgrade will freeze, so care must be taken to ensure that all areas of the roadway can drain properly.

3.9 Scenic Overlook

A scenic turnout overlooking Mooselookmeguntic Lake will be built on the Left side of the road between Stations 42+00 and 50+00. Exposed bedrock on this side of Spruce Mountain was polished by the advancing glacier, and is smooth and fairly level in many places. The scenic overlook will have sideslopes at a 1.5h:1v angle, and a shear key excavated into the rock or a berm of heavy riprap may be needed to hold the toe of slope in place. The determination of need for a berm or shear key will be made during construction, after excavation of the overburden soils.

The appearance of this turnout from the lake below is a concern, and the facing on the outer slope of the turnout will be primarily riprap, broken up by the placement of small areas of vegetated soil. This should help the turnout to blend into the surrounding slopes when viewed from a distance.

Appendix A
Resource Maps

NRCS Soils Survey
Bedrock Geology
National Wetlands Inventory

70° 43' 5"

70° 41' 53"

44° 50' 48"

44° 50' 49"

44° 49' 39"

44° 49' 40"

70° 43' 3"

70° 41' 51"

Map Scale: 1:10,100 if printed on A size (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 350 700 1,400 2,100

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:10,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Somerset County Area and Parts of Franklin and Oxford Counties, Maine
Survey Area Data: Version 15, Jul 27, 2009

Date(s) aerial images were photographed: 6/9/1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

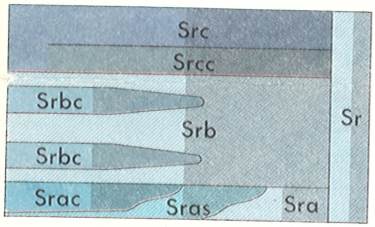
Somerset County Area and Parts of Franklin and Oxford Counties, Maine (ME619)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CHD	Chesuncook-Elliottsville-Telos association, 5 to 30 percent slopes	17.0	4.2%
CPB	Colonel-Pillsbury-Dixfield association, 1 to 8 percent slopes	13.9	3.5%
DTC	Dixfield-Colonel-Rawsonville association, 3 to 15 percent slopes	12.0	3.0%
LTE	Hogback-Rawsonville complex, 20 to 60 percent slopes	188.0	46.7%
MED	Marlow-Dixfield-Rawsonville association, 12 to 30 percent slopes	135.9	33.8%
MKD	Masardis-Adams association, 16 to 60 percent slopes	35.7	8.9%
Totals for Area of Interest		**402.4**	**100.0%**

Oqs
Oqg
Oqs
Qt
Srcc
Srbc
Srb
Og
Srbc
Pond
Qt
Oqc
Srac
Sra
Srb
Srcc
Sp
Sras
Sra
Dps
Dga
Srbc
Srcc
Oqc
Dga
Srb
Dga
Og
Dp
Oqs
Sras
Srac
Sras
Og

Perry Mountain Formation

Cyclically bedded very light gray muscovite-rich metashale and white quartz-rich metasandstone; locally slightly rusty weathering. Metasandstone beds graded, commonly cross laminated, locally with convolute structure; typically 1–4 inches thick, but as much as 10 feet thick. In upper part, metasandstone more abundant than metashale; in lower part, metashale more abundant than metasandstone

Rangeley Lake area | Brimstone Mountain anticline area | Houghton area



Rangeley Formation

Sr, *gray locally sulfidic metashale irregularly interbedded with subordinate amounts of arkosic metasandstone; metasandstone beds less than 1 inch to 5± feet thick, commonly coarse grained, well graded, some parallel laminated, a few cross laminated; load casts, flute casts; abundant irregular inclusions of gray metamudstone*

Part C:

Src, *gray metashale and subordinate amounts of metasandstone*

Srcc, *quartz metaconglomerate, metasandstone, and gray metashale; coarse clastics locally calcareous; metaconglomerate clasts are vein quartz and quartzite, commonly closely packed in thick graded beds*

Part B:

Srbc, *quartz-rich polymictic metaconglomerate, conglomeratic metamudstone, metasandstone, and gray metashale. Coarse clastics locally calcareous. Most clasts are vein quartz, quartzite, granitic rocks and felsic volcanic rocks, basic igneous rocks, and various sedimentary rocks; quartz clasts more abundant in upper layer. Abundant slump deformation*

Srb, *gray locally sulfidic metashale and subordinate amounts of metasandstone*

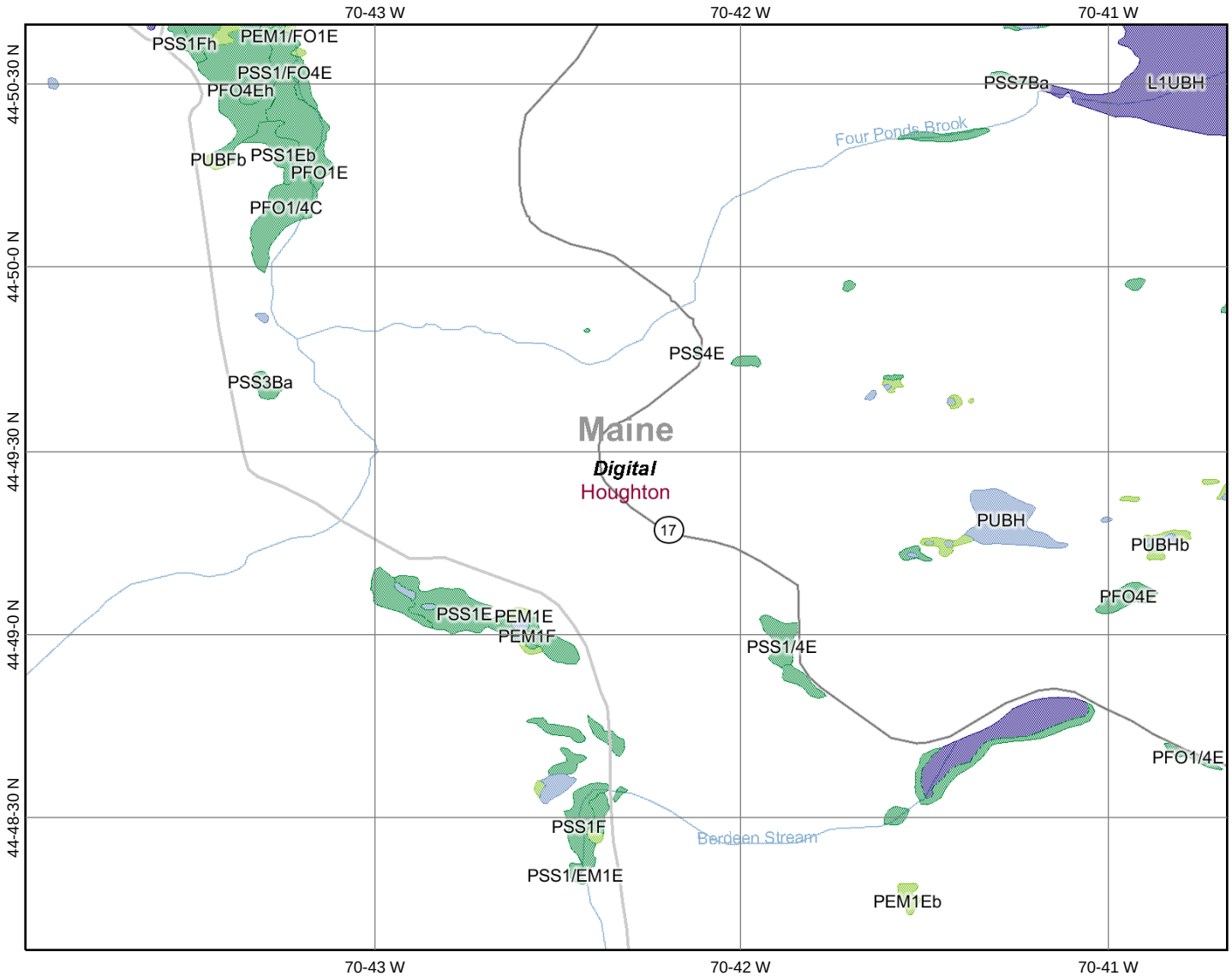
Part A:

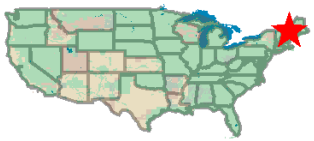
Srac, *polymictic and quartz-rich polymictic metaconglomerate and arkosic metasandstone; graded beds as much as 30 feet thick. Largest clasts are 2-foot boulders in north; common clasts are granite, felsic volcanics, mafic to intermediate igneous rocks, various sedimentary rocks, limestone, and vein quartz; quartzose fragments more abundant toward top*

Sras, *arkosic metasandstone; graded beds as much as 30 feet thick*

Sra, *gray locally sulfidic metashale and subordinate amounts of metasandstone*

Letter D Township





Legend

- Interstate
- Major Roads
- Other Road
- Interstate
- State highway
- US highway
- Roads
- Cities
- USGS Quad Index 24K
- Lower 48 Wetland Polygons
- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine
- Lower 48 Available Wetland Data
- Non-Digital
- Digital
- No Data
- Scan
- NHD Streams
- Counties 100K
- States 100K
- South America
- North America

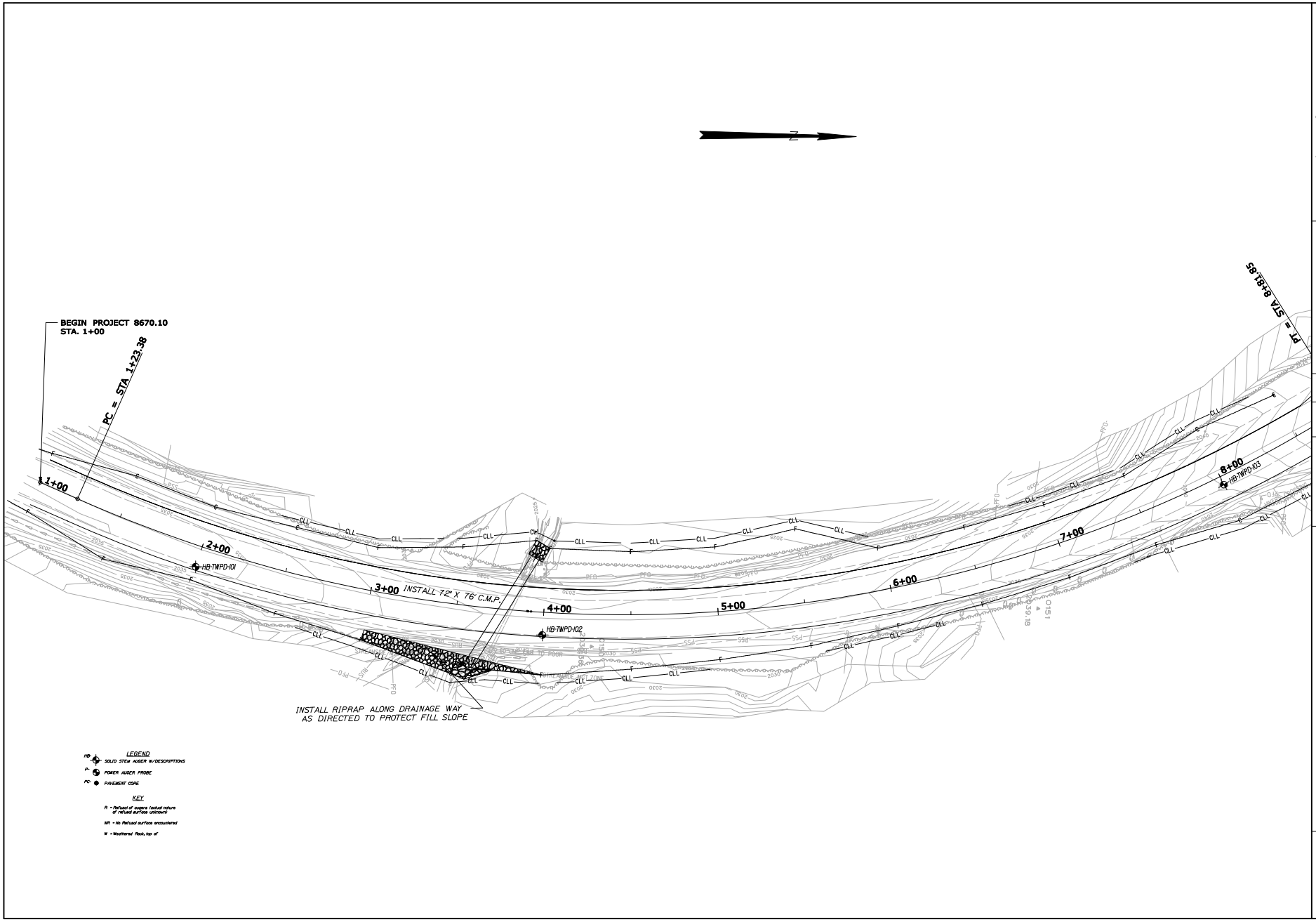
N

Scale: 1:32,746

Map center: 44° 49' 24" N, 70° 42' 19" W

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Appendix B
Geoplans



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS

	BY	DATE	SIGNATURE
PROJ. MANAGER	R.CRAWFORD		
DESIGN-DETAILER1	K. BRESNAN	T. WHITE	DEC 2005
DESIGN-DETAILER2			
DESIGN-DETAILER3			
REVISIONS 1			P.E. NUMBER
REVISIONS 2			7/05/05
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			DATE

TOWNSHIP D
ROUTE 17

GEOPLANS

SHEET NUMBER

1

OF 9

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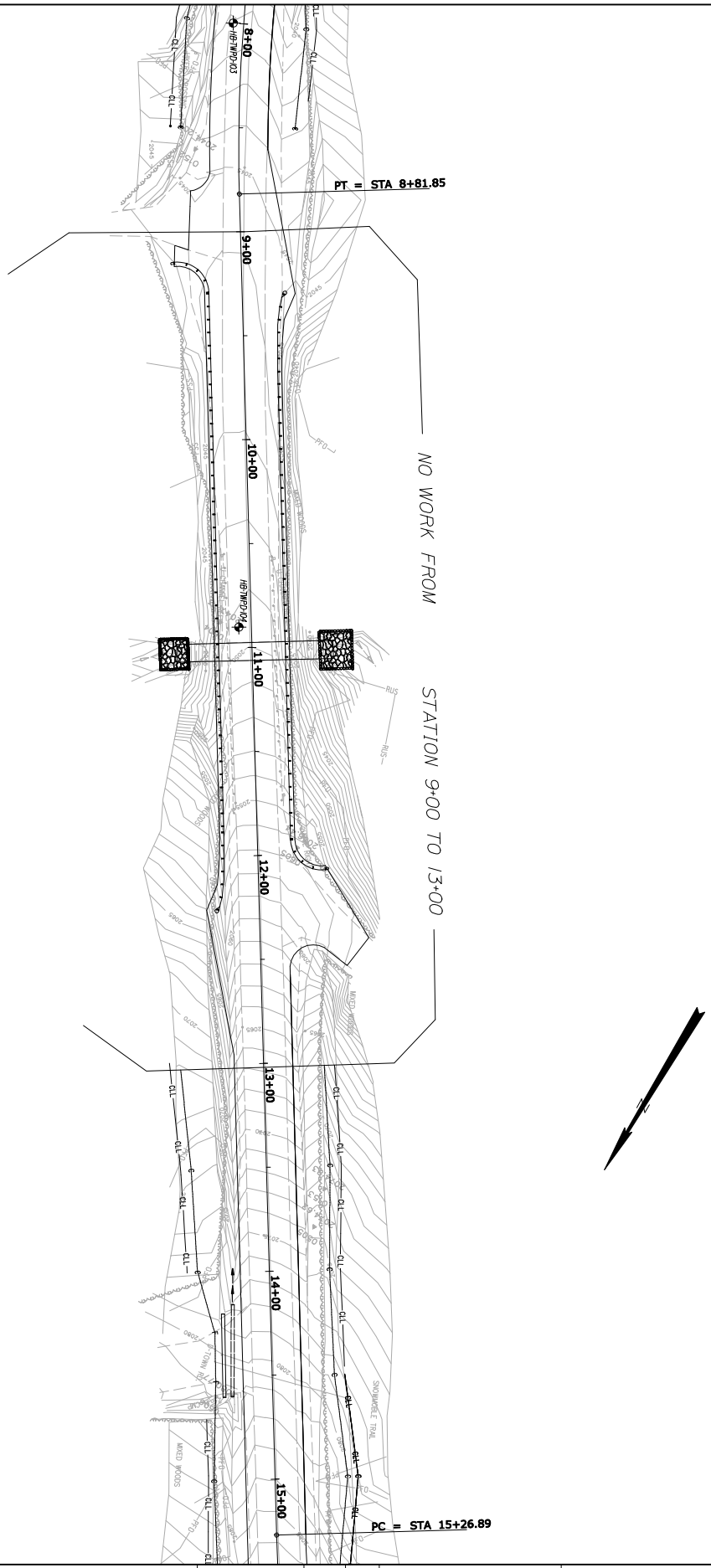


SHEET NUMBER 2 OF 9	TOWNSHIP D ROUTE 17	PROJ. MANAGER	R.CRAWFORD	BY	DATE
		DESIGN-DETAILED	K. BRESKIN	T. WHITE	DEC 2005
		CHECKED-REVIEWED	------	------	------
		DESIGN2-DETAILED2	------	------	------
		DESIGN3-DETAILED3	------	------	------
		REVISIONS 1	------		7\05\05
		REVISIONS 2	------		------
		REVISIONS 3	------		------
		REVISIONS 4	------		------
		FIELD CHANGES	------		------
	GEOPLANS				

SIGNATURE

P.E. NUMBER

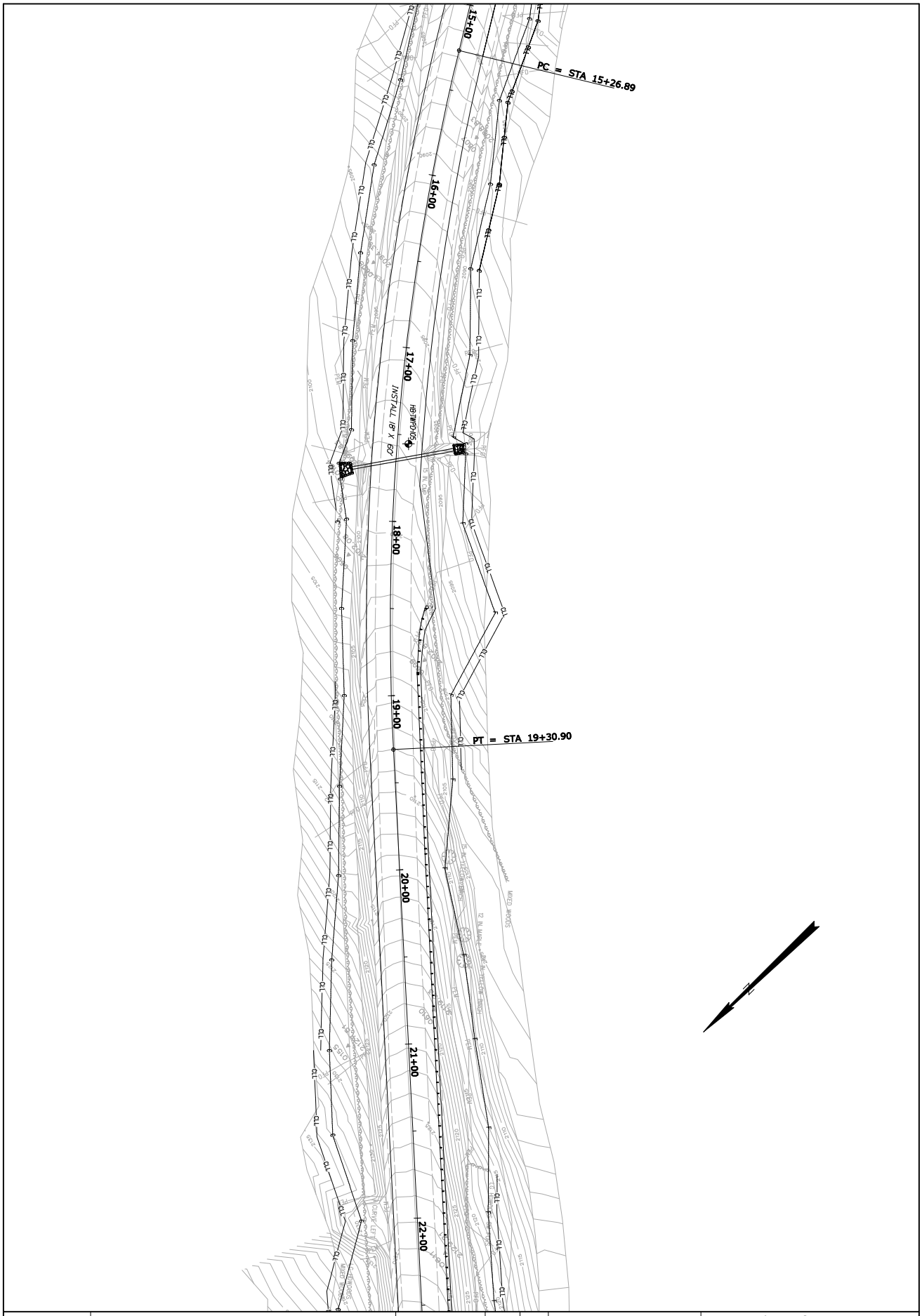
DATE

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN 8670.10

HIGHWAY PLANS



PROJ. MANAGER	R.CRAWFORD	BY	DATE
DESIGN-DETAILED	K. BRESKIN	T. WHITE	DEC 2005
CHECKED-REVIEWED	------	------	------
DESIGN2-DETAILED2	------	------	------
DESIGN3-DETAILED3	------	------	------
REVISIONS 1	------		7\05\05
REVISIONS 2	------		------
REVISIONS 3	------		------
REVISIONS 4	------		------
FIELD CHANGES	------		------

SIGNATURE

P.E. NUMBER

DATE

SHEET NUMBER 3 OF 9

TOWNSHIP D
ROUTE 17

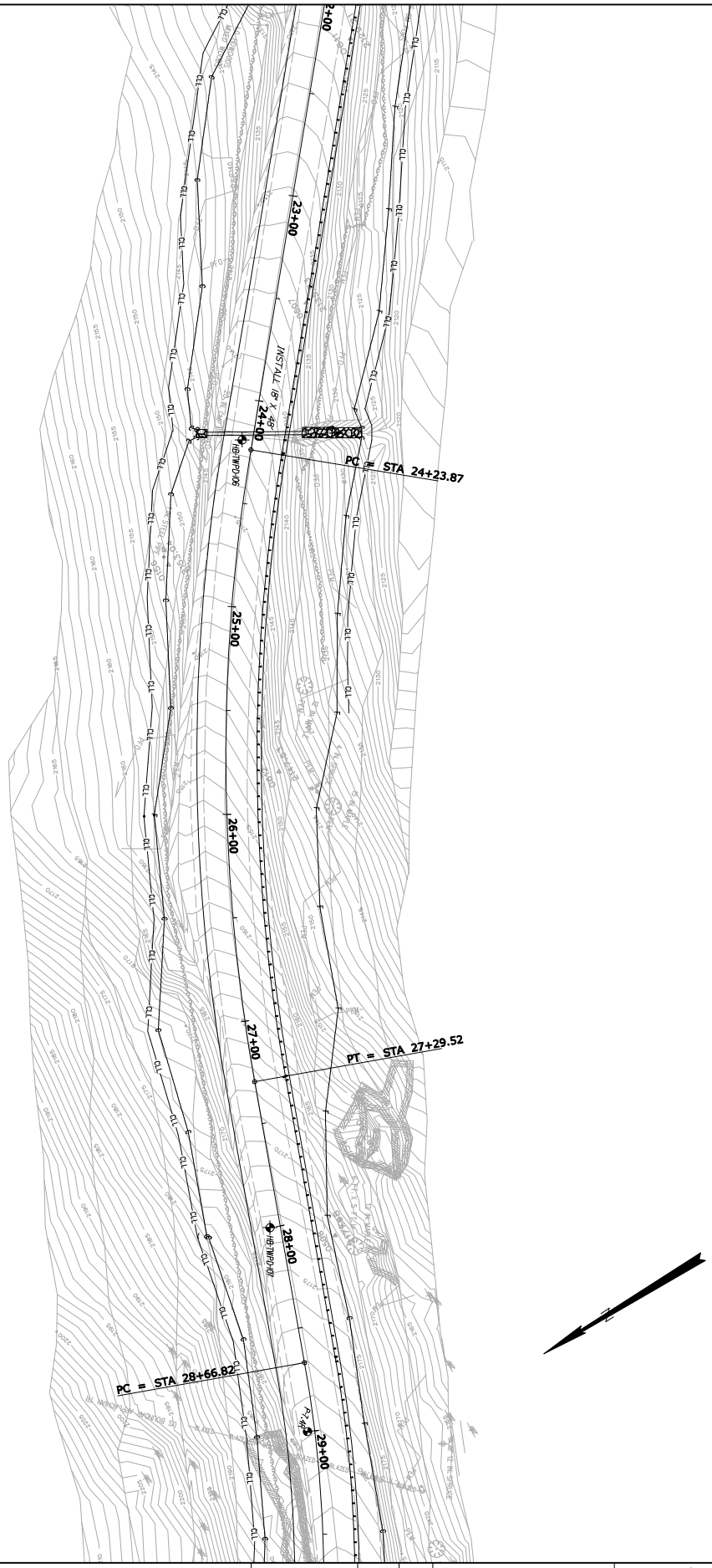
GEOPLANS

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS



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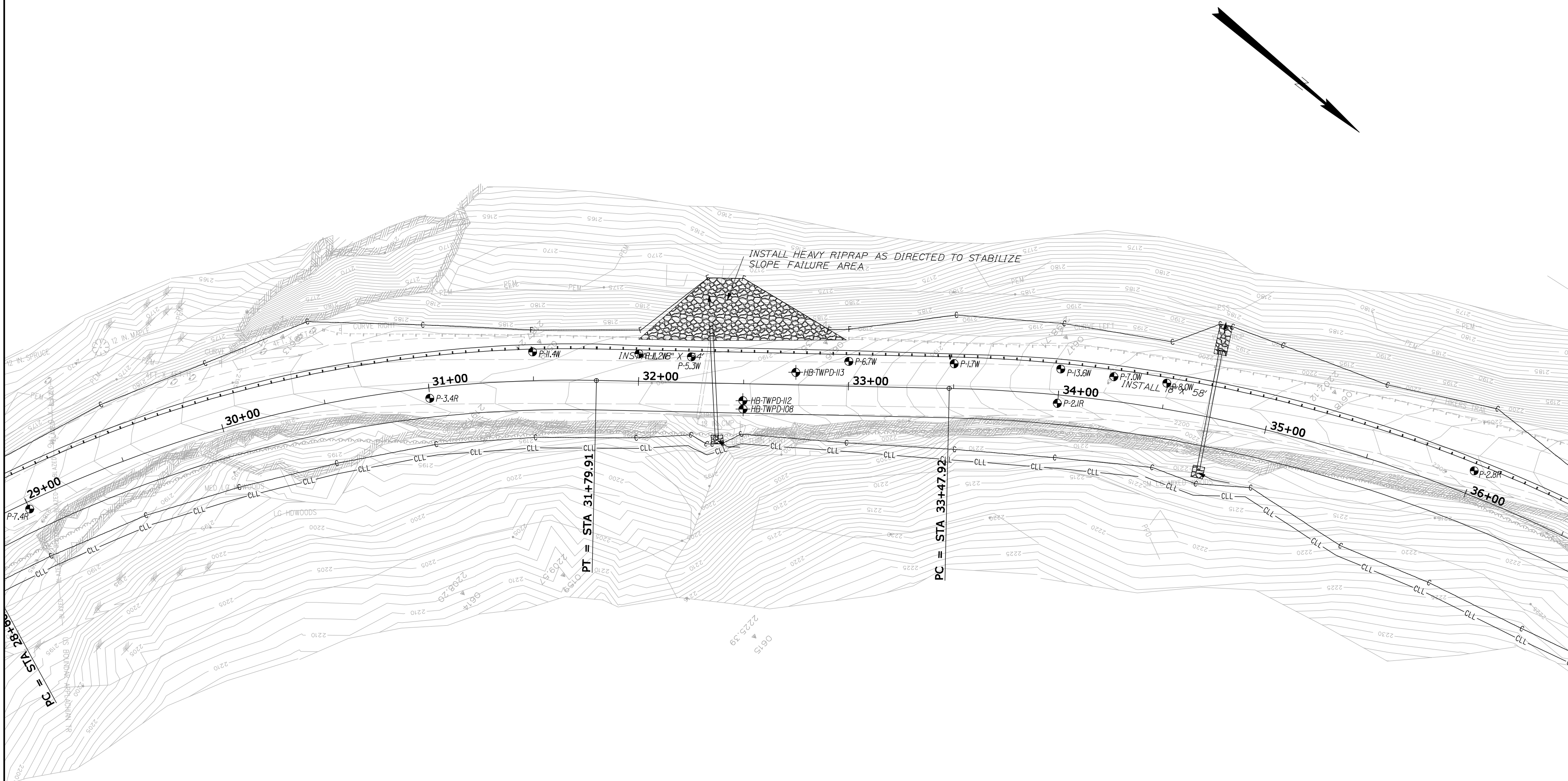
		CHECKED-REVIEWED	------	------	------	SIGNATURE
		DESIGN2-DETAILED2	------	------	------	
		DESIGN3-DETAILED3	------	------	------	
		REVISIONS 1	------		7\05\05	P.E. NUMBER
	GEOPLANS	REVISIONS 2	------		------	
		REVISIONS 3	------		------	DATE
		REVISIONS 4	------		------	
		FIELD CHANGES	------		------	

PIN 8670.10 HIGHWAY PLANS



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS

	BY	DATE
PROJ. MANAGER	R.CRAWFORD	
DESIGN-DETAILED	K. BRESKIN	
CHECKED-REVIEWED	T. WHITE	DEC 2005
DESIGN2-DETAILED2		7/05/05
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

TOWNSHIP D
ROUTE 17

GEOPLANS

SHEET NUMBER

5

OF 9

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Username: kitty.breskin
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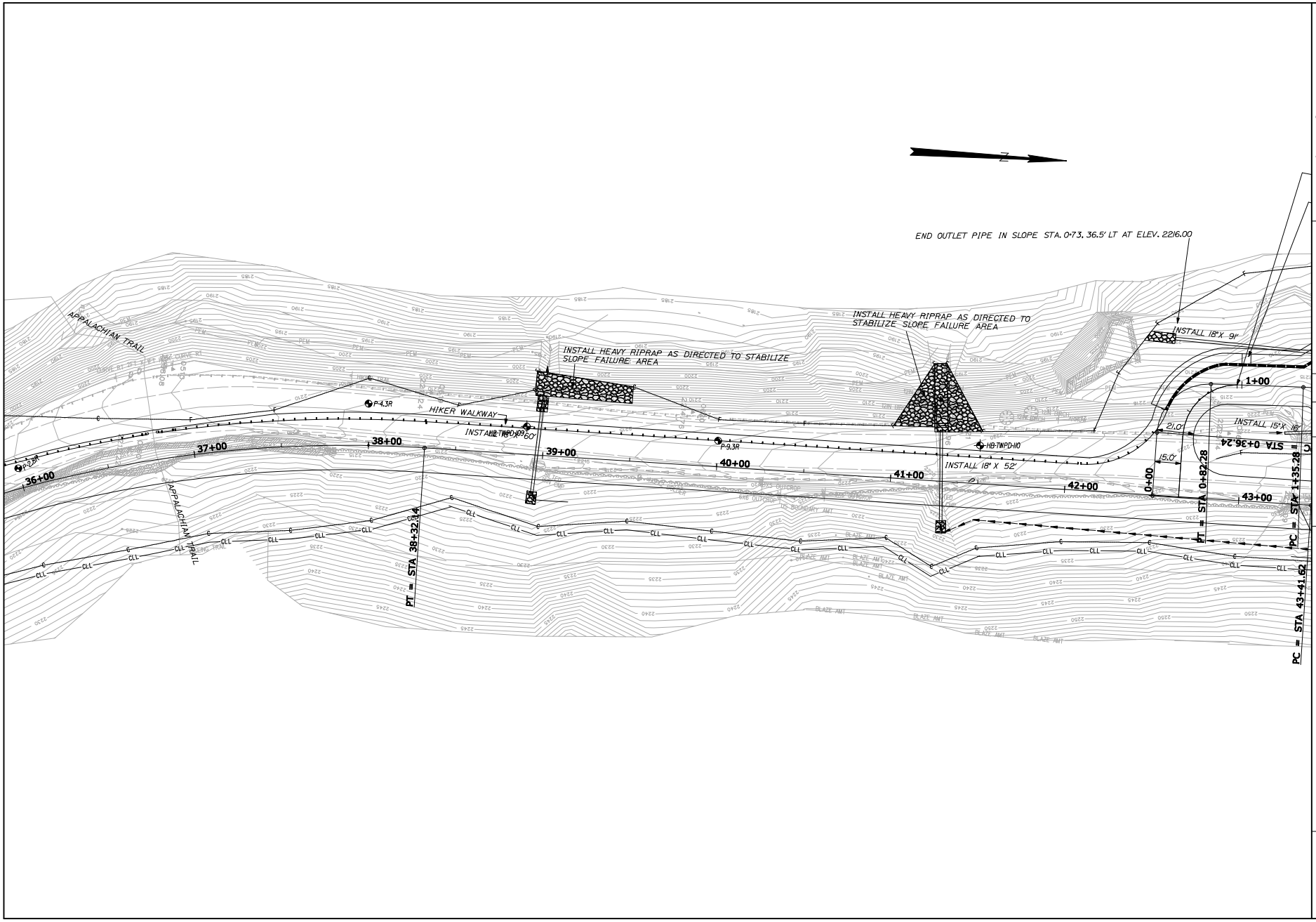


STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS

PROJ. MANAGER	R.CRAWFORD	BY	DATE	
DESIGN-DETAILED1	K. BRESKIN	T. WHITE	DEC 2005	SIGNATURE
DESIGN-DETAILED2	-------	-------	-------	
DESIGN-DETAILED3	-------	-------	-------	
REVISIONS 1	-------	-------	7/05/05	P.E. NUMBER
REVISIONS 2	-------	-------	-------	
REVISIONS 3	-------	-------	-------	
REVISIONS 4	-------	-------	-------	DATE
FIELD CHANGES	-------	-------	-------	

TOWNSHIP D
ROUTE 17

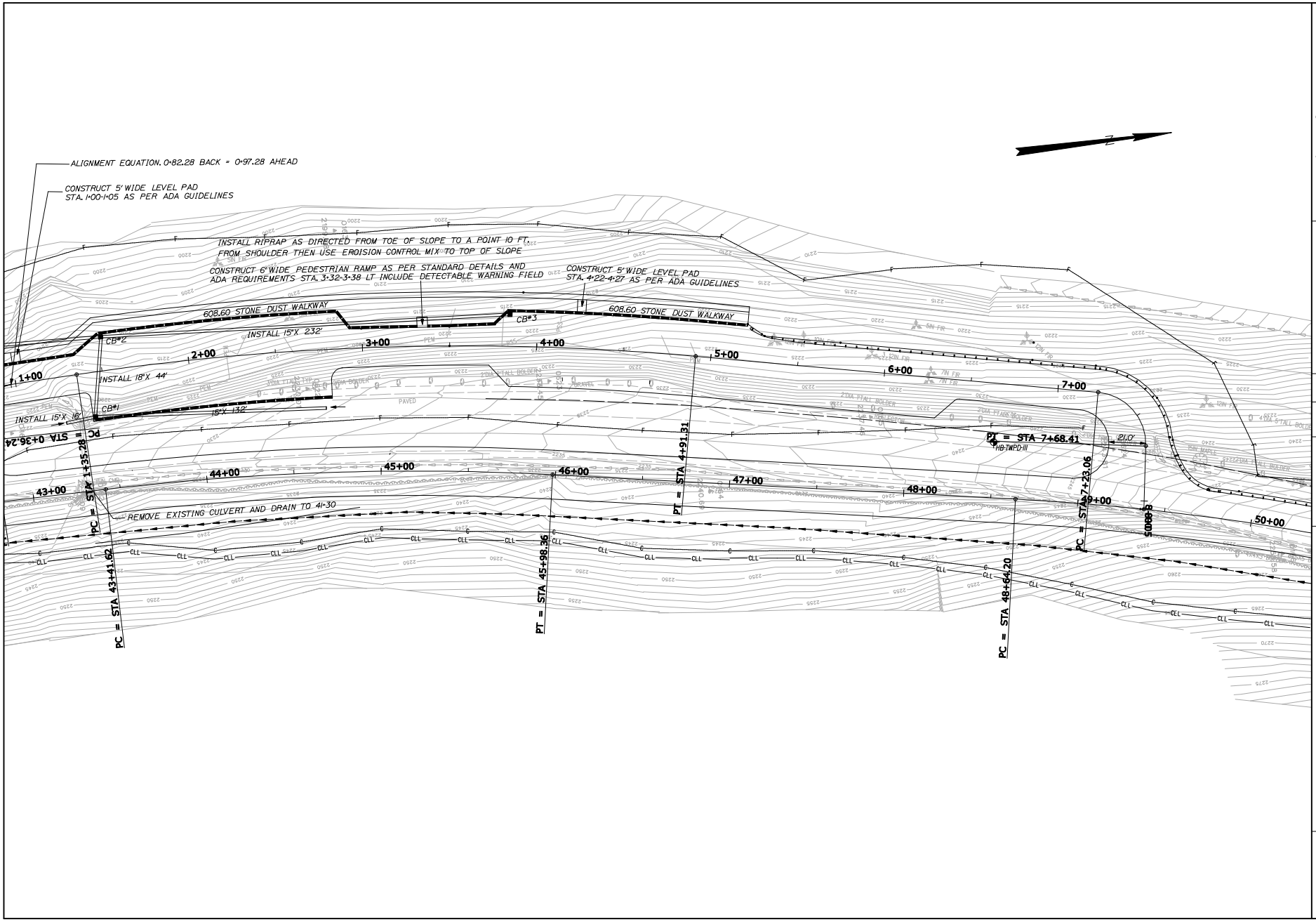
GEOPLANS

SHEET NUMBER

6

OF 9

Filename: ...\geotech\msta\006_Geoplan6.dgn Division: GEOTECH Username: kitty.breskin Date:4/5/2010



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS

PROJ. MANAGER	R.CRAWFORD	BY	DATE	
DESIGN-DETAILED1	K. BRESKIN	T. WHITE	DEC 2005	SIGNATURE
DESIGN-DETAILED2				
DESIGN-DETAILED3				P.E. NUMBER
REVISIONS 1			7/05/05	
REVISIONS 2				
REVISIONS 3				
REVISIONS 4				DATE
FIELD CHANGES				

TOWNSHIP D
ROUTE 17

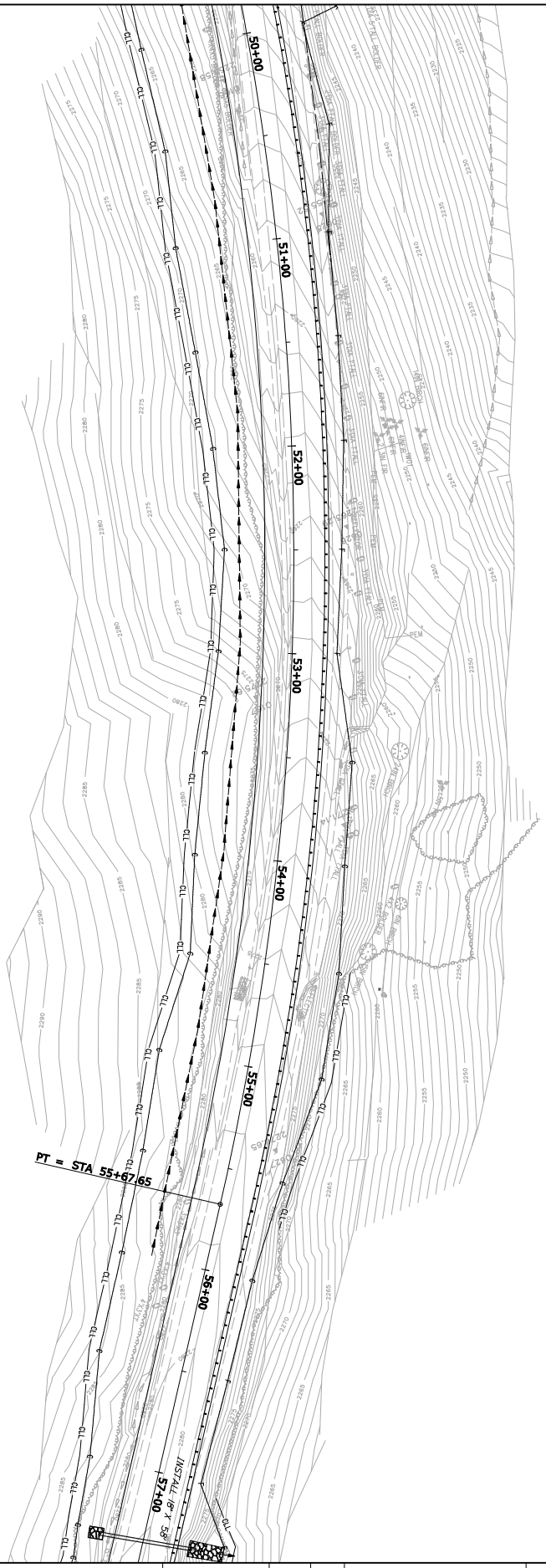
GEOPLANS

SHEET NUMBER

7

OF 9

Filename: ...\geotech\msta\007_Geoplan7.dgn Division: GEOTECH Username: kitty.breskin Date:4/5/2010



PROJ. MANAGER	R.CRAWFORD	BY	DATE	
DESIGN-DETAILED	K. BRESKIN	T. WHITE	DEC 2005	
CHECKED-REVIEWED	------	------	------	SIGNATURE
DESIGN2-DETAILED2	------	------	------	
DESIGN3-DETAILED3	------	------	------	
REVISIONS 1	------		7\05\05	P.E. NUMBER
REVISIONS 2	------		------	
REVISIONS 3	------		------	DATE
REVISIONS 4	------		------	
FIELD CHANGES	------		------	

SHEET NUMBER 8 OF 9

TOWNSHIP D
ROUTE 17

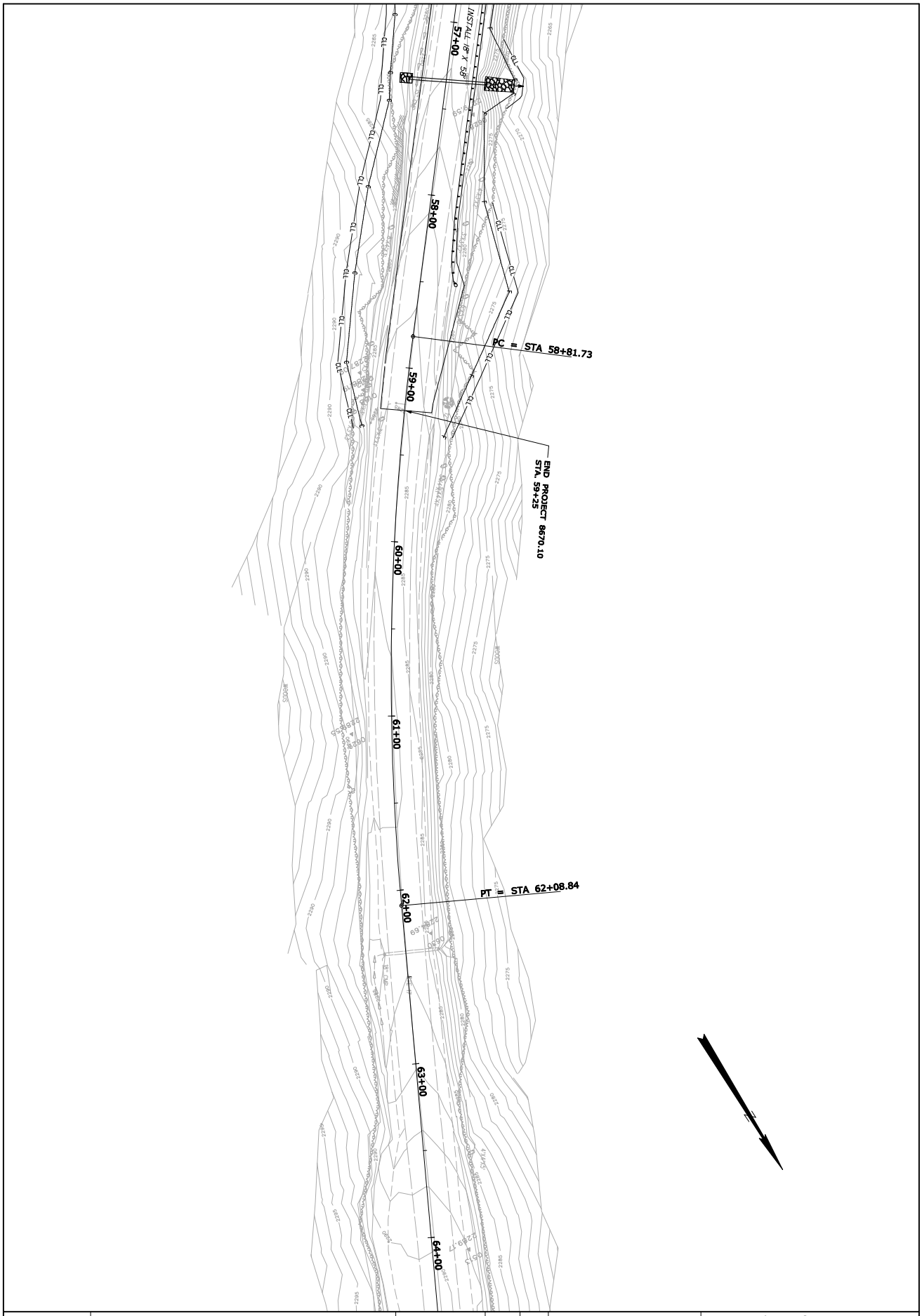
GEOPLANS

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN
8670.10

HIGHWAY PLANS



PROJ. MANAGER	R.CRAWFORD	BY	DATE	
DESIGN-DETAILED	K. BRESKIN	T. WHITE	DEC 2005	
CHECKED-REVIEWED	------	------	------	SIGNATURE
DESIGN2-DETAILED2	------	------	------	
DESIGN3-DETAILED3	------	------	------	
REVISIONS 1	------		7\05\05	P.E. NUMBER
REVISIONS 2	------		------	
REVISIONS 3	------		------	DATE
REVISIONS 4	------		------	
FIELD CHANGES	------		------	

TOWNSHIP D
ROUTE 17

GEOPLANS

SHEET NUMBER 9 OF 9

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

SB-ME-98(007)

PIN 8670.10 HIGHWAY PLANS

Appendix C
Field Exploration Data

Soils Descriptions
Boring Logs
Probe Summary Sheet
FWD Analysis

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations: (in this order)

Color (Munsell color chart)
Moisture (dry, damp, moist, wet, saturated)
Density/Consistency (from above right hand side)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc., if applicable)
Cementation (weak, moderate, or strong, if applicable, ASTM D 2488)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation
Groundwater level

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Modified Burmister System

Descriptive Term	Portion of Total
trace	0% - 10%
little	11% - 20%
some	21% - 35%
adjective (e.g. sandy, clayey)	36% - 50%

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value blows per foot	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily Penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnai
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

$$RQD = \frac{\text{sum of the lengths of intact pieces of core* > 100 mm}}{\text{length of core advance}}$$

*Minimum NQ rock core (1.88 in. OD of core)

Correlation of RQD to Rock Mass Quality

Rock Mass Quality	RQD
Very Poor	<25%
Poor	26% - 50%
Fair	51% - 75%
Good	76% - 90%
Excellent	91% - 100%

Desired Rock Observations: (in this order)

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -tightness (tight, open or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A
Recovery

Maine Department of Transportation
Geotechnical Section
Key to Soil and Rock Descriptions and Terms
Field Identification Information

Sample Container Labeling Requirements:

PIN	Blow Counts
Bridge Name / Town	Sample Recovery
Boring Number	Date
Sample Number	Personnel Initials
Sample Depth	

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-101

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2035.0	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	2+00, 12.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	6.0' bgs.

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA			Brown, moist, gravelly, fine to coarse SAND, little silt.	
							2033.80		1.2	
									Brown, wet, silty, fine to medium SAND, little gravel, cobbles, (Till).	
5										
10							2025.00		10.0	
									Bottom of Exploration at 10.00 feet below ground surface. NO REFUSAL	
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-102

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2031.0	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	4+00, 13.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	5.5' bgs.

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S1		0.2 - 2.4			SSA	2030.80	PAVEMENT. 0.2	
								Brown, moist, gravelly, fine to coarse SAND, little silt.	
	S2		2.4 - 10.0				2028.60	2.4	
								Grey, saturated, fine to coarse SAND, little gravel, little silt.	
5									
10							2021.00	10.0	
								Bottom of Exploration at 10.00 feet below ground surface. NO REFUSAL	
15									
20									
25									

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-103

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2041.1	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	8+00, 5.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	3.5' bgs.

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2040.50		PAVEMENT. 0.6	
									Brown, damp, gravelly, fine to coarse SAND, little silt.	
							2038.60		2.5	
									Light brown, wet, fine to coarse SAND, some silt, little gravel, wetter with depth.	
5										
10							2031.10		10.0	
									Bottom of Exploration at 10.00 feet below ground surface. NO REFUSAL	
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-104

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2049.4	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	10+90, 6.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2048.50		PAVEMENT.	
									0.9	
									Brown, damp, gravelly, fine to coarse SAND, trace silt, cobbles, (Fill Area).	
5										
							2042.40		7.0	
									Light brown, moist, fine to coarse SAND, some silt.	
10							2039.40		10.0	
									Bottom of Exploration at 10.00 feet below ground surface. NO REFUSAL	
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-105

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2097.6	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	17+55, 6.5 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	7.0' bgs.

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2097.10		PAVEMENT. 0.5	
	S3		1.7 - 10.0						Brown, damp, gravelly, fine to coarse SAND, little silt.	
							2095.90		1.7 Olive-brown, moist, fine to coarse sandy SILT, little gravel, (Till).	
5										
10							2087.60		10.0 **Bottom of Exploration at 10.00 feet below ground surface.** NO REFUSAL	
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-106

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2142.5	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	24+20, 5.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2142.00		PAVEMENT. 0.5	
									Brown, damp, gravelly, fine to coarse SAND, little silt.	
							2140.40		2.1	
									Dark brown, wet, fine to coarse sandy-SILT, some organics.	
							2139.10		3.4	
									Light brown, moist, fine to coarse sandy SILT, little gravel, (Till).	
5										
10							2132.50		10.0	
									Bottom of Exploration at 10.00 feet below ground surface. NO REFUSAL	
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-107

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2173.4	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	28+00, 5.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2172.95		PAVEMENT. 0.5	
							2172.40		Brown, damp, gravelly, fine to coarse SAND, little silt. 1.0	
							2171.90		Light browm, damp, fine to coarse sandy SILT, little gravel, (Till). 1.5	
									Bottom of Exploration at 1.50 feet below ground surface.	
									REFUSAL	
5										
10										
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-108

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2190.4	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	32+50, 12.0 Rt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S4		0.0 - 14.0			SSA			Brown, moist, gravelly, fine to coarse SAND, some silt, little gravel(Fill).	G,DS#181199 A-2-4, SM WC=21.2%
5										
10										
							2176.40		14.0	
15									Light browm, moist, fine to coarse sandy SILT, little gravel, (Till).	
							2173.10		17.3	
20									**Bottom of Exploration at 17.30 feet below ground surface.** REFUSAL	
25										

Remarks:

DS=Direct Shear Test

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-109

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2213.8	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	38+90, 16.0 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	2213.35		PAVEMENT. 0.5	
									Brown, damp, gravelly, fine to coarse SAND, little silt. 2.5	
							2211.30		Light browm, moist, fine to coarse sandy SILT, little gravel, (Till). 3.6	
							2210.20		**Bottom of Exploration at 3.60 feet below ground surface.** REFUSAL	
5										
10										
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-110

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2220.3	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	41+50, 22.0 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S5		0.4 - 5.5			SSA	2219.90		PAVEMENT.	
									0.4 Brown, damp, gravelly, fine to coarse SAND, trace silt.	
5							2214.80		5.5 **Bottom of Exploration at 5.50 feet below ground surface.** REFUSAL	
10										
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-111

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	2240.4	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Off Flights
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	12/1/05-12/1/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	48+50, 32.0 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	S6		0.0 - 4.0			SSA		Brown, moist, gravelly, fine to coarse SAND, trace silt.	
							2236.40	4.0	
	S7		4.0 - 15.0					Light brown, damp, silty, fine to medium SAND, little gravel.	
5									
10									
15							2225.40	15.0	
								Bottom of Exploration at 15.00 feet below ground surface. AUGER BROKE OFF AT 15.0'	
20									
25									

Remarks:

Blew a hydraulic hose and spilled 3 gallons of hydraulic oil, call environment office.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-112

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	1290.9	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	130#/30"
Date Start/Finish:	12/28/05-12/28/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	32+50, 8.0 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	None Observed

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA	1290.55		PAVEMENT. 0.4	
									Grey, medium dense, SAND, some silt, little gravel.	
5	1D	20.4/14	5.0 - 6.7	5/8/20/50(2.4")	28					G#182542 A-2-4, SM WC=14.7%
							1284.20		6.7	
							1283.40		LEDGE REFUSAL at 6.7' bgs, augered into rock to 7.5' bgs. 7.5	
									Bottom of Exploration at 7.50 feet below ground surface.	
10										
15										
20										
25										

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log

US UNITS

Project: Route 17

Location: Township D, Maine

Boring No.: HB-TWPD-113

PIN: 8670.10

Driller:	MaineDOT	**Elevation (ft.)**	1291.6	**Auger ID/OD:**	5" Dia.
Operator:	E. Giguere	**Datum:**	NGVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	130#/30"
Date Start/Finish:	12/28/05-12/28/05	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	32+75, 6.0 Lt.	**Casing ID/OD:**	N/A	**Water Level*:**	8.5' bgs.

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
R = Rock Core Sample
V = Insitu Vane Shear Test
SSA = Solid Stem Auger

Definitions:
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WOH = weight of 140lb. hammer
WOR = weight of rods

Definitions:
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-value	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0						SSA				
5										
									Saturated soil at 8.5' bgs.	
10	1D	18/6	10.0 - 11.5	2/3/3	5		281.60		Brown, wet, loose, sandy GRAVEL, some silt. (10.0)	G#182543 A-1-b, GM WC=12.7%
							280.10		(11.5) **Bottom of Exploration at 11.50 feet below ground surface.** REFUSAL	
15										
20										
25										

Remarks:

Almost nothing came out on the auger flights. We had to get Maintenance to bring sand to fill in the hole.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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State of Maine - Department of Transportation

Power Auger Probe Summary Sheet

Town(s): Township D Project Number: 8670.10

Station (Feet)	Offset (Feet)	Weathered Rock (Feet)	Refusal (Feet)	No Refusal (Feet)	Water Depth (Ft.)	Comments / Date 12/1/2005
29+00	3.5 Rt.		7.4			
29+00	16.0 Rt.					Ledge Outcrop
31+00	5.0 Rt.		3.4			
31+00	18.5 Rt.					Ledge Outcrop
34+00	4.0 Rt.		2.1			
34+00	12.6 Rt.					Ledge Outcrop
36+00	11.5 Lt.		2.8			
36+00	1.5 Rt.					Ledge Outcrop
38+00	24.0 Lt.		4.3			
40+00	15.0 Lt.		9.3			
						10/10/2006
31+50	13.7 Lt.	11.4	11.9			
32+00	13.1 Lt.	11.2	11.9		9.7	
32+25	12.3 Lt.	5.3	6.4			
33+00	11.8 Lt.	6.7	7.1		6.3	
33+50	11.8 Lt.	1.7	2.3			
34+00	12.4 Lt.	13.6	14.1		8.3	
34+25	11.6 Lt.	7.0	7.6			
34+50	12.3 Lt.	8.0	8.2		6.0	

MaineDOT
Logged By: B. Wilder
Logged By: E. Giguere 10/10/06

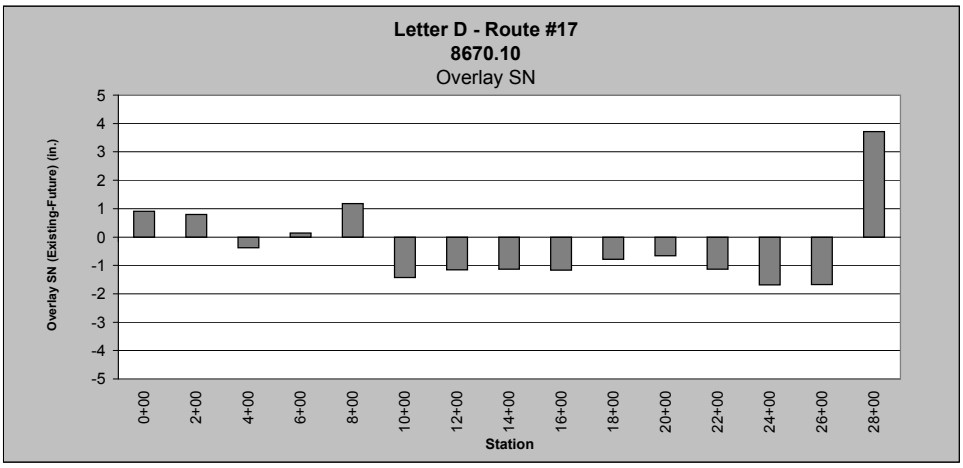
5" SSA

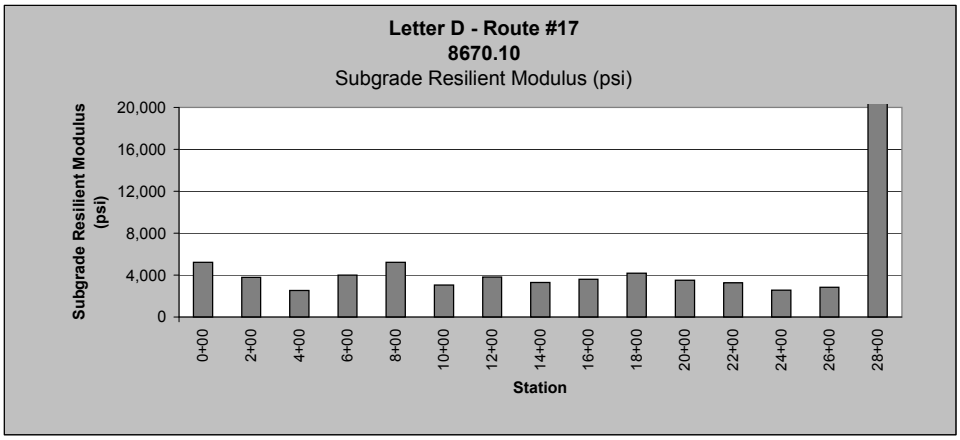
Letter D Township - Route #17
8670.10

December 28, 2005

Station (Feet)	Existing Structural Number (in.)	Future Traffic Structural Number (in.)	Overlay Structural Number (Existing - Future)	Recommended Pavement Thickness (in.)	Subgrade Resilient Modulus (psi)	Pavement Modulus (psi)	Pavement Depth (in)	* Combined Pavement/Gravel Depth Used for Calculation (in)
0+00	4.58	3.67	0.91	-	5,218	39,046	7	30
2+00	4.89	4.1	0.79	-	3,777	47,609	7	30
4+00	4.31	4.69	**-0.38**	**0.86**	2,534	32,532	7	30
6+00	4.16	4.02	0.14	-	4,013	29,237	7	30
8+00	4.85	3.67	1.18	-	5,207	46,503	7	30
10+00	2.98	4.41	**-1.43**	**3.25**	3,047	36,197	6	**20**
12+00	2.93	4.09	**-1.16**	**2.64**	3,804	34,584	6	**20**
14+00	3.16	4.29	**-1.13**	**2.57**	3,309	43,288	6	**20**
16+00	3	4.17	**-1.17**	**2.66**	3,604	37,047	6	**20**
18+00	3.18	3.96	**-0.78**	**1.77**	4,174	22,571	6	25
20+00	3.55	4.21	**-0.66**	**1.5**	3,500	31,419	6	25
22+00	3.17	4.3	**-1.13**	**2.57**	3,280	22,275	6	25
24+00	2.97	4.66	**-1.69**	**3.84**	2,580	18,414	6	25
26+00	2.84	4.51	**-1.67**	**3.8**	2,846	16,023	6	25
28+00	5.83	2.11	3.72	-	23,613	80,611	5	30

*** For actual Gravel Depths, see logdraft forms**



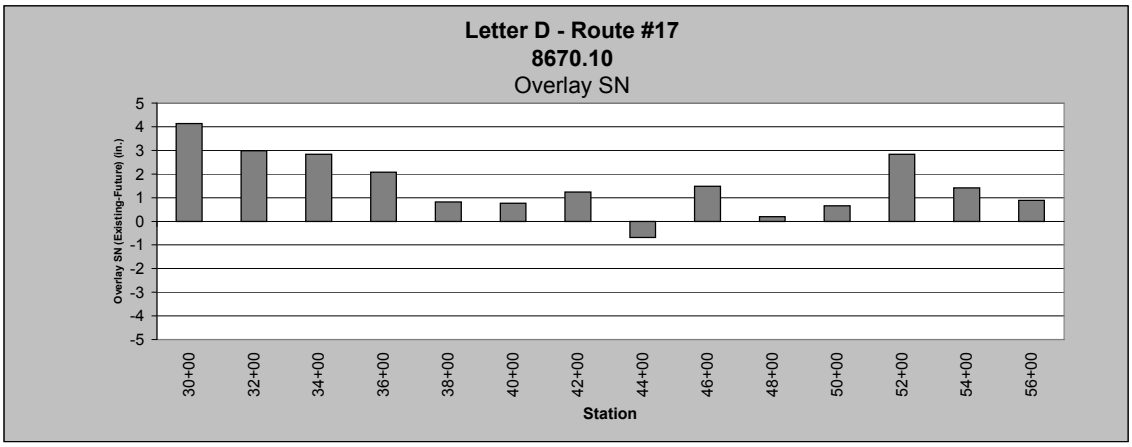


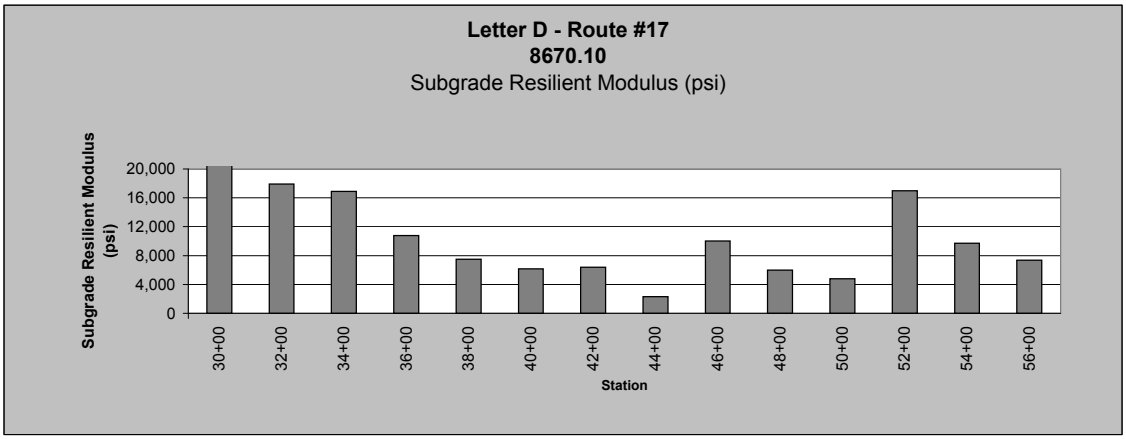
Letter D Township - Route #17
8670.10

December 28, 2005

Station (Feet)	Existing Structural Number (in.)	Future Traffic Structural Number (in.)	Overlay Structural Number (Existing - Future)	Recommended Pavement Thickness (in.)	Subgrade Resilient Modulus (psi)	Pavement Modulus (psi)	Pavement Depth (in)	* Combined Pavement/Gravel Depth Used for Calculation (in)
30+00	6.12	1.99	4.13	-	27,311	93,236	5	30
32+00	5.32	2.34	2.98	-	17,916	61,162	5	30
34+00	5.22	2.39	2.83	-	16,891	57,663	5	30
36+00	4.91	2.83	2.08	-	10,757	47,975	5	30
38+00	4.04	3.22	0.82	-	7,500	26,896	5	30
40+00	4.22	3.46	0.76	-	6,151	30,471	5	30
42+00	4.66	3.42	1.24	-	6,370	41,153	5	30
44+00	4.16	4.84	**-0.68**	**1.55**	2,290	29,266	5	30
46+00	4.38	2.9	1.48	-	10,011	34,174	5	30
48+00	3.69	3.49	0.2	-	6,002	20,490	5	30
50+00	4.42	3.77	0.65	-	4,807	35,133	5	30
52+00	5.22	2.39	2.83	-	16,979	57,964	5	30
54+00	4.34	2.93	1.41	-	9,700	33,114	5	30
56+00	4.13	3.24	0.89	-	7,369	28,626	5	30

*** For actual Gravel Depths, see logdraft forms**





Appendix D
Lab Test Data
Lab Testing Summary Sheet
Grain Size Curves
Direct Shear Test Results

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Township D Project Number: 8670.10

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C.	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
HB-TWPD-108, S4	32+50	12.0 Rt.	0.0-14.0	181199	1	21.2			SM	A-2-4	II
HB-TWPD-112, 1D	32+50	8.0 Rt.	5.0-6.7	182542	1	14.7			SM	A-2-4	II
HB-TWPD-113, 1D	32+75	6.0 Lt.	10.0-11.5	182543	1	12.7			GM	A-1-b	I

Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible). The "Frost Susceptibility Rating" is based upon the MDOT and Corps of Engineers Classification Systems.

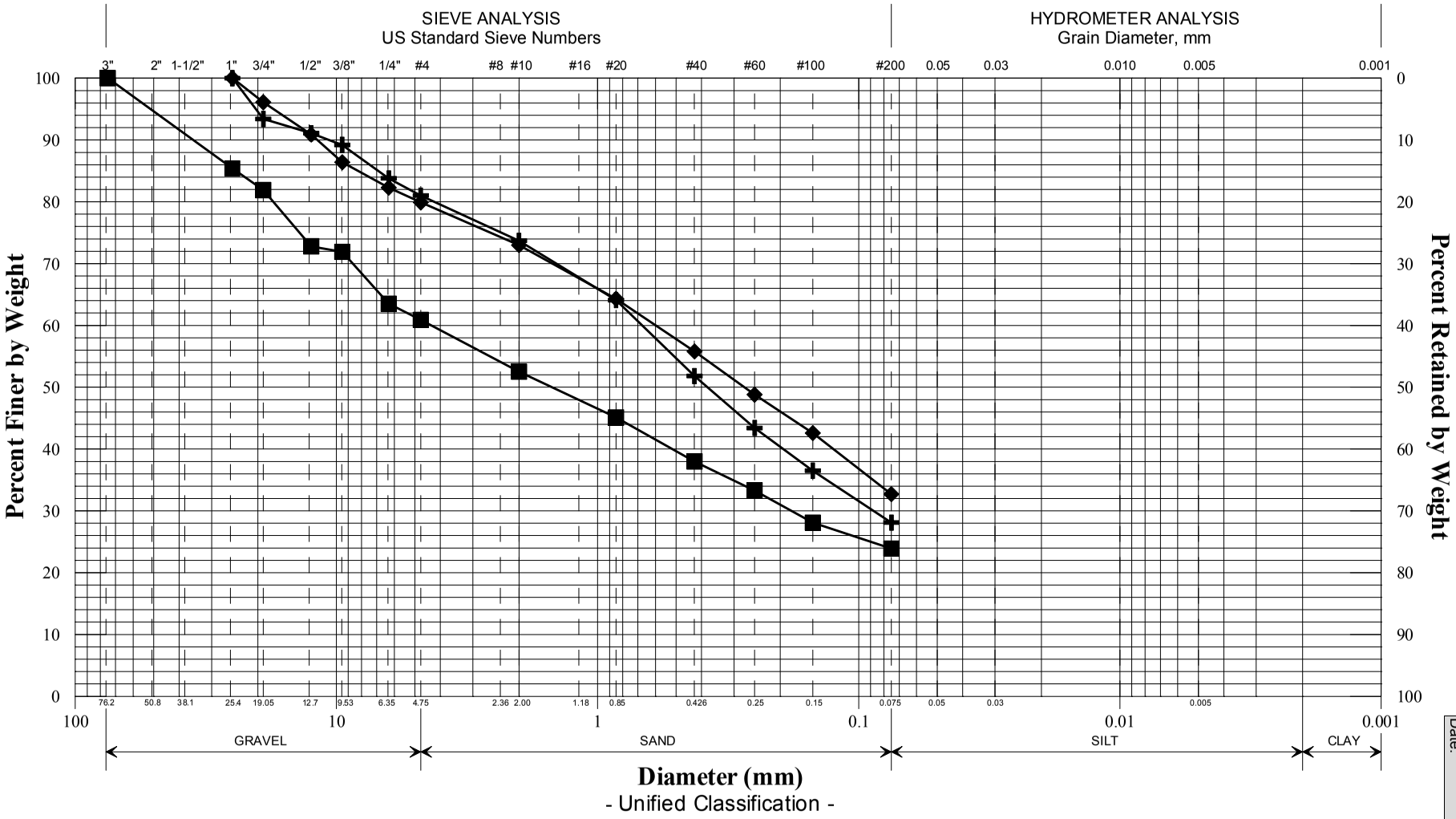
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE

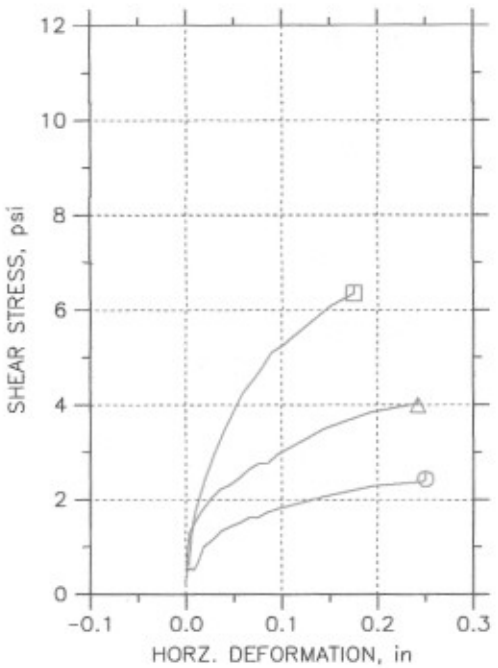


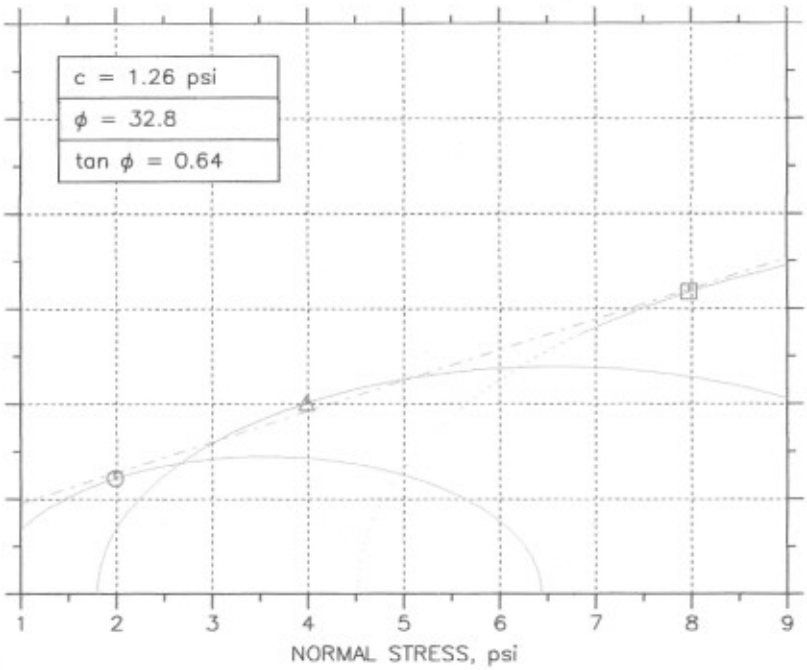
	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	HB-TWPD-108/S4	32+50	12.0 RT	0.0-14.0	SAND, some silt, little gravel.	21.2			
◆	HB-TWPD-112/1D	32+50	8.0 RT	5.0-6.7	SAND, some silt, little gravel.	14.7			
■	HB-TWPD-113/1D	32+75	6.0 LT	10.0-11.5	Sandy GRAVEL, some silt.	12.7			
●									
▲									
✕									

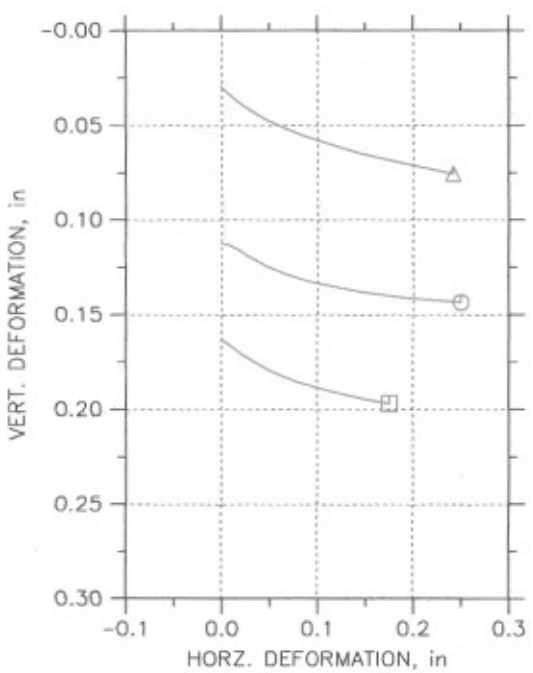
PIN:	008670.10
Town:	Township D
Reported by:	WHITE, TERRY A
Date:	1/30/2006

SHEET NO. 1

DIRECT SHEAR TEST REPORT







Symbol		⦶	△	⊡	
Test No.		181199	181199	181199	
Sample No.		S4	S4	S4	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.485	2.485	2.485	
	Area, in^2	4.85	4.85	4.85	
	Height, in	0.9987	1.013	0.9807	
	Water Content, %	11.16	9.02	8.77	
	Dry Density, pcf	92.267	96.801	89.471	
	Saturation, %	37.28	33.71	27.36	
	Void Ratio	0.793	0.70901	0.84903	
Consol. Height, in		0.90153	0.98633	0.82236	
Consol. Void Ratio		0.61855	0.66401	0.5505	
Final	Water Content, %	23.00	22.56	22.02	
	Dry Density, pcf	107.77	104.65	112	
	Saturation, %	113.95	102.91	122.29	
	Void Ratio	0.535	0.58084	0.47705	
Normal Stress, psi		1.9879	3.9839	7.9759	
Max. Shear Stress, psi		2.425	4.0068	6.3442	
Ult. Shear Stress, psi		2.425	3.9776	6.3442	
Time to Failure, min		25.305	25.004	17.2	
Disp. Rate, in/min		0.01	0.01	0.01	
Estimated Specific Gravity		2.65	2.65	2.65	
Liquid Limit		NP	NP	NP	
Plastic Limit		NP	NP	NP	
Plasticity Index		NP	NP	NP	

Project:
Location: TOWNSHIP D
Project No.: 8670.10
Boring No.: HB-TWPD-108
Sample Type: cup
Description:
Remarks:

Thu, 05-JAN-2006 08:15:46

3	0.02	[illegible]	[illegible]	[illegible]	[illegible]
4	0.03	7.968	0.1641	0.6678	0.000247
5	0.04	7.964	0.1641	0.6887	0.0003352
6	0.05	7.98	0.1642	0.6678	0.0004587
7	0.06	7.98	0.1642	0.672	0.0005469
8	0.07	7.984	0.1642	0.672	0.0006703
9	0.08	7.988	0.1642	0.6678	0.0007938
10	0.09	7.976	0.1643	0.6678	0.000882
11	0.10	7.968	0.1643	0.6678	0.0009526
12	0.20	7.98	0.1644	0.6261	0.001923
13	0.30	7.984	0.1646	0.6135	0.002946
14	0.40	7.96	0.1647	0.8097	0.003881
15	0.50	7.964	0.165	1.048	0.004886
16	0.60	7.984	0.1653	1.252	0.005857
17	0.70	7.911	0.1657	1.382	0.006809
18	0.80	7.976	0.1661	1.511	0.00785
19	0.90	7.915	0.1665	1.628	0.008838
20	1.00	7.976	0.1669	1.728	0.009791
21	1.50	7.972	0.1688	2.099	0.0148
22	2.00	7.956	0.1707	2.425	0.01974
23	3.00	7.972	0.174	2.963	0.02964
24	4.00	7.976	0.1769	3.439	0.03959
25	5.00	7.976	0.1795	3.848	0.04962
26	6.00	7.939	0.1818	4.249	0.05973
27	7.00	7.972	0.1838	4.499	0.06972
28	8.00	7.984	0.1857	4.779	0.07974
29	9.00	7.976	0.1873	5.096	0.08976
30	10.00	7.98	0.1888	5.226	0.09971
31	15.00	7.976	0.1952	6.081	0.1516
32	17.20	7.976	0.1973	6.344	0.1754

Appendix E

SP 203 Controlled Blasting
SP 203 Fracture Rock Subgrade
SP 203 Rock Scaling

Township D
PIN 8670.10
April 21, 2010

SPECIAL PROVISION
SECTION 203
EXCAVATION AND EMBANKMENT
(CONTROLLED BLASTING)

203 – EXCAVATION AND EMBANKMENT, is amended to include the following:

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. The work to be done under this Special Provision includes furnishing all labor, equipment, materials and services and performing operations required to fragment and excavate materials classified as rock utilizing controlled blasting procedures specified herein to the grades and limits indicated on Drawings, or as directed by the Resident on sections were the cut exceeds 8 feet in height and the overburden slope exceeds 1v:2h, such that damage is minimized to adjacent slopes and highway structure.

2. The purpose of the controlled blasting is to create a stable rock face with a fall zone to protect the traveling public from rock fall hazard.

3. Protecting existing structures, adjacent property, workers, Department personnel and consultants, and the general public from damage or injury from improper handling of explosives, flyrock, excessive ground vibrations and/or excessive air blast overpressure levels.

4. Furnishing, installing, and implementing an audible warning system to indicate impending blasting and familiarizing workers, Department personnel and consultants, and the general public with the system implemented.

1.02 SYSTEM DESCRIPTIONS

A. Definitions:

1. Earth is defined as all materials not classified as rock.

2. Rock is defined as naturally-occurring, intact material which cannot be broken and removed by large power excavation equipment and requires use of hoe rams, systematic drilling and blasting, or other mechanical means to fracture and remove. Boulders over two cubic yards in volume located within soil in open excavation or in trenches, requiring the use of hoe rams, drills, or explosives for removal are also defined as rock excavation. Rock does not include boulders less than two cubic yards in volume, or loose, weathered, or fragmented rock which can be excavated with a large backhoe.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Persons responsible for blasting shall be licensed blasters in the State of Maine and shall have had acceptable experience in similar excavations in rock and controlled blasting techniques. The Blasting Contractor shall document, with project descriptions, successful experience performing controlled blasting for at least three similar projects within the last five years.

B. Codes, Permits and Regulations:

1. The Contractor shall comply with all applicable Federal, State, and Local laws, rules, ordinances and regulations governing the transportation, storage, handling and use of explosives. All labor, materials, equipment and services necessary to make the blasting operations comply with such requirements shall be provided without additional cost to the Department.

2. The Contractor shall obtain and pay for all permits and licenses required to complete the work of this Special Provision.

3. In case of conflict between regulations or between regulations and Specifications, the Contractor shall comply with the strictest applicable codes, regulations, or Specifications.

1.04 SUBMITTALS

A. Advance Submittal:

The Contractor shall submit the following information to the Resident at least ten (10) business days prior to commencing drilling and blasting operations. It is the Department's intent to respond to the major items in the Contractor's submittal within five (5) business days after receipt.

1. Sequence and schedule of blasting rounds, including the general method of developing the excavation, lift heights, etc.

2. Listing of inclinometer device to be used to accurately position drill angle on all drill rigs, complete with catalog cuts, specifications, and operation procedures.

3. Include the following blast round details:

a. Plan of a typical round design showing hole spacing and delay pattern.

b. Diameter, spacing, burden, depth, and orientation of each blast hole for each round design, including test blasts, production blasts, and blasts where perimeter control methods are required.

c. Nomenclature and amount (in terms of weight and/or number of cartridges) of explosives and distribution of charge to be used within each hole, on each delay, and the total for the blast.

d. Nomenclature and type of detonators; delay pattern wiring diagram for the round: type and capacity of firing source, size, type and location of safety switches and lightning gap.

e. Type and location of stemming to be used in holes.

f.. Calculation of anticipated vibration levels at fill slopes on opposite side of roadway.

4. Manufacturers' data sheets for all explosives, primers and initiators to be employed.

5. Methods of matting or covering of the blast area in open excavations to prevent flyrock and excessive air blast overpressure.

6. Written evidence of the licensing, experience and qualifications of the blasters who will be directly responsible for the loading of each shot and for firing it.

7. Name and qualifications of the person(s) responsible for design and directing the blasting. This submittal shall document by project lists that the person has the required experience in controlling open-cut blast vibrations in blasting rounds of the type required on the project.

7. Details of an audible advance signal system to be employed at the job site as a means of informing workers, Department personnel or its representatives, and the general public that a blast is about to occur.

8. Submit a copy of the blasting permit(s) obtained to conduct blasting on the site (when received).

9. Review by the Department of blast designs and techniques shall not relieve the Contractor of responsibility for the accuracy, adequacy and safety of the blasting, exercising proper supervision and field judgment and producing the results within the blasting limits required by this Special Provision

C. The time period specified for submittal is the minimum required by the Department to review, evaluate and respond to the Contractor. It is the intent of the Department to review the submittals within one week, although this may not be possible. If, after review, the Department requires re-submission for any reason, the specified time period shall commence upon the date of receipt of the re-submittal. The Contractor is responsible for scheduling specified submittal and re-submittal so as to prevent delays in the work.

1.05 INDEMNITY

A. Notwithstanding full compliance with this Special Provision, approval of blasting plan, and successful limitation to maximum peak particle velocity and air blast overpressure noted above,

the Contractor shall be solely responsible for any damage, direct or indirect, arising from blasting and shall hold the Department and their consultants harmless from any costs, liens, charges, claims or suits, including the costs of defense, arising from such damage, real or alleged.

PART 2 - EXECUTION

2.01 MINIMUM SAFETY PRECAUTIONS

A. The specified Danger Area for this project shall include all sections of the Appalachian Trail, including any temporary alternate routes, where hikers could be at risk from flying blast rock. Additional warning signs will be required at the parking area for Saddleback Mountain on Route 4 in Sandy River Plantation, and where the Trail crosses South Arm Road at Black Brook Notch in Andover North Surplus, and/or other areas as designated by a representative of the Appalachian Trail.

B. Clearing the Danger Area Before Blasting: No blasting shall be permitted until all personnel in the danger area have been removed to a place of safety. A loud, audible, warning system, devised and implemented by the Contractor, shall be sounded before each blast. The Contractor shall familiarize all personnel on the project and the general public with the implemented system. The danger area shall be patrolled before each blast to make certain that it has been completely cleared, and guards shall be stationed to prevent entry until the area has been cleared by the blaster following the blast.

C. Explosives shall be stored, handled and employed in accordance with Federal, State, and local regulations including 29CFS 1926 Subpart U – Blasting and Use of Explosives. Maine DOT Standard Specification Section 105.2.6 – Use of Explosives shall also apply.

D. No explosives, caps, detonators or fuses shall be stored on the site during non-working hours.

E. The Contractor shall be responsible for determining any other safety requirements unique to blasting operations on this particular site so as not to endanger life, property, the Appalachian Trail, the southern slope of Route 17, or any property adjacent to the site.

F. No requirement of, or omission to require, any precautions under this Contract shall be deemed to limit or impair any responsibility or obligations assumed by the Contractor under or in connection with this Contract; and the Contractor shall at all times maintain adequate protection to safeguard the public and all persons engaged in the work, and shall take such precautions as will accomplish such end, without undue interference to the public.

2.02 GENERAL BLASTING PROCEDURES

A. Pre-blast meeting: A Pre-blast meeting shall be held prior to the start of any drilling or blasting activities. The purpose of the meeting shall be to review the blasting procedures, to facilitate coordination between all parties involved, and to discuss the final appearance of the rock face in the vicinity of the Appalachian Trail.

B. The initial blasting at the site shall consist of at least one test blast, for the purpose of assessing the vibration attenuation characteristics at the site and the effectiveness of the perimeter

controlled blasting measures. The test blast shall take place in an area agreed to by the Resident and the Blasting Contractor.

C. In order to assure adequate rock fragmentation, minimize the damage to remaining rock beyond the excavation limits, and minimize the possibility of excessive throw of rock onto the highway, the Contractor shall utilize borehole deviation techniques in order to determine the actual burden (distance to free face) for selected production and perimeter holes.

D. Contractor will not be allowed to drill ahead of the first completed section until the area has been excavated and the results evaluated by the Resident.

E. If at any time during the progress of the work, the methods of drilling and blasting do not produce the desired result of slope and shear face, the Contractor shall be required to drill, blast and excavate in short sections, not exceeding 100 feet in length, until a technique is arrived at that will produce the desired results. Extra cost resulting from this requirement shall be borne entirely by the Contractor.

F. Blasting shall be limited to between the hours of 8:00 A.M. and 5:00 P.M. Monday through Friday or as otherwise restricted by the Department. No blasting shall be conducted on Sundays, holidays, or other times unless prior written permission is received from the Resident.

G. The Contractor shall notify the Resident at least 48 hours before blasting operations are to commence, and at least 24 hours prior to recommencing blasting if operations are suspended for any reason.

H. Blasting agents that contain perchlorates shall not be used for any blasting for this Project.

I. Immediately after blasting, the Contractor shall have sufficient equipment available at the site to clean pavement of blast rock. At the completion of each blast round, the Contractor shall collect the fragmented rock and dispose of all material outside the limits of the Rock Cut area. The Contractor shall also use, as required, a mechanical sweeper to control dust and small stones.

J. Production blast holes shall be drilled on the patterns submitted by the Contractor and approved by the Resident. The production blast holes shall be drilled to within 2 blasthole diameters of the staked collar location. If more than 5% or the holes are drilled outside this tolerance, at the option of the Resident the Contractor may be required to refill these holes with crushed stone and redrill them at the proper location.

K. First-row-in production blast holes (adjacent to perimeter blast holes) shall be drilled and loaded such that no portion of these holes are closer than 5 feet to the preplit lines to avoid overbreak of the design rock face. Spacing and loading of the first-row-in holes should be 0.5 to 0.75 times the production hole loading and spacing.

L. Drilling logs shall be kept on each blasthole to show open bedding, jointing and open or mud filled seams, zones of sort or weathered rock, mud pockets etc. These logs shall be provided to the Resident before any blastholes are loaded. The logs shall be used to properly design and load blastholes.

2.03 SPECIAL PERIMETER CONTROL BLASTING PROCEDURES

A. Special perimeter control blasting shall be conducted as required to control the limits of the excavation.

B. Cushion Blasting:

1. Cushion (trim) blasting shall be used where the designed slope is 2v:1h or greater, and the rock cut is 10 feet or greater.

2. Prior to drilling, all soil and loose and disintegrated rock shall be removed down to solid rock for a distance of at least 30 feet beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the cushion blast line.

3. Cushion blast holes shall be loaded and fired separately after the main round to create a fracture plane along the perimeter of the excavation. Alternatively, they may be fired as the last delay(s) of a round, a minimum of 25 milliseconds after detonation of adjacent production holes. In general, the cushion blast row should be detonated with a row-to-row timing of 1.5 to 3 times the production hole row-to-row timing.

4. Cushion blast holes shall be 4 inches or less in nominal diameter, spaced no greater than eight times the hole diameter on-center, and shall be drilled along the cushion blast line and at the required slope inclination to the full depth of the cut or to a pre-determined lift elevation.

5. Drilling 2 feet below the payment line will be allowed to facilitate removal of the toe berm.

6. Continuous column charge explosives manufactured especially for cushion blasting shall be used for all cushion blasting. The top of the hole, for a minimum distance of 18 inches, or 0.7 times the burden whichever is greater, shall be unloaded and stemmed. The bottom charge concentration within the bottom 1 to 3 feet of hole shall be no greater than three times the column charge concentration.

7. The maximum diameter of explosives used in cushion blast holes shall not be greater than ½ the diameter of the cushion blast hole. The maximum column charge concentration shall be 0.4 lb/ft.

8. The upper portion of all cushion blast holes, from the top most charge to the hole collar, shall be stemmed. Stemming materials shall be dry angular granular material with a maximum particle size of ½ inch.

9. Cushion blast charges shall be fired with detonating cord extending the full depth of each hole.

10. The Contractor shall control drilling operations by the use or proper equipment and technique to ensure that no hole shall deviate from the plane of the planned slope.

11. Cushion blast holes shall be drilled within 3 inches of the staked collar location. If more than 5% of the cushion blast holes are outside of this tolerance, they will be filled with crushed stone, stemmed and re-drilled.

C. Pre-Splitting: If used, pre-split blast holes shall be loaded and fired separately before the main round to create a fracture plane along the perimeter of the excavation. Alternatively, they may be fired as the first delay of a round, a minimum of 25 milliseconds prior to detonation of adjacent production holes. With the exception of the above criteria, requirements for cushion blasting also apply to pre-splitting.

2.04 SCALING AND STABILIZATION

A. The primary purpose of the scaling effort is to remove potentially unstable blocks of rock and rock fragments from the top and face of the slope. Scaling should be accomplished by the manual method using a suitable standard steel mine scaling rod or other hand-held means to detach partially loosened blocks and loose rock fragments. Subject to the Resident's approval, other methods such as machine scaling, hydraulic splitting or light blasting may be used in lieu of or to supplement hand scaling. Special Rock Scaling needed to produce the desired appearance or slope surrounding the Appalachian Trail will be used only between Stations 35+00 and 38+50 and will be paid under Pay Item no. 203.215; all other scaling will be incidental to Section 203.21, Rock Excavation.

B. The scaling operations must be conducted by personnel experienced in scaling work so as to minimize damage to the surrounding sound rock. Scaling shall start at the top of the slope and work down. The scaling operations shall be sufficient to only remove the loose surficial rock surface and loose rock blocks.

C. Scaling should be completed to remove loose or hanging rock during or upon completion of excavation in each lift of rock removed to the Resident's satisfaction. Drilling of the next lift will not be allowed until this work has been completed.

D. The Resident or an approved representative will a) approve the method of scaling, b) determine the limits of scaling, and c) inspect the new rock face after scaling and determine if additional scaling or other remediation is required.

2.05 MEASUREMENT AND PAYMENT

A. Measurement

Rock removed in accordance with this Special Provision will be paid using the neat lateral and horizontal limits indicated on the Drawings, and the measured quantity shall be an in place measurement. If the blasting and rock excavation is performed using multiple lifts, any remaining bench shall be less than 2.5 feet wide and any additional excavation required as a result of the benching shall not be measured for payment.

There will be no separate measurement for conducting pre-blast surveys, or installing, maintaining and monitoring blast instrumentation, borehole deviation surveys, collecting blast debris, disposal of materials and all other work noted above. All cost in connection therewith will be considered incidental.

Production holes will not be measured for payment.

Special perimeter control blasting procedures (Section 2.03) at the perimeter of the rock slopes shall be measured by the linear foot of presplit or cushion blast hole, measured from the collar of the hole to a depth six inches below the finished ditch line. Holes which deviate from the correct alignment by more then six inches or one percent of the hole depth (whichever is greater) shall not be measured for payment.

The quantities in the contract are only an estimate; final quantities will be determined during construction. There will be no adjustment in the contract price for difference between the estimated and the actual quantities involved.

B. Payment

1. Rock removed in accordance with this Special Provision will be paid for at the contract unit price per cubic yard for Pay Item 203.21 – Rock Excavation. Scaling will be incidental to Pay Item 203.21, Rock Excavation except for scaling within the Appalachian Trail corridor (Station 35+00 to 38+50) that is required purely to produce the required appearance or slope. Work associated with conducting pre-blast surveys, blast monitoring, borehole deviation surveys, collecting blast debris disposal of materials and all other work noted above will not be paid for separately but are considered incidental to the contract unit price for Pay Item 203.21 – Rock Excavation

2. Payment for special perimeter control blasting (Section 2.03) will be paid for at the contract unit price per linear foot for Pay Item 203.211. Rock Excavation, Special Perimeter Control.

PIN 8670.10
Township D
April 5, 2010

Special Provision
Section 203
Excavation and Embankment

Standard Specification Section 203.17 Preparation and Protection of Subgrade shall be amended as follows:

Drilling and Blasting of Solid Rock Subgrade. Subgrade areas shall be shattered to the dimensions shown on the Plans or directed by the Resident.

The area of blasted rock subgrade shall extend sufficiently beyond the beginning and end of cut areas to ensure the shattering of all rock to a depth of 6 feet below subgrade elevation to eliminate water pockets.

After detonation, any rock that protrudes above the subgrade elevation shall be removed. When directed by the Resident, the Contractor shall excavate a trench across the blasted rock to determine if the rock is broken and rearranged to a depth of 6 feet below subgrade. Afterwards, the trench shall be backfilled with the rock removed.

Method of Measurement. The quantity of Drilling and Blasting of Solid Rock Subgrade to be measured for payment will be the number of square meters (square yards) of subgrade plan area drilled and detonated in accordance with this Section, measured at subgrade level.

The number of cubic meters (cubic yards) of excavation required by the Resident to inspect the depth of shattered and rearranged rock, computed at a maximum width of 30 inches will be measured for payment as Structural Earth Excavation – Drainage and Minor Structures Below Grade.

When Structural Rock Excavation – Drainage and Minor Structures, and Drilling and Blasting of Solid Rock Subgrade occur at the same location, measurement and payment for Structural Rock Excavation - Drainage and Minor Structures will be made for the required trench. This area will not be included in the measurement and payment for Drilling and Blasting of Solid Rock Subgrade.

Basis of Payment. The accepted quantities as measured will be paid for at the Contract unit price per square meter (square yard) for the specified Contract items. Payment will be full compensation for performing the work specified including any necessary stripping of rock below subgrade, the removal of blasted subgrade rock that may swell above subgade, and its disposition on the project as directed by the Resident.

Excavation and backfill required to inspect the depth of broken rock below subgrade will be paid for at the Contract unit price per cubic meter (cubic yard) for Structural Rock Excavation – Drainage and Minor Structures.

Payment will be made under:

Pay Item		Pay Unit
203.213	Drilling and Blasting of Solid Rock Subgrade	Square yard
203.214	Exploratory Drilling	Hour

Special Provision
Section 203
Rock Scaling

General: A secondary purpose of Rock Scaling is to produce a rock face similar in appearance to the existing rock face in the vicinity of the Appalachian Trail.

Description. This work shall consist of scaling rock slopes with the use of hand and machine equipment in the area of the Appalachian Trail, Station 35+00 to Station 38+50, Right. If scaling can be done using conventional rock excavation methods to produce an acceptable appearance of the rock face, work will be accomplished under the provisions of Standard Specification 203.04. Work under this Special Provision will be done only if needed and as directed by the Resident, and includes any work needed for hauling and disposing of the scaled material.

General. Contractor shall perform rock slope scaling to remove all loose and potentially unstable rock from the slope face at locations as directed, including loose rock that may be resting on the soil slope above the rock face. This work will also include the removal and disposal of all vegetation that would jeopardize the integrity of the slope within the scaling area, both on the slope face and for 20 feet above the top of the scaling area. Work shall be done by personnel equipped with appropriate hand tools and/or by machine scaling and using equipment and methods appropriate for safety and the conditions of the site, and approved by the Resident.

Rock Scaling Equipment. The Contractor shall furnish equipment capable of reaching the limits of the rock scaling area. Hand scaling equipment shall include standard steel mining rods or other appropriate tools. Machine scaling shall be done by large excavators, hydraulic or pneumatic splitters or expanders, and/or other approved non-explosive means.

Construction Requirements. Scaling of loose or potentially unstable rock shall be accomplished by hand or machine scaling. The rock slope shall be thoroughly scaled to the satisfaction of the Landscape Architect to ensure that desired appearance is obtained. Upon completion, the scaled rock slope shall be stable and free from possible hazards of falling rocks, overhangs or rockslides that would endanger the public safety.

After scaling, large pieces of rock shall be reduced in size as needed for transportation by mechanical or other approved means. Care shall be taken to minimize damage to the surface of the adjacent roadway by construction equipment and/or falling rock. Any scaled rock that falls within the clear zone as indicated by the Resident must be removed from this clear zone before the end of operations on the same day the rock is scaled. No fallen rock may remain in this clear zone when flaggers are not present.

All areas disturbed by the Contractor's operations shall be restored to a condition equal to that found prior to construction. Restoration shall include, but not be limited to, loaming,

fertilizing, reseeding and mulching, and realignment of any curb disturbed by these operations. Any damage to the pavement or drainage structures adjacent to rock scaling and disposal operations shall be repaired by the Contractor at no additional cost to the Department.

Method of Measurement. Scaling of the rock slope will be measured per operation by the hour, to the nearest ¼ hour. If the Contractor has more than one scaling site on-going during a day that is separated by at least 500 feet or at different ledge sites, they will be considered separate operations. Time of daily equipment set-up and removal at a site will not be measured for payment. Downtime for rock scaling equipment repair will not be measured. No measurement of time for the disposing of scaled rock, including secondary fracturing and handling, will be made.

Basis of Payment. The accepted quantity of rock scaling by the type of method specified will be paid for at the contract unit price per hour. Repair of pavement, curb, vegetation or drainage structures damaged during rock scaling will be incidental to the scaling work.

The quantity in the contract is an estimate only; final quantities will be determined during construction. There will be no adjustment in the contract price for difference between the estimated and the actual time involved.

Payment will be made under:

Pay Item	Unit
203.215 Rock Scaling	Hour

Appendix F
Geophysics Report

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
ROUTE 17 REALIGNMENT
TOWNSHIP D
FRANKLIN COUNTY, MAINE

PIN 8670.10

Prepared for:

Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - D10
Salem, New Hampshire 03079

File 06J19
December, 2006

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HAGER-RICHTER
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December 22, 2006
File 06J19

Kitty Breskin, P.E.
Maine Department of Transportation
16 State House Station
Augusta, ME 04333-0016

RE: Geophysical Survey
Township D, Franklin County, Maine

Dear Ms. Breskin:

Please find enclosed three copies of a report entitled "Geophysical Survey, Township D, Franklin County, Maine." If you have any questions or comments after reviewing the report, please contact us at your convenience.

It was a pleasure to work with you and other representatives of Maine Department of Transportation on this interesting site. We hope to have the opportunity of working with you again in the future.

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Jeffrey Reid
Project Manager/Sr. Geophysicist

Enc: 3 copies or report

0. EXECUTIVE SUMMARY

Hager-Richter Geoscience, Inc. conducted a geophysical survey along Route 17 in Township D, Maine for the Maine Department of Transportation (MaineDOT) in November, 2006. The geophysical survey was performed in support of a geotechnical investigation of the Site by MaineDOT.

MaineDOT is undertaking a geotechnical design for the realignment of Route 17 in Township D, Maine. As part of the geotechnical design, MaineDOT requires information on the depth of bedrock along a section of the roadway from Station 31+50 to Station 35+00 for a slope stability analysis. Additionally, several sections of the highway are showing signs of slumping, indicating possible void formation or low density soils. MaineDOT requested a geophysical survey be conducted between Stations 32+00 and 35+00, 40+00 and 42+00, and 48+50 and 52+50 to identify the limits of voids or low density soils, if possible. According to information provided by MaineDOT, soils at the Site are generally comprised of sand, silt, and gravel over bedrock.

The objectives of the geophysical survey were 1) to provide information on the depth of bedrock along the specified section of the roadway alignment, and 2) to detect, and if detected, to locate areas of possible voids and low density soils along the specified sections of roadway alignment.

The geophysical survey consisted of a seismic refraction survey and a ground penetrating radar (GPR) survey. The seismic refraction survey was conducted along two survey lines between Stations 31+20 and 35+10. The traverses are located 22 feet left and 70 feet left of the proposed centerline of the realigned highway. The slope in this area is relatively steep and partially wooded. MaineDOT staked a baseline offset 40 left of the proposed centerline.

The GPR survey was conducted along a series of parallel traverses located in the active roadway between Stations 32+00 and 35+00, 40+00 and 42+00, and 48+50 and 52+50. MaineDOT had marked the location of the proposed centerline at 50-foot intervals in the active roadway.

Based on the results of the seismic refraction and GPR surveys conducted for the MaineDOT along Route 17 in Township D, Maine, we conclude:

- The depth of competent bedrock along the seismic line located 70 feet left of centerline varies between about 0.6 and 6.1 feet below ground surface.

- The depth of competent bedrock along the seismic line located 22 feet left of centerline varies between about 3.5 and 12.4 feet below ground surface.

- The elevation of competent bedrock along the seismic line located 70 feet left of centerline varies between about 2173.3 feet and 2157.6 feet for a total relief of 15.7 feet.

- The elevation of competent bedrock along the seismic line located 22 feet left of centerline varies between about 2190.8 feet and 2175.6 feet for a total relief of 15.2 feet.

- Two areas of disturbed soils possibly indicative of low density soils were detected in the vicinity of existing culverts. These areas are located near Stations 32+30 and 41+30.

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1. INTRODUCTION

Hager-Richter Geoscience, Inc. conducted a geophysical survey along Route 17 in Township D, Maine for the Maine Department of Transportation (MaineDOT) in November, 2006. The geophysical survey was performed in support of a geotechnical investigation of the Site by MaineDOT.

MaineDOT is undertaking a geotechnical design for the realignment of Route 17 in Township D, Maine. The general location of the Site is shown in Figure 1. As part of the geotechnical design, MaineDOT requires information on the depth of bedrock along a section of the roadway from Station 31+50 and 35+00 for a slope stability analysis. Additionally, several sections of the highway are showing signs of slumping, indicating possible void formation or low density soils. MaineDOT requested a geophysical survey be conducted between Stations 32+00 and 35+00, 40+00 and 42+00, and 48+50 and 52+50 to identify the limits of voids or low density soils, if possible.

The objectives of the geophysical survey were 1) to provide information on the depth of bedrock along the specified section of the roadway alignment, and 2) to detect, and if detected, to locate areas of possible voids and low density soils along the specified sections of roadway alignment.

The geophysical survey consisted of a seismic refraction survey and a ground penetrating radar (GPR) survey. The seismic refraction survey was conducted along two survey lines between Stations 31+20 and 35+10. The traverses are located 22 feet left and 70 feet left of the proposed centerline of the realigned highway. The slope in this area is relatively steep and the area is partially wooded. MaineDOT staked a baseline offset 40 left of the proposed centerline. The locations of the seismic lines are shown on Figure 2.

The GPR survey was conducted along a series of six or seven parallel traverses located in the active roadway between Stations 32+00 and 35+00, 40+00 and 42+00, and 48+50 and 52+50. MaineDOT had marked the location of the proposed centerline at 50-foot intervals in the active roadway. MaineDOT provided traffic control services for the work conducted.

Hager-Richter personnel were on-site on November 15-16, 2006. Jeffrey Reid, P.G., and Erik Rickert conducted the geophysical survey. The fieldwork was coordinated with Ms. Kitty Breskin, PE., of the MaineDOT. Ms. Breskin specified the areas of interest for the survey. Site Plans were received by Hager-Richter on December 13, 2006. Data analysis and interpretation were completed at the Hager-Richter offices. Original data and field notes will be retained in the Hager-Richter files for a minimum of three years.

2. EQUIPMENT AND PROCEDURES

2.1 Seismic Refraction Survey

2.1.1 General. The general equipment and procedures for seismic refraction surveys as conducted by Hager-Richter are described below. Details specific to this site are given in section 2.3, Site Specific.

We use two Geometrics Geode units connected to, and controlled by, a notebook PC computer. The software provides for the acquisition, display, plotting, filtering and storage of seismic data. The seismogram image presented in real time on the notebook screen allows the operator to verify the quality of the data. The stored digital data are transferred to floppy disks or CDs at the end of the field day for storage, backup, and future data processing.

The Geodes are coupled to two 24-element seismic spread cables for a total of 48 geophones. The geophones measure only the vertical component, and their resonant frequency is 14 Hz.

Seismic energy was provided by a 12-lb sledge hammer striking a steel base plate, an EWG, or a Betsy seisgun. The Betsy seisgun uses a shotgun blank as the seismic source and is not classified as a weapon or explosive under Federal regulations. The EWG is an accelerated weight drop, using industrial elastics to accelerate the weight. The number of stacks per shot point is variable, and the quality of the stacked seismic signal for each shot point was verified in the field with the paper record. Five shot points are used for each 48-geophone spread -- one off each end of the cable, one at each end of the cable, and one at the 24th geophone. This configuration provides reversed profiles. Shot points (and geophone locations, if necessary) are flagged in the field.

The seismic data are analyzed using the Generalized Reciprocal Method (GRM) of seismic refraction interpretation. The method is described in detail in Palmer (1980).[1] GRM allows for some variation in the surface topography as well as lateral variation in the seismic velocity of the upper layers. The method uses the principle of migration whereby the refractor need only be planar over a short distance, thus allowing the calculation of depth to an undulating interface. In addition, GRM is relatively insensitive to dip angles as high as 20°, unlike most other methods that can be sensitive to dips as low as 5°. GRM also allows for the calculation of depth below each geophone instead of below only the shot points as in the Time-Intercept and

[1] Palmer, Derecke (1980) The Generalized Reciprocal Method of Seismic Refraction Interpretation, Society of Exploration Geophysicists, 104 p.

Crossover Distance methods. The GRM software that we use for data analysis (GREMIX by Interpex) contains several internal tests for data consistency.

The results are used to construct an interpreted velocity profile of the subsurface for each seismic line. The velocities of seismic waves are functions of the types of geologic material through which they pass. One can thus infer the general subsurface stratigraphy from the velocities determined. Seismic velocities are expressed in feet per second (fps).

A widespread misconception about the seismic refraction method is that one cannot detect velocity inversions (layers of lower velocity material underlying higher velocity material) or hidden layers (layers of intermediate velocity too thin to produce first arrival signals), common conditions in stratified sediments. If present and undetected, such layers can cause large errors in the depths calculated for the various layers. However, using GRM, the presence of such layers can be inferred readily, and more importantly, the method uses average velocities for the detected and undetected layers to determine accurate depths to the refractors that are detected. Typical uncertainties in depths determined seismically are 10% or 2 feet, whichever is larger.

2.1.2 Limitations of the Method. Like all geophysical methods, the seismic refraction method is based on the assumption that the local geology is uncomplicated. In particular, the seismic refraction method assumes that interfaces between geologic materials correlate with sharp increases in seismic velocity and that the interfaces are relatively flat-lying. The method is not very sensitive to lateral variations within layers, and relatively subtle features such as fracture zones within bedrock are generally difficult to detect unless there is a topographic expression of the feature. The accuracy of the method is degraded in areas with strong topographic relief at the surface and/or where the interfaces have apparent dips greater than about 20°.

Where two materials do not exhibit contrasting velocities, or where velocities gradually increase with depth, a clear refracted signal is not generated, and the seismic refraction method cannot be used to distinguish the two materials. In some cases, the "geophysical contact" between materials with contrasting velocities does not correlate exactly with the "geologic contact." For example, where a highly weathered bedrock is overlain by a dense material such as till, the velocity range of the weathered bedrock might overlap or approach the velocity range of the till, and the two materials cannot be distinguished seismically. In such cases, the depth determined by seismic refraction is the depth of *competent* bedrock, which might be located at some depth below the geologic contact.

The depth relations of the water table and bedrock may constitute a significant problem for the seismic refraction technique. This problem is that of a "blind layer." A blind layer occurs where the thickness of the saturated overburden is less than about half the depth of bedrock. In such cases, the water-saturated material immediately above bedrock is "blind" in the sense that

no refracted seismic energy from it will be received as a first arrival of seismic energy, and all methods used to reduce the seismic data to determine the depth of bedrock, the objective of this survey, use *only* first arrivals. Thus, the saturated layer will not be detected where it is close to bedrock, and most methods of seismic data reduction will indicate that bedrock is considerably deeper than it actually is. Although GRM, the method used by Hager-Richter to reduce the seismic refraction data, does not use first arrivals through the water saturated zone (because there is none to use) in such cases, GRM determines the depth of bedrock correctly by using the *average* velocity of the saturated and unsaturated zones.

A "hidden layer" occurs where a lower velocity material underlies a higher velocity material, a common situation in stratified sediments. An example is where sands are present under layers of clay or till. As in the case of a "blind layer," most methods of seismic refraction data reduction will indicate that bedrock is considerably shallower than it actually is, if a hidden layer is present but not detected. Internal tests in the seismic refraction data reduction software that we use (GREMIX by Interpex) indicate that such layers might be present, and an average velocity of the two layers is used to determine the depth of bedrock.

2.1.3 Site Specific. The area of interest was specified by MaineDOT. The seismic refraction survey consisted of two lines totaling 690 feet. A geophone spacing of 10 feet was used for all seismic lines. The seismic source was a 12 lb hammer striking a steel baseplate. At least six shot points were used per spread -- two located internal to the spread, one at each end of the spread, and two off-end shots. The seismic line locations were tied to the proposed centerline of the roadway shown on plans provided by MaineDOT.

2.2 Ground Penetrating Radar Survey

2.2.1 General. The general equipment and procedures for GPR surveys as conducted by Hager-Richter are described in this section. Details specific to this site are given below in section 2.2.3, Site Specific.

The GPR survey was conducted using a Sensors and Software Noggin Plus digital GPR system. The system includes a survey wheel to trigger recording of the data at equal intervals. The transmit/receive antenna is housed in a box that is moved across the surface. The antenna transmits electromagnetic signals into the subsurface and then detects, amplifies, and displays reflections of the signals in real-time on the monitor and stores the data in digital form. The result is a digital radar record of the subsurface.

The maximum depth of penetration of the GPR signal and the resolution of the reflections are controlled in part by the frequency of the antenna used and in part by the electrical properties of the subsurface. Hager-Richter owns antennas with the following center frequencies: 120

MHz, 250 MHz, 300 MHz, 500 MHz, and 1000 MHz. The total time during which radar signals are recorded can be varied from a few to 1,000 nanoseconds (ns). However, there is a trade-off between total time, corresponding to depth range, and resolution. As the total time of recording is increased, the resolution of the GPR records decreases. For a given site, the total time window is set to detect features located somewhat below the maximum expected target depth.

The horizontal axis of a GPR record represents distance across the surface and the vertical axis represents round-trip travel time of the radar signal. For those sites where the subsurface is electrically heterogeneous, the travel times of the radar signal may be different in the various materials, and the vertical scale for the radar records is not necessarily uniform with depth.

The reflections in a GPR record are produced by spatial changes in the physical properties (e.g., type of material, subsurface fluids, porosity, etc.) and related changes in the electrical properties (dielectric constant) of the subsurface materials in the path of the signals. The greater the difference in electrical properties between two materials in the subsurface, the stronger the reflection observed in the GPR record.

The size, shape, and amplitude of the GPR reflections are the characteristics that are considered in the interpretation of the data from any site. Because the electrical properties of air filled voids and low density soils differ significantly from those of the surrounding soil, such features can produce GPR reflections with high amplitude and distinctive shapes that permit identification. Most other objects, although readily detectable, require "ground truth" for identification. Only excavations provide positive identification for most objects detected in GPR surveys.

2.2.2 Limitations of the Method. The maximum depth to which GPR signals can penetrate depends on the electrical properties of the subsurface materials. The higher the electrical conductivity of the subsurface materials, the lower the radar signal penetration. Clay minerals and/or brackish water in the subsurface, for example, attenuate the GPR signal, so reflections are not received from materials at greater depths.

There are limitations of the GPR technique as used to detect and/or locate particular targets: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical conductivities of the targets and the ground, and (4) spacing between lines. Of these limitations, only the fourth, line spacing, is controlled by the operator.

The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna

with the ground. In many cases, the GPR signal will not penetrate below concrete pavement, and a target may not be detectable.

The electrical conductivity of the ground determines the attenuation of the GPR signals, and thereby limits the maximum depth of exploration. The GPR signal does not penetrate clay-rich soils, and targets buried in clay can be missed.

A contrast in the electrical conductivities of the ground and the target is required to obtain a reflection of the GPR signal. If the contrast is too small, possibly due to extremely corroded conditions of a metal target, then the reflection may be too weak to recognize, and the target can be missed.

The spacing between lines is under control of the GPR operator, and the design of the survey is based on the dimensions of the smallest target of interest. Targets with dimensions smaller than the spacing between GPR survey lines can be missed.

Interpretation of GPR data is subjective. As noted above, "ground truth" through correlation with borings and excavations is required for positive identification of most objects detected on the basis of GPR data.

2.2.3 Site Specific. The GPR survey was conducted along a series of six or seven parallel traverses located in the active roadway from Stations 32+00 to 35+00, 40+00 to 42+00, and 48+50 to 52+50. MaineDOT had marked the location of the proposed centerline at 50-foot intervals in the active roadway. MaineDOT provided traffic control services for the work conducted in the active roadway. The GPR survey consisted of 14 lines totaling approximately 6,100 feet of traverse.

3. RESULTS AND DISCUSSION

3.1 Seismic Refraction Survey

3.1.1 General. The seismic refraction survey consisted of two seismic lines designated as Seismic Lines 1 and 2. The locations of the seismic lines are shown in Figure 2. The results of the survey are shown in profile form in Figures 3 and 4 and are listed in Table 1.

3.1.2 Data Quality. The quality of the seismic refraction data for all lines is good to very good. Vibration "noise" from traffic impacted the quality of the seismic signals slightly.

A measure of the accuracy of the data can be obtained by comparing the depths determined seismically with those of borings that intersect bedrock. MaineDOT provided tabular information on the depth of refusal for probes conducted along the alignment. The depths of bedrock as reported by MaineDOT were compared with the interpolated depths of bedrock determined from the seismic data for Seismic Line 2. The depths compare well as shown in Table 2 and we judge that the data are consistent with a standard deviation of about 10 %.

3.1.3 Interpretation of Velocities. Materials with two distinct velocity ranges were detected at the Site. Materials with a velocity range of 1100 fps to 1500 fps and are interpreted to consist of unsaturated soils and sediments.

The lower material exhibits a velocity range of 12300 fps to 16200 fps and is interpreted to be competent bedrock. Where the top of bedrock is highly fractured and/or deeply weathered, it might exhibit lower velocities that cannot be detected as a distinct layer on the basis of the seismic refraction data. Thus, the top of rock determined on the basis of seismic refraction data generally is the top of *competent* bedrock, which might be located somewhat below the geologic contact between the overburden and bedrock.

3.1.4 Bedrock Depths and Configuration. Figures 3 and 4 indicate that the bedrock surface generally follows the ground surface with some minor variations. The depth of competent bedrock along Seismic Line 1 varies between about 0.6 and 6.1 feet below ground surface, and the depth of competent bedrock along Seismic Line 2 varies between about 3.5 and 12.4 feet below ground surface. The elevation of competent bedrock along Seismic Line 1 varies between about 2173.3 feet and 2157.6 feet for a total relief of 15.7 feet, and the elevation of competent bedrock along Seismic Line 2 varies between about 2190.8 feet and 2175.6 feet for a total relief of 15.2 feet.

3.2 Ground Penetrating Radar Survey

3.2.1 General. The GPR survey was conducted along a series of six or seven parallel traverses located in the active roadway from Stations 32+00 to 35+00, 40+00 to 42+00, and 48+50 to 52+50. The locations of the traverses and our interpretation of the data for Stations 32+00 to 35+00, 40+00 to 42+00, and 48+50 to 52+50 are shown on Figures 5-7, respectively.

3.2.2 GPR Signal Penetration. GPR data were acquired using a 250 MHZ antenna and an 80 nsec time window. Apparent GPR signal penetration varied from fair to excellent, with two-way traveltime reflections received for 10 to 80 nsec. Based on handbook time-to-depth conversions for the GPR signal in average soils, the GPR signal penetration is estimated to have ranged from about 2-10 feet.

3.2.3 Results. The GPR records for the Site contain reflections typical of sedimentary structures, gravel and boulders, possible bedrock, culverts, and two areas of disturbed soils. The areas of disturbed soils are present around the locations of two culverts that cross the highway at 32+30 and 41+30. Significant slumping of the roadway is also present at these locations. We infer that the disturbed soils are indicative of low density soils where the soil may be moving laterally to areas of lower elevation. Reflections typical of voids were not observed in the data for the Site.

4. LIMITATIONS

This report was prepared for the exclusive use of the Maine Department of Transportation (Client). No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by Client or any third party shall be at Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the preparation of this Report consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and are not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

Geophysical Survey
Route 17 Realignment
Township D, Franklin County, Maine
PIN 8670.10
File 06J19 December, 2006

HAGER-RICHTER GEOSCIENCE, INC.

TABLE 1
SEISMIC REFRACTION SURVEY RESULTS
ROUTE 17 REALIGNMENT
TOWNSHIP D, MAINE

Station (feet)	Surface Elevation (feet)	Bedrock Depth (feet)	Bedrock Elevation (feet)
Seismic Line 1			
3120	2168.8	1.0	2167.8
3130.0	2168.6	1.0	2167.6
3140	2168.5	1.0	2167.5
3150	2168.3	2.1	2166.2
3160	2168.2	2.4	2165.8
3170	2168.0	3.0	2165.1
3180	2168.0	2.3	2165.7
3190	2168.0	1.7	2166.3
3200	2168.0	0.6	2167.4
3210	2168.0	0.8	2167.2
3220	2168.0	2.1	2165.9
3230	2167.0	3.4	2163.6
3240	2165.6	4.7	2160.8
3250	2164.8	5.5	2159.3
3260	2164.5	5.8	2158.7
3270	2164.2	6.1	2158.1
3280	2163.5	5.4	2158.1
3290	2163.5	5.9	2157.6
3300	2164.0	5.6	2158.4
3310	2164.0	5.4	2158.6
3320	2164.3	6.0	2158.4
3330	2165.3	4.7	2160.6
3340	2166.8	2.6	2164.2
3350	2168.3	2.7	2165.6
3360	2169.8	3.9	2165.9
3370	2171.2	4.2	2167.0
3380	2172.4	3.8	2168.6
3390	2173.6	3.1	2170.6
3400	2175.0	3.4	2171.6
3410	2175.0	2.2	2172.8
3420	2175.0	2.3	2172.7
3430	2175.0	2.2	2172.8
3440	2175.0	2.1	2172.9
3450	2175.0	1.7	2173.3
3460	2174.2	1.4	2172.9
3470	2173.3	1.0	2172.3
3480	2172.8	1.0	2171.8
3490	2172.5	1.0	2171.5
3500	2172.3	1.0	2171.2
3510	2172.0	1.0	2171.0

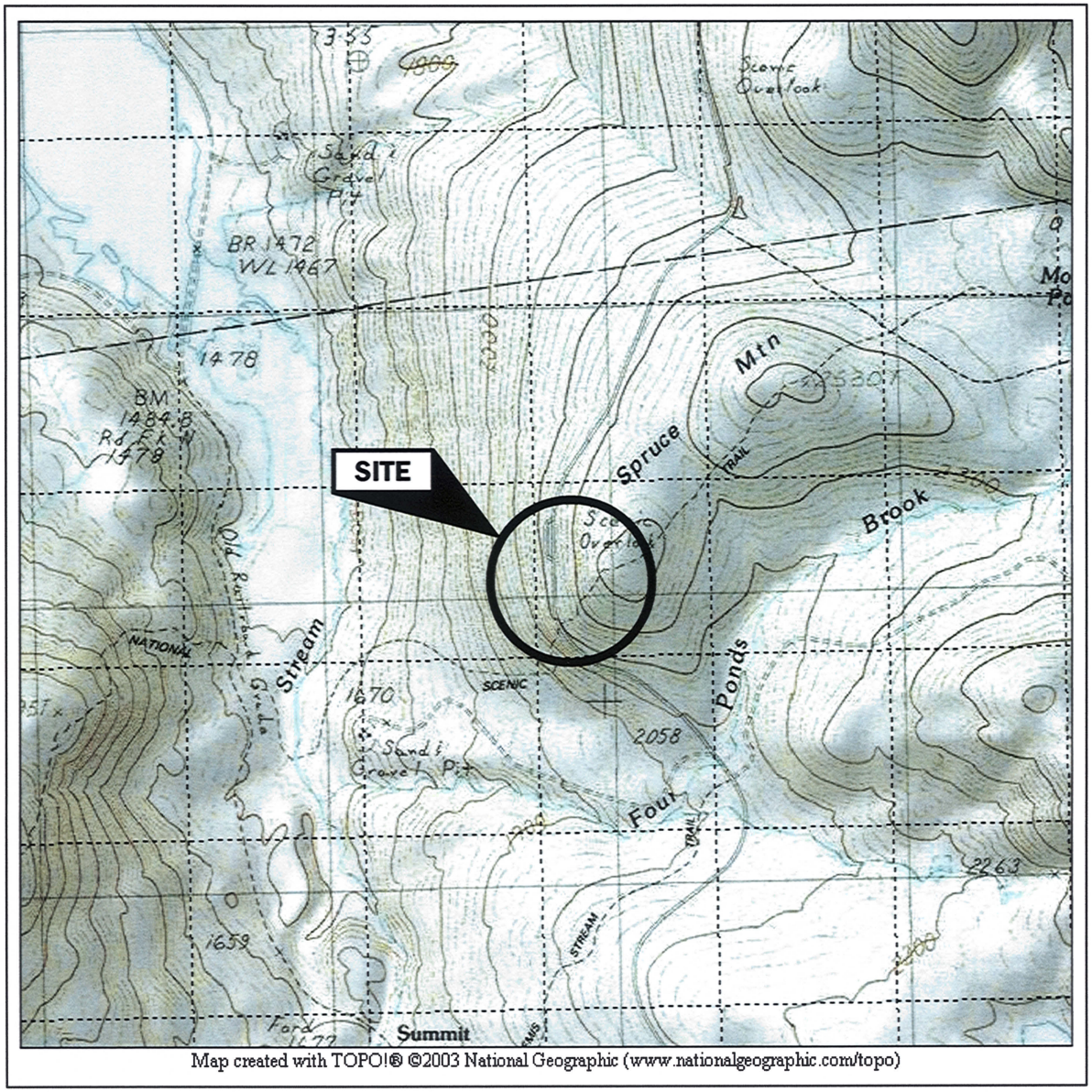
Station (feet)	Surface Elevation (feet)	Bedrock Depth (feet)	Bedrock Elevation (feet)
Seismic Line 2			
3120	2187.9	10.1	2177.8
3130	2187.9	11.1	2176.8
3140	2187.9	11.1	2176.8
3150	2188.0	12.2	2175.8
3160	2188.0	12.4	2175.6
3170	2188.0	12.0	2176.0
3180	2188.0	11.6	2176.4
3190	2188.0	11.2	2176.8
3200	2188.0	11.1	2176.9
3210	2188.0	9.1	2178.9
3220	2188.0	7.1	2180.9
3230	2188.0	6.8	2181.2
3240	2188.0	6.4	2181.6
3250	2188.2	6.8	2181.4
3260	2188.5	7.5	2181.0
3270	2188.8	7.4	2181.4
3280	2189.1	7.6	2181.5
3290	2189.9	7.1	2182.8
3300	2190.5	6.7	2183.8
3310	2191.1	6.3	2184.8
3320	2191.7	5.6	2186.1
3330	2192.4	4.9	2187.5
3340	2193.3	3.8	2189.5
3350	2194.3	3.5	2190.8
3360	2195.4	5.5	2189.9
3370	2196.4	7.8	2188.6
3380	2197.1	9.7	2187.4
3390	2197.6	10.5	2187.1
3400	2198.0	12.2	2185.8
3410	2198.3	10.3	2188.0
3420	2198.5	9.6	2188.9

Estimated standard deviation of depth of bedrock is 10% or 2 feet, whichever is greater. Depths of bedrock determined here are depths of competent bedrock. Weathered or highly fractured bedrock may occur at shallower depths. Elevations for seismic lines taken from plans provided by Maine DOT.

TABLE 2
COMPARISON OF BEDROCK DEPTHS
ROUTE 17 REALIGNMENT
TOWNSHIP D, MAINE

Seismic Line Location / Probe			Distance from Seismic Line to Probe	Bedrock Elevations (feet)		Difference	
				Seismic Line	Probe	Feet	Percent
Line 2 31+50	/	Probe 31+50	9' E	12.2	11.9	0.3	2.5%
Line 2 32+00	/	Probe 32+00	9' E	11.1	11.9	0.8	7.2%
Line 2 32+25	/	Probe 32+25	10' E	7.0	6.4	0.6	8.6%
Line 2 33+00	/	Probe 33+00	10' E	6.7	7.1	0.4	6.0%
Line 2 33+50	/	Probe 33+50	10' E	3.5	2.3	1.2	34.3%
Line 2 34+00	/	Probe 34+00	10' E	12.2	14.1	1.9	15.6%
Line 2 34+20	/	Probe 34+25	15' SE	9.6	7.6	2.0	20.8%
					Average	1.0	13.6%
					Standard Deviation	0.7	11.1%

Probe information provided by MaineDOT.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

LOCATION

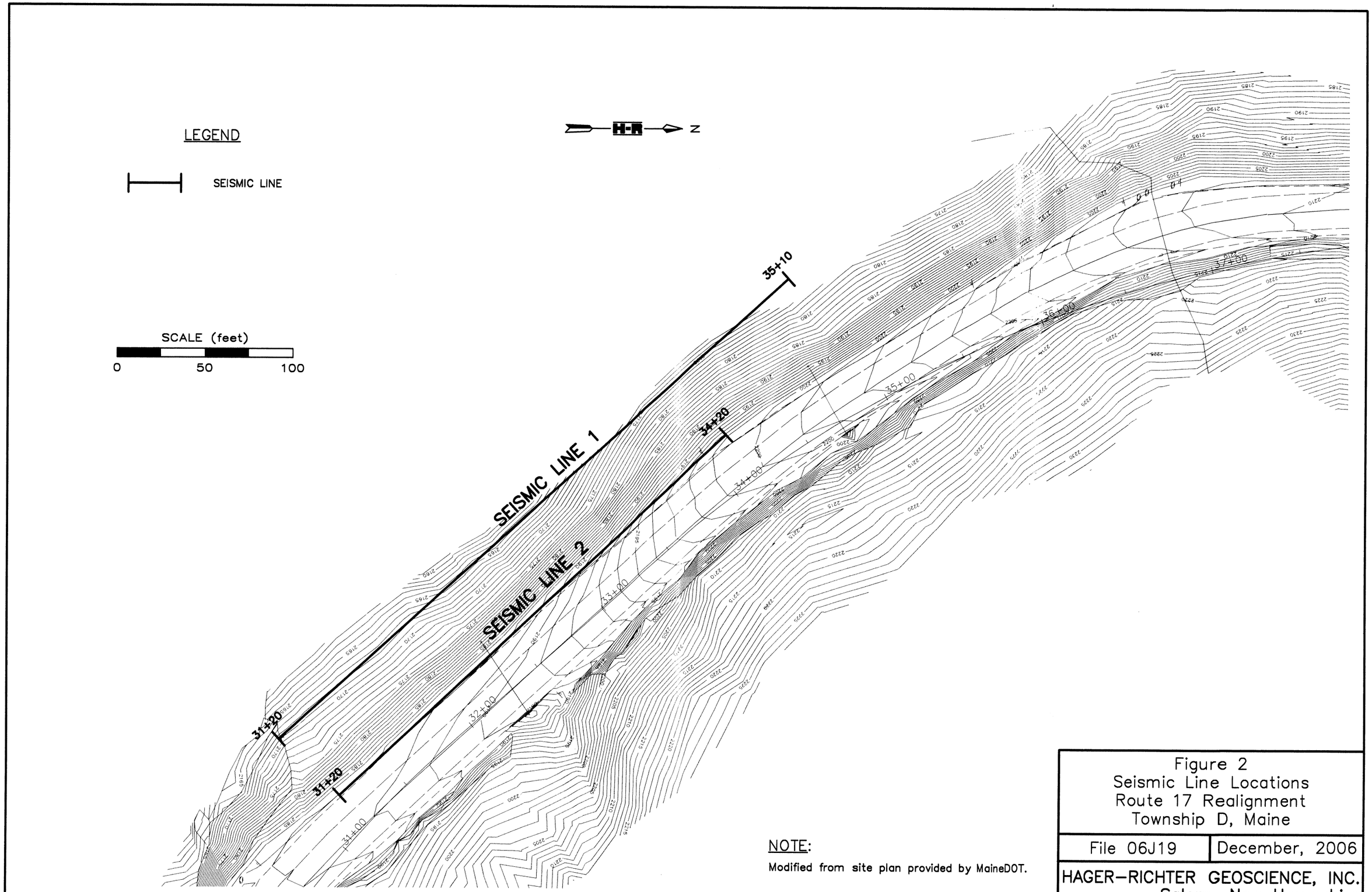
SCALE (feet)

0 2000 4000

Figure 1
General Site Location
Route 17 Realignment
Township D, Maine

File 06J19	December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

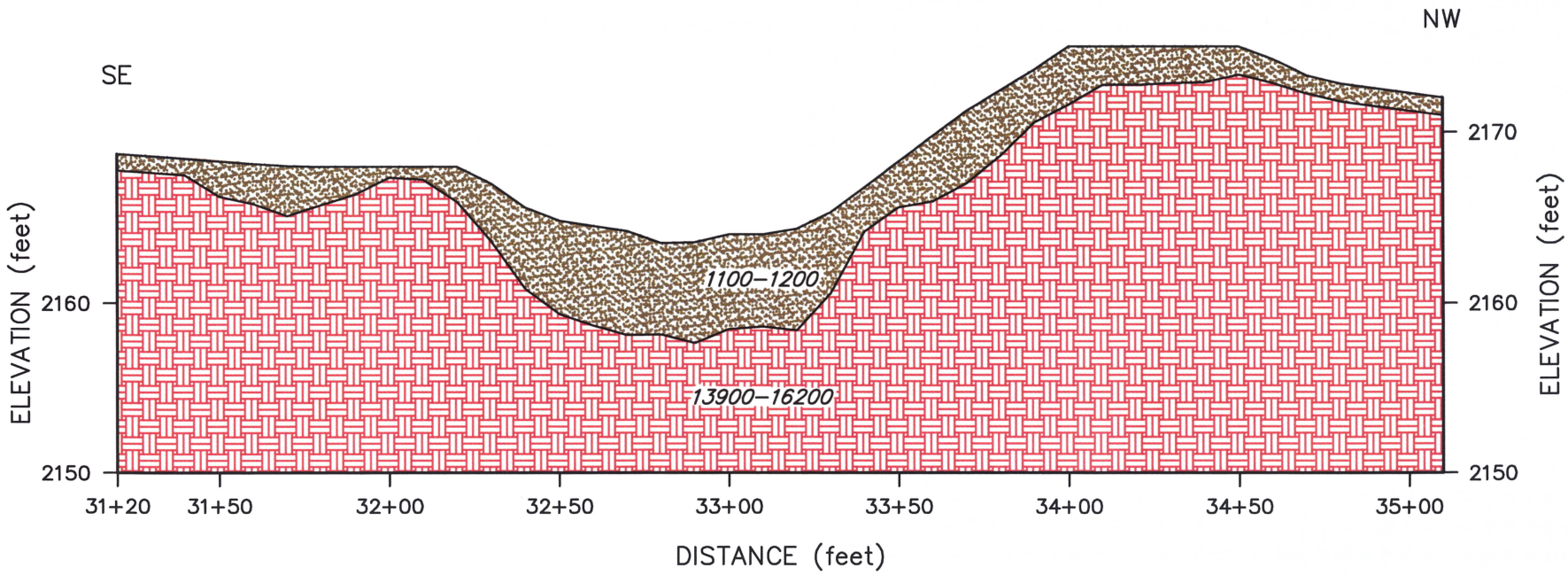


NOTE:
Modified from site plan provided by MaineDOT.

Figure 2
Seismic Line Locations
Route 17 Realignment
Township D, Maine

File 06J19	December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



HORIZONTAL SCALE (feet)

0 50 100

Vertical Exaggeration = 5X

LEGEND

Unsaturated soils

Competent bedrock

13900–16200 Velocity (fps)

Interface determined from seismic refraction data

31+50 9'E R — Probe with stationing, distance from traverse, and depth of refusal, based on data provided by MaineDOT

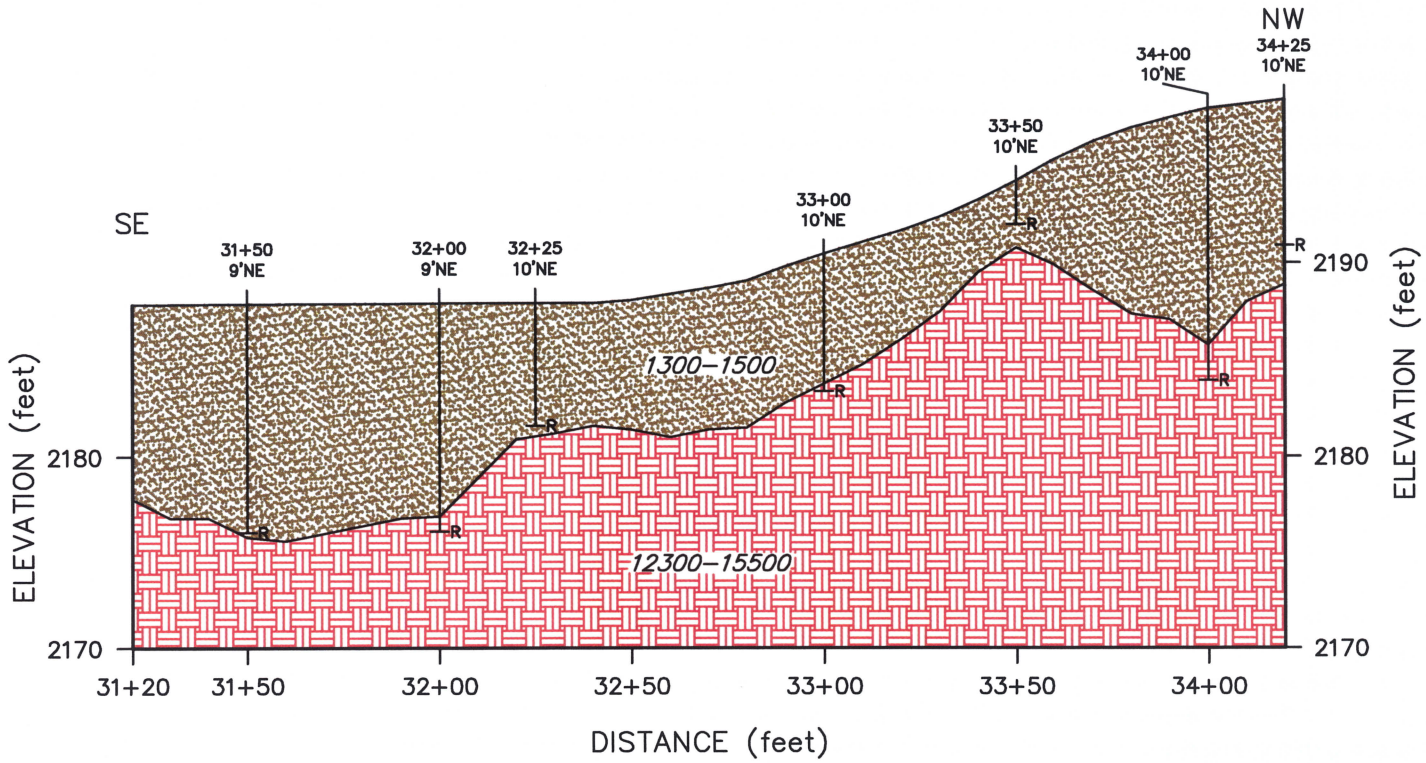
NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of relatively competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by MaineDOT.
4. Data were analyzed using the Generalized Reciprocal Method.

Figure 3
Seismic Line 1
Route 17 Realignment
Township D, Maine

File 06J19 | December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



HORIZONTAL SCALE (feet)

0 50 100

Vertical Exaggeration = 5X

LEGEND

	Unsaturated soils
	Competent bedrock
13900–16200	Velocity (fps)
	Interface determined from seismic refraction data
31+50 9'E R	Probe with stationing, distance from traverse, and depth of refusal, based on data provided by MaineDOT

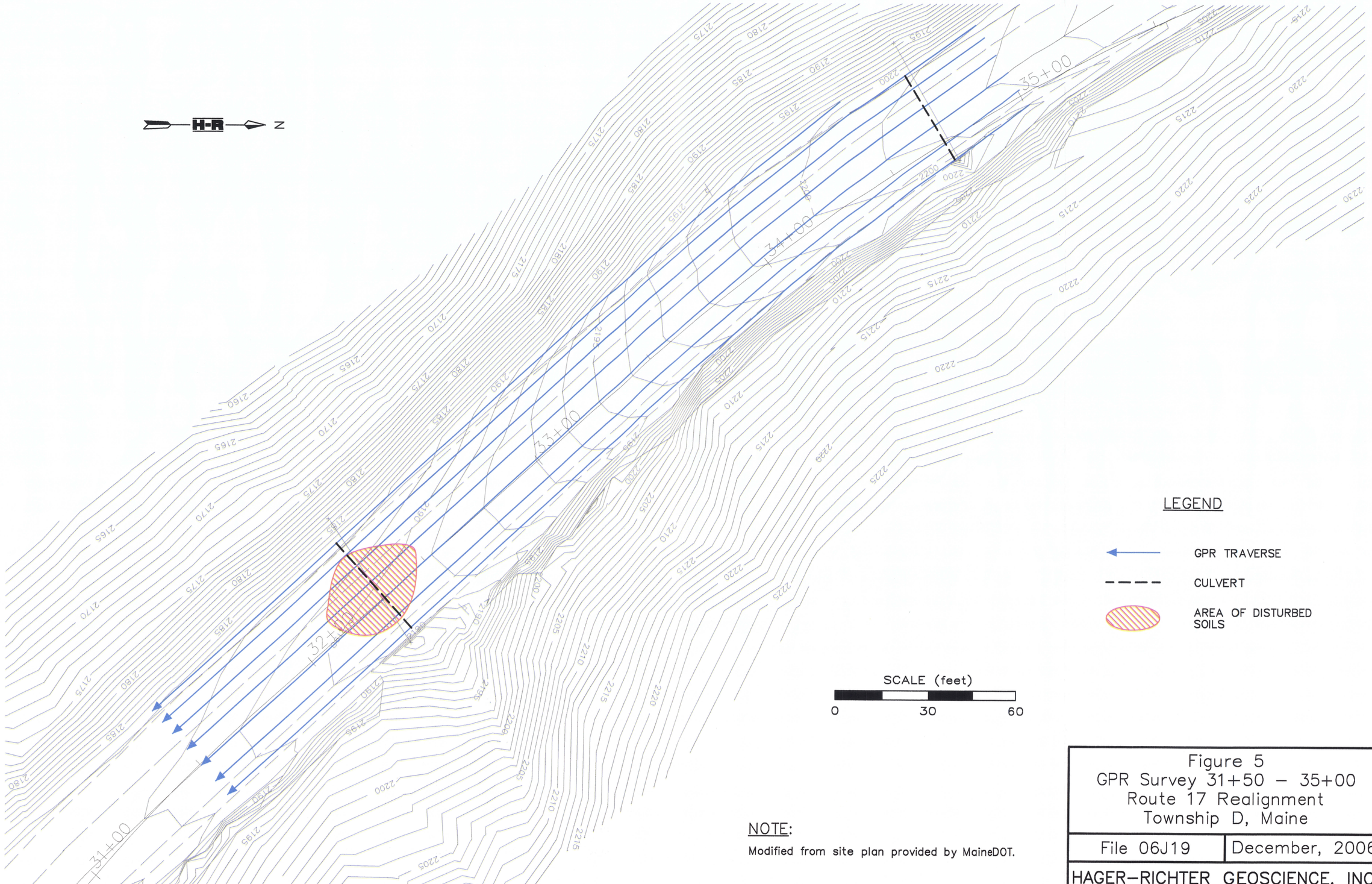
NOTES:

1. Estimated standard deviation of depth of bedrock is ±10% or 2 feet, whichever is greater.
2. The depths determined for bedrock are depths of relatively competent rock; weathered and/or fractured bedrock might occur at shallower depths.
3. Surface elevations determined from plans provided by MaineDOT.
4. Data were analyzed using the Generalized Reciprocal Method.

Figure 4
Seismic Line 2
Route 17 Realignment
Township D, Maine

File 06J19 | December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire

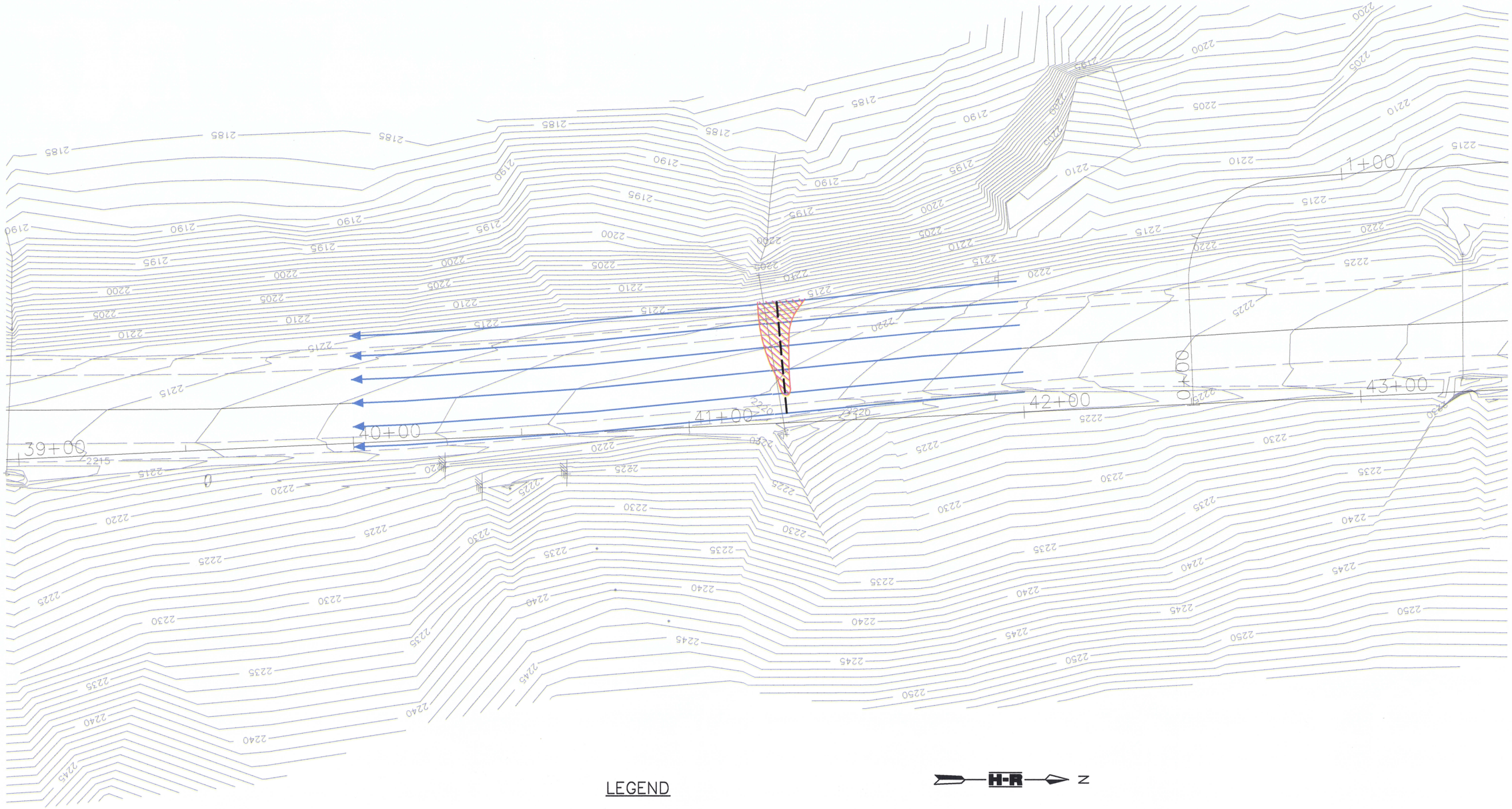


NOTE:
Modified from site plan provided by MaineDOT.

Figure 5
GPR Survey 31+50 – 35+00
Route 17 Realignment
Township D, Maine

File 06J19	December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

GPR TRAVERSE

CULVERT

AREA OF DISTURBED SOILS

SCALE (feet)

0 30 60

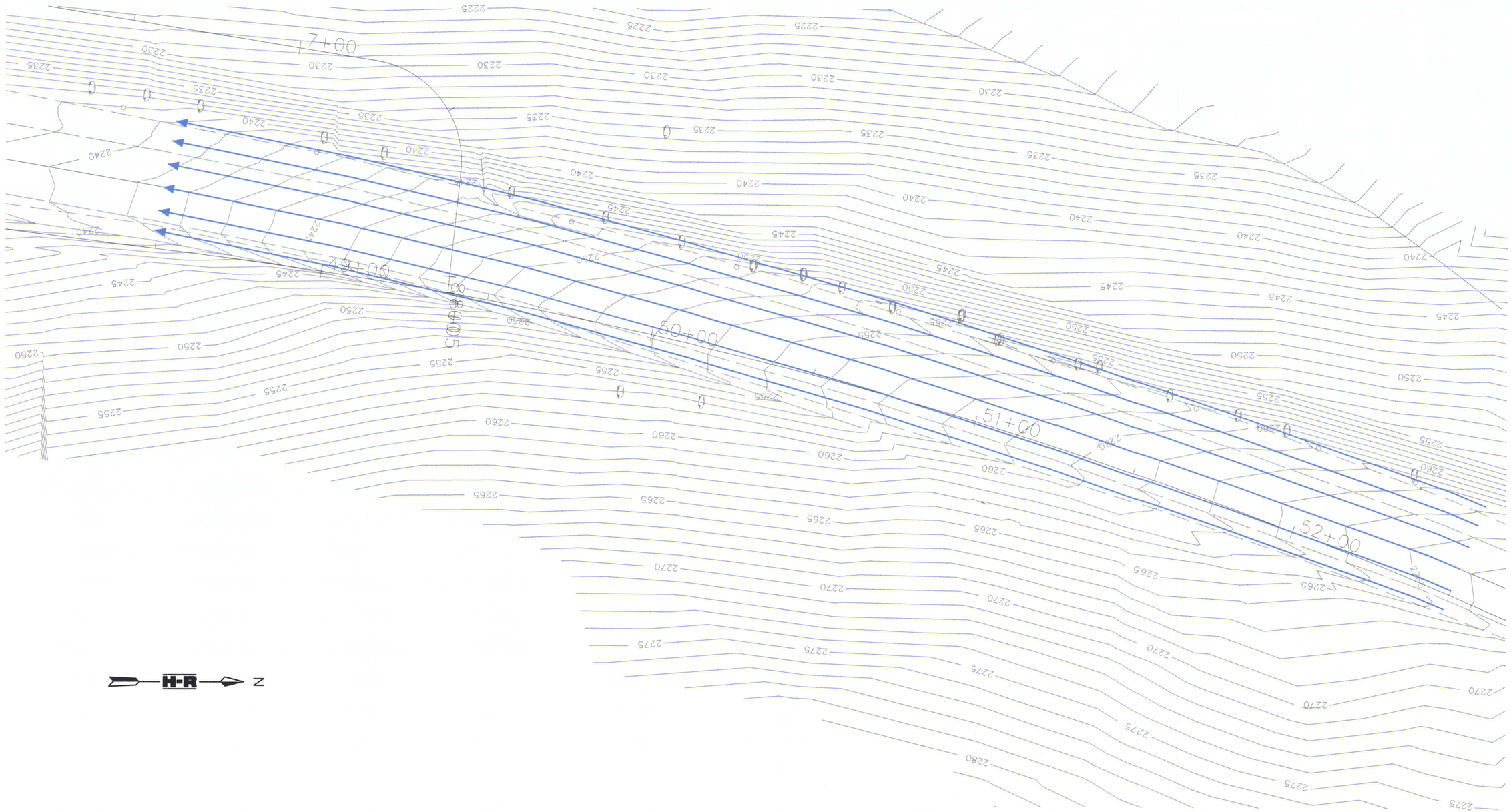
NOTE:

Modified from site plan provided by MaineDOT.

Figure 6
GPR Survey 40+00 – 42+00
Route 17 Realignment
Township D, Maine

File 06J19	December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire



LEGEND

GPR TRAVERSE

SCALE (feet)

0 30 60

NOTE:

Modified from site plan provided by MaineDOT.

Figure 7
GPR Survey 48+50 – 52+50
Route 17 Realignment
Township D, Maine

File 06J19	December, 2006

HAGER–RICHTER GEOSCIENCE, INC.
Salem, New Hampshire