The Redington Wind Farm

Section 11: Soils

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1.0 Introduction

Redington Mountain Wind Farm LLC is proposing to develop an electric generating facility from wind turbines. The project will include roadway access up the mountainside and wind turbine sites along the ridge lines of *Mount Redington* and *Black Nubble*. The purpose of the soil information is to assist in developing erosion and sediment control methods applicable to anticipated situations of combinations of soil conditions, drainage and slopes. (See Appendix C pre-application letter regarding soil information requirements) The soil information was used in coordination to develop erosion and sediment control, and stormwater management techniques to address LURC standards, specifically (10.25G). Engineering specifications of Deluca-Hoffman are designed to meet or exceed these standards.

2.0 Soil Information Used During Impact Assessment and Erosion and Sediment Control, Stormwater and Stability

The information utilized to assess the impacts of the proposed project on the soil resources and to develop erosion and sediment control methods, includes field observation of soils on portions of road alignment, and available NRC Service soil survey worksheets.

2.1 Field Surveys

2.1.1 Soils

Albert Frick Associates excavated hand-dug shovel test pits on August 22, 1994, August 23, 1994, September 22, 1994, September 11, 2001, and June

13, 2005, along proposed road alignments. The United States National Resource Conservation Services field soil survey sheets for the immediate area were assembled by Albert Frick Associates and registered onto the project CAD site plan. (See Appendix A-1 for Soils Map, Appendix B for Soil Narrative Report)

The soils information from earlier proposal effort (1994) of the Redington Ridge alignment was done with hand-dug shovel test pits along the proposed alignment. Hand shovels and hand augers were used in remote areas due to the inaccessibility of mechanical excavators at that time. Hand tools have limited ability to gather soils information due to the very stony surface horizons. (See Photo 1) It was determined and agreed upon by working with LURC, DEP and Soil and Water Conservation personnel during field reviews and workshops during the 1994 project phase that integration of the anticipated soil conditions, grades, and soil drainage would be more meaningful for the permitting process. (See Appendix C, Albert Frick letter of October 13, 2003 to David Rocque).

Photo 1: Extremely stony surface phase encountered in segments of proposed road on Redington Ridge. Photographed by A.F. 8/22/2003.

The soils occupying the project where the new road work and windfarm tower pads are to be constructed, are predominantly soils derived from glacial till sediments. The soils information of the 2003 project phase was redirected at integrating the anticipated soil characteristics that would be encountered by the road construction and wind tower sites with erosion and sediment control methodology, specification and details, as recommended by LURC soils technical review staff.

The lower valleys with the entry roads contain pockets of soil derived from stratified drift *Colton* and ablation till *Hermon* (See B.4 and B.6).

The mountain peaks, mountain ranges, and higher elevation are areas where the shallow to bedrock thin soils are encountered (*Lyman, Ricker, Saddleback, Tunbridge* (See B.7, B.11, B.12 and B.17).

In the higher positions in the uplands along the mountain side slopes, the well drained glacial tills of *Marlow*, *Monadnock*. *Sisk* are encountered. (See B.9, B.10, and B.14).

The middle position in the mountain side slope exhibits the moderately well drained glacial till soils of *Chesuncook*, *Dixfield* and *Surplus*. (See B.2, B.5, and B.15).

In the lower mountain side slopes in the uplands, and in borders of drainage swales are found the somewhat poorly drained *Colonel*, *Telos* soils (See B.3 and B.16)

The lowest portion on the mountain side slopes and within drainage swales encounter the poorly drained hydric soils (wetland) of *Brayton* (see B.1). Typically, directly beneath steep mountain side slopes are *Mahoosic* soils (see B.8), which are derived from colluvium boulders, cobbles derived from broken bedrock fragments breaking off from steep bedrock side slopes.

The specific soil characteristics and limitations for the soils within the proposed project are discussed in the soil narrative report. DeLuca-Hoffman Engineers have selected and designed roadway details, back slope details, ditch details, erosion control details and fill slope details (see Section 1, Appendix 2.2 Engineering Plans C-21, C-22, C-23, C-24 and C-25, respectively.

*2.1.2 Soil Utilization for Erosion and Sediment Control on Road Construction Workshop_*

Redington Mountain Wind Farm design team sought native road construction knowledge and experience by interviewing local excavating contractors and

local forestry companies (i.e. Jim Brochu, *Brochu Excavation*, Peter DelFonso, *M & H Construction*, and Gary Voisine, *Voisine Brothers*). Excavating contractors reviewed *Redington Mountain Wind Farm* proposed road sections for input and Redington Mountain Design Teams reviewed existing high elevation forestry roads to examine practices, methodology, specification and experience of high elevation road construction techniques that are effective, practical and environmentally sound.

A field workshop was held on November 12, 2003 with *David Rocque*, State Soil Scientist of the Soil and Water Conservation Commission, *John Nelepovitz*, Senior Forester in charge of forestry road construction for the northern Region of International Paper Company, *Dwight Anderson*, Professional Engineer of Deluca-Hoffman, *Bill Conners*, Project Manager at that time for Endless Energy and *Albert Frick*, Soil Scientist.

This field workshop visited several miles of high elevation (2400' to 2700') existing roadways that had been constructed on similar soils that *Redington Wind Farm* project will encounter with identical growing season, similar topography and drainage characteristics (see Figure 1 for road sections examined). (See Photos 2 and 3 for typical soil road cuts observed).

Photo 2: Existing high elevation road cut at Seven Ponds TWP at 2,600'+/-. Photo illustrates typical strong surface horizon over glacial basal till substratum. Location not in project area, however, used as available example of deep road cut in high elevation mountainous area, exhibiting typical very stony soil surface over firm basal till. Photographer A.F. 11/12/2003.

Photo 3: Existing road profile at Seven Ponds TWP at 2,500'+/-. Photo illustrates stony surface horizon over deep glacial till substratum. Photographer A.F. 11/12/2003.

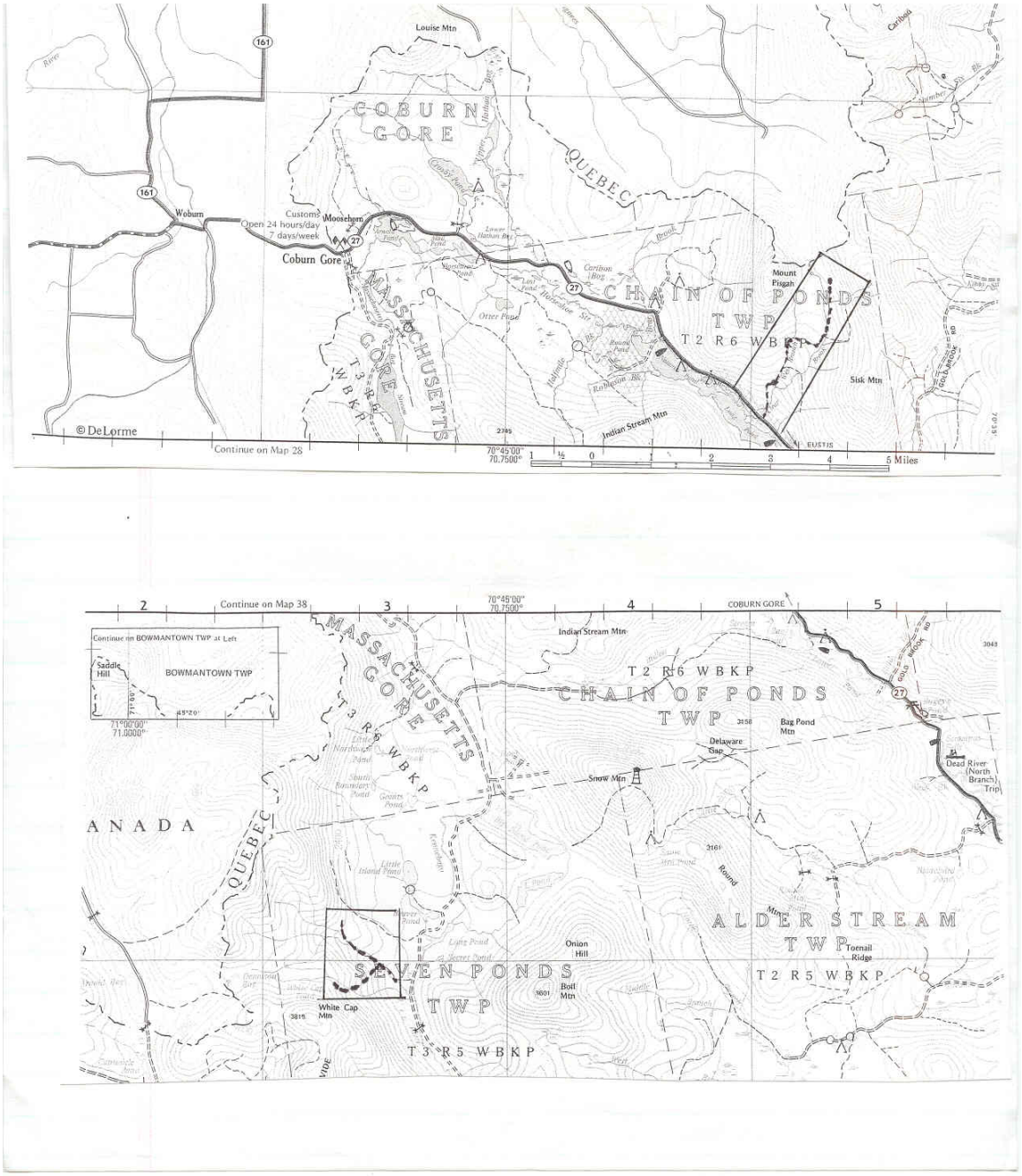


Figure 1: Existing higher elevation roads examined during November 12, 2003 field workshop with David Rocque, State Soil Scientist, John Nelepovitz, Senior Forester for International Paper Company, Dwight Andersen, P.E., Bill Conners and Albert Frick at 2,400' to 2,700'.

Redington Wind Farm design team, after examining existing high elevation steep gradient roadways, evaluated techniques that were found to be effective, and translated and integrated local “know-how” into engineering specifications, and erosion and sediment control details. Additionally, DeLuca-Hoffman, S.W. Cole, and Albert Frick Associates provided special erosion/sediment control methods and road construction methods that will need to be utilized in special highly sensitive segments of the proposed roadway.

TABLE 1. EXISTING AND PROPOSED ROADWAY LENGTHS

1. Length of Existing Roads

Roadway Segment	Distance (ft)
I.P. Road from Rte 16 to tee intersection just past Maintenance Building Lot.	25,600
Road segment [tee intersection to Black Nubble (includes portion of RE2)]	13,200
Road segment from tee intersection start of RE6B	16,300
Road to Substation	2,000
TOTAL	**57,100**

Note: Does not include existing access roads from Route 27 to transmission line.

2. Length of Proposed Roads

Roadway Segment	Distance (feet)
Redington Ridge Mountain Top	18,800
Black Nubble Mountaintop	26,800
Access Roadway to Redington Range	9,600
Access Roadway to Upper Black Nubble Mountain	6,275
Access Roadway to Lower Black Nubble Mountain	500
Access Roadway to Substation	400
Power line Access Roadway	3,300
TOTAL	**65,675**

3. Length of portion of Proposed Roads in areas where existing grade exceeds 20%

Roadway Segment	Distance (feet)
Redington Ridge Access Roadway	8,300
Redington Ridge Summit Roadway	3,500
Lower Black Nubble Principal Roadway	2,025
Upper Black Nubble Principal Roadway	100
Black Nubble Summit Roadway	12,500
Access Roadway to Substation	0
Power line Access Roadway	1,650
TOTAL	**29,375**

Note: The above data provides approximate roadway lengths which may change as spur locations are adjusted to reflect updated turbine locations.

3.0 Soil Impact Assessment of Roadway and Wind Farm Pad Development on Soil Erosion and Sediment Control

The array of soil characteristics likely to be encountered along with slope gradients, and soil drainage classes were input into the erosion and sediment control methodology analyzed by DeLuca-Hoffman Civil Engineers, S.W. Cole Geotechnical Engineers and Geologists and Albert Frick Associates, Soil Scientists.

The predominant soil parameters driving *the erosion and sediment control measures* are soil drainage, presence of concentrated surface flows (streams, seeps), soil depth, slope gradient, stoniness, soil textured, soil organics (thixotrophic) and growing season. Following is a summary of the analysis of the soil characteristics listed above and the proposed **treatments** of the erosion and sediment methods that are proposed to address the issues:

3.1 Soil Drainage/Concentrated Surface Flow (streams, seeps):

Whenever the proposed roadway cross-cut intercepts a stream, major ground water seep (spring) or a natural wetland swale(see Photos 4, 5, 6 and 7), a properly sized culvert, of the correct diameter, will be installed to collect and channel the flow from above the roadway and convey it directly downslope to be a proper outlet with appropriate stabilization (e.g. plunge pool, armored rip-rapped channel, etc.). (See Section 1, Appendiz 2.2 Engineering Plan C-21, C-22, C-23, C-24 details).

The proposed road will be intercepting natural slope drainage, in order to maintain as much natural sheet flow as practical. Cross drainage detail (see

Section 1, Appendix 2.2 Engineering Plans, C-20A, C-20B) is designed to provide for cross flow seepage underneath proposed road beds.

Photo 4: Typical major ground water seep area encountered in mountainous road cut. Photograph by Albert Frick, 11/12/2003.

Photo 5: Typical mountain stream. Photograph by A.F. 11/12/2003.

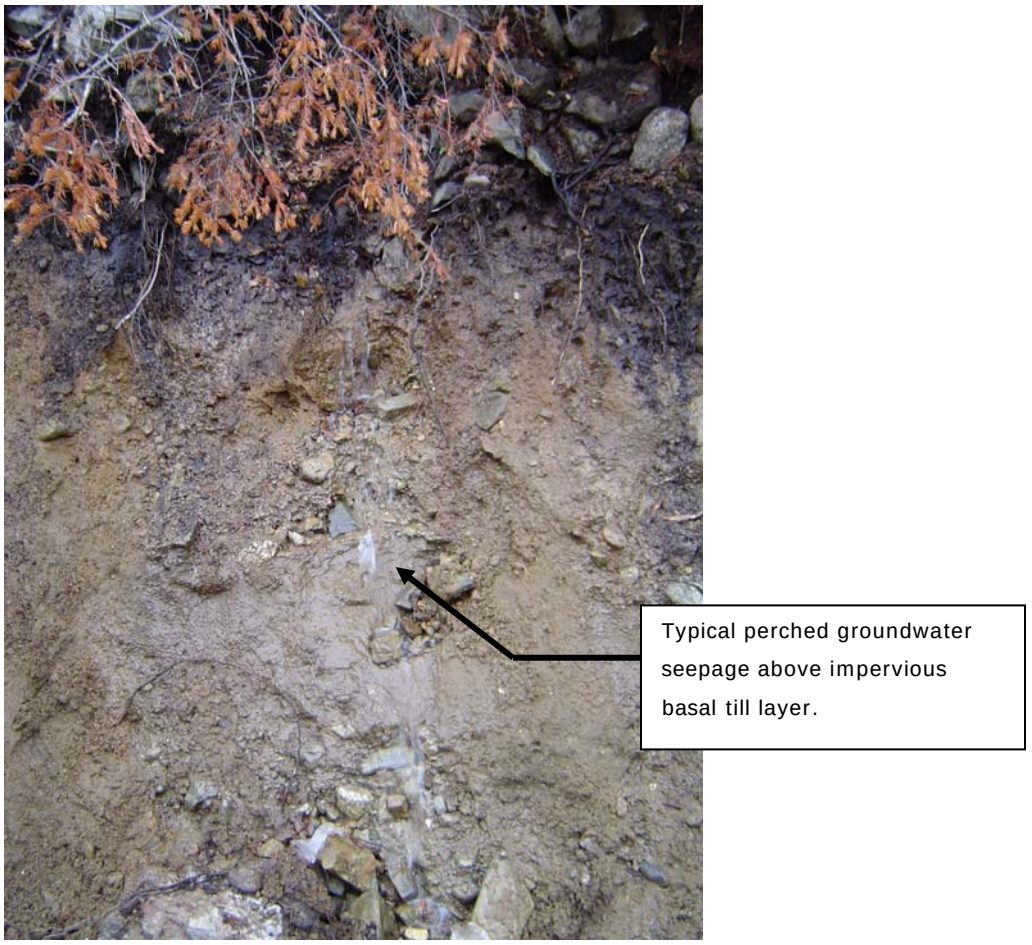


Photo 6: Ground water seepage. Photographed by A.F. 11/12/2003.

Road cuts transcending along well drained soils shall have cross-culverts properly spaced along the roadway to intercept the side drainage ditched along the roadway. (See Section 1, Appendix 2.2 Engineering Plan Details, C-22A, C-22D, C-22G).

Photo 6A: Downslope cross culvert with stabilized channel utilizing vegetation. Photograph by Albert Frick, 11/12/2003.

Road cuts transcending along moderately well drained and somewhat poorly drained soils shall have more cross-culverts spaced at shorter intervals, to not only handle the anticipated surface water flow but also the intercepted groundwater flow. (See Photo 7).

Photo 7: Recently built existing road cut across moderately well drained soil exhibiting seepage on top of soil underlying glacial till. Erosion and sediment control not yet in place. Photographed by A.F. 11/12/2003.

Road cuts transcending along poorly drained soils shall have larger and more culverts (shorter spacing), as well as underlying highly permeable layer in the road base to allow for higher uninterrupted flow under travel surfaces (See Section 1, Appendix 2.2 Engineering Plan Details, C-20A)..

Photo 7A: Typical area with a natural existing drainage swale with concentrated flow, which would receive additional culverts and potentially subdrainage. Photographed by A.F. 11/12/2003.

3.2 Stoniness:

Road alignment across the surface of soils exhibiting extremely bouldery, stony or cobbly surfaces shall utilize the coarse fragments in areas in need of rip rap, plunge pools or bank stabilization. Excess stones, cobbles and boulders shall be used on the downslope and side of the road cut fills for side

slope (armament) or potentially crushed by a portable crusher and reused as subgrade in very wet areas for cross drainage subsoil flow. (See Photos 1,2,3,9 and 10). (See Section 1, Appendix 2.2 Engineering Plan Details, C-24D, C-21F and C-24F).

Photo 8: Boulders and cobbles encountered on surface shall be utilized to downslope fill extensions. Photograph by Albert Frick, 11/12/2003.

Photo 9: Large boulders utilized on downslope side of fill extension for fill retainment and rip rap armament. Photograph by Albert Frick, 11/12/2003.

Photo 10: Armored downslope road fill extension, 11/12/2003.

3.3 Slope Gradient

Proper roadway is designed to meet with specific required grades, turning radii, widths, and land bearings to allow the turbine blades and parts to be transported to the ridge tops (See Section 1, Appendix 2.2 Engineering Plan Details, C-20E). Long term use will be for maintenance and potential educational visitor tours. Road grade cannot exceed 14% for excessive lengths. Proposed road is designed to utilize the shortest length of roads to accomplish the design goals, while avoiding environmentally sensitive areas. In areas of steeper road grades, the side drainage channels will require extra erosion and sediment control such as rip rap, stone check drains, increased side culverts, geotextile fabrics, etc) (see Photo 11). (See Section 1, Appendix 2.2 Engineering Plan Details, C-24).

Photo 11: View of existing 14% road grade, which is typical upper tolerable design limit. Photograph by Albert Frick, 11/12/2003.

3.4 Growing Season

The proposed project is in northern Maine which has a limited growth season (typically June through September). The higher elevations (i.e. above 2,700') have a shorter growing season due to their elevation. However, the canopy cover, aspect, and microclimate conditions tend to affect soil temperatures and growing season as well.

It was observed from local practice that the conservation mixture blended for use in that area by a Kingfield seed supplier is effective in producing germination as late as late August, in time to obtain a minimal vegetative cover *catch* (See Photo 12). However, soil conservation seed mix shall be limited to lower elevations outside of the 'special' areas (e.g. not in high mountain elevations or near wetlands), so as to avoid the potential for introducing 'invasive' plant species.

Photo 12: Vegetative cover catch of northern conservation mixture seeded in late August at 2,700' elevation in northern Maine. Photograph by Albert Frick, 11/12/2003.

Erosion and sediment control practice will require strict attention to timeliness of vegetative cover reliance in higher elevations. The primary erosion and sediment control method will be "wood product chips or rip rap. In sensitive areas, construction later in the allowable season, and on steeper slopes may necessitate a geotextile fabric or rip rap armament method shall be utilized (See Section 1, Appendix 2.2 Engineering Plan Details, C-21A, B, C, D, E) .

3.5 Soil Organics (Soil Thixothrophy)

High elevation mountain soils have a tendency to be high in organics due to slow organic decay in the cold climates. Soil is organic surface layer along with high organic accumulation in subsoil layer (Bhs layer). Thixotropic soil conditions can be found in isolated locations in cold, high elevations. The

term “smeary” is used by NRCS to characterize soil materials that are thixotropic. A NRCS field test for thixotrophic soil is:

> *“To press a bit of wet soil between thumb and forefinger; at first it resists deformation, having some rigidity, or elasticity, or both; under increasing pressure, the soil can be molded and deformed; under greater pressure, suddenly the soil changes from a plastic solid to a liquid, and the fingers skid. After the soil smears in this fashion, usually free water can be seen on the fingers. In a matter of a second or two, the liquefied soil sets again to its original soil state”.*

Soil thixotropic characteristics were observed to be in isolated areas throughout typical road cuts during Project Road Review Workshop of November 12, 2003 (see Section 2.1.2 and Photo 13).

The surface horizon as well as upper horizons in the mineral subsoil suspected to be high in organics (due to very dark brown to black colors) shall be excavated and utilized on the downslope fill extensions to promote vegetative cover growth.

Photo 13: Soil profile exhibiting area of higher organic material accumulation. Photo by Albert Frick, 11/12/2003.

3.6 Soil Texture

The finer textured basal tills with silt loam, loam, fine sandy loam textures will have higher soil erodibility potential (K factor) than the coarser textured glacial tills. Erosion and sediment measures shall address the higher erodibility of these soils and soil horizons, utilizing stabilization techniques detailed in Section 1, Appendix 2.2 Engineering Plans C-23).

3.7 Soil Depth

The *Lyman, Ricker, Saddleback* and *Tunbridge* soils are shallow to bedrock. Bedrock may present excavation issues in cuts for road grades and will require low impact blasting and/or mechanical hammering (see B.7, B.12 and B.17). However, for erosion and sediment control, these soils tend to have

ess erodibility due to the absence of soil fragments and the presence of bedrock. These soils types are typically on the higher ridge tops and higher elevations. The lack of soil sediments and the reduction in watershed area (being on the top of the watershed) reduce the erosion potential.

3.8 Construction / Remediation / Repair

The project engineer overseeing the project, and the excavating company overseeing construction of the project shall apply the appropriate erosion control details, fill slope details, back slope details, roadway details and ditch details, where applicable. (See Section 1, Appendix 2.2 Engineering Plan Details, C-20, C-21, C-22, C-23, C-24).

Any limited areas that are found to be ineffective by the erosion and sediment method applied, either due to ineffectiveness of erosion and sediment application, inappropriate timing, or combination will be immediately repaired. The erosion and sediment method shall be reevaluated, and reapplied at the first available opportunity. Consideration of more effective treatment or improved timing may be necessary. Areas of pre-existing access roadways shall be inspected for erodibility and repaired, if present, with appropriate techniques detailed in (See Section 1, Appendix 2.2 Engineering Plan Details, C-21, C-22, C-23, C-24.

4.0 Literature Cited

Guidelines for Maine Certified Soil Scientists for Soil Identification and Mapping. Maine Associates of Professional Soil Scientists, February 1995, as amended.

National Resource Conservation Services, Soil Survey Field Work Sheets. Franklin County, Maine.

Soil Series of Maine, Soil Descriptions, Maine Associates of Professional Soil Scientists, USDA Soil Conservation Services.

Soil Series of Maine, Soil Interpretations, Maine Associates of Professional Soil Scientists, USDA Soil Conservation Services.

Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys, December 1975 as amended.

APPENDICES

A Soil Maps
- A-1 Project Area
- A-2 Maintenance Building

B Soil Narrative Report

C Letters of Correspondence

D Additional Photographs

Appendix A

Soils Maps

A-1 Project Area

A-2 Maintenance Building

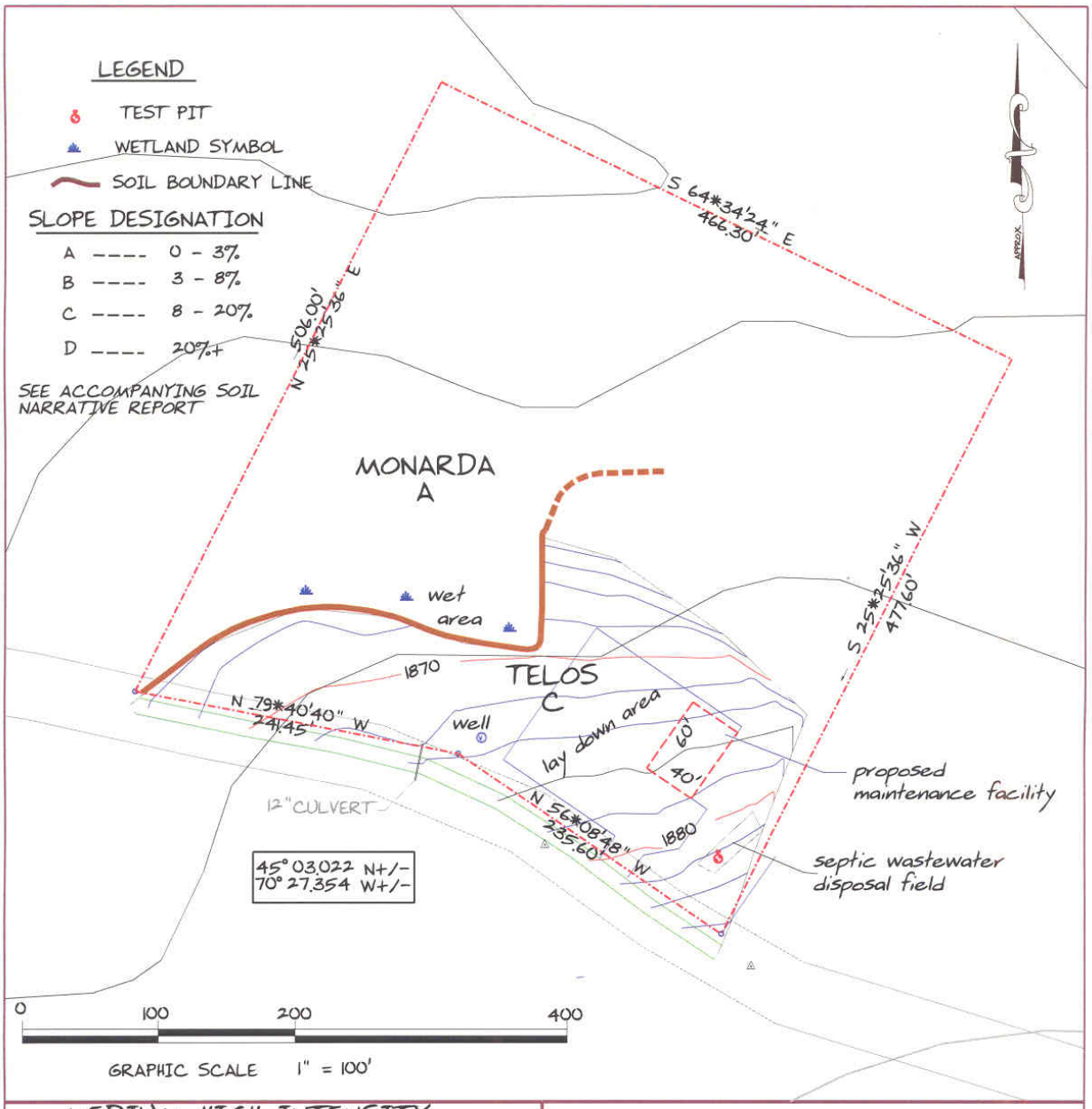
A-1

Project Area

[NOTE: 2x3 hard copy to be scanned and inserted here as .PDF file]

A-2

Maintenance Building



MEDIUM-HIGH INTENSITY SOILS MAP
CLASS C
REDINGTON MOUNTAIN WINDFARM, LLC.
MAINTENANCE BUILDING
REDINGTON TWP, MAINE

Albert Frick Associates, Inc.
Soil Scientists & Site Evaluators
Gorham, Maine 04038

Date:	Revision Description	Drawn By: B.F.	Checked By: A.F.
		Date: 7/20/05	Scale: 1" = 100'

APPENDIX B

Soil Narrative Report

REDINGTON MOUNTAIN WIND FARM

SOIL NARRATIVE

Redington (T1 P2 WBKP)

DATE: July 2005

BASE MAP: Contour map 20-foot intervals, scaled 1"=2000', provided by DeLuca-Hoffman Engineers.

THE SOIL MAPPING CONFORMS WITH A CLASS D SURVEY.

Class D - Soil Survey

1. Mapping units larger than 3 acres.
2. Scale of 1" = 2000' or larger.
3. Up to 50% inclusions in mapping units of which no more than 35% may be dissimilar soils.
4. Ground control - as determined by mapper.
5. Base map does not require contour lines.

The accompanying soil profile descriptions, soil map and this soil narrative report were done in accordance with the standards adopted by the Maine Association of Professional Soil Scientists, and the Maine Board of Certification of Geologists and Soil Scientists.

This was prepared to be used for development as an electric energy generating facility from wind turbines. Project will include roadway access up the mountainside and wind turbine sites along the ridge lines of Mount Redington and Black Nubble.

_____ C.S.S. #66, S.E. #163 / /

Albert Frick Date

B.1 BRAYTON (Aeric Haplaquepts)

BRAYTON (Aeric Haplaquepts)

SETTING

Parent Material: Compact loamy glacial till.

Landform: Depressions and toeslopes of glaciated uplands.

Position in Landscape: Lowest positions on landform.

Slope Gradient Ranges: **(A)** 0-3% **(B)** 3-8% **(C)** 8-20%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Somewhat poorly to poorly drained, with a perched water table 0 to 1.0 feet beneath the soil surface from November through May or during periods of excessive precipitation.

Typical Profile Description:

Surface layer:	Very dark grayish brown sandy loam, 0-5"
Subsurface layer:	Grayish brown sandy loam, 5-15"
Subsoil layer:	Olive gray fine sandy loam, 15-24"
Substratum:	Olive sandy loam, 24-65"

Hydrologic Group: Group C

Surface Run Off: Moderate to moderately rapid.

Permeability: Moderate in solum, moderately slow or slow in dense substratum.

Depth to Bedrock: Deep, greater than 40 inches.

Hazard to Flooding: None

Erosion Factors:

0 - 6"	K (.24 - .32)
6 - 23"	K (.32)
23 - 65"	K (.24)

INCLUSIONS (Within Mapping Unit)

Similar: Colonel, Westbury

Contrasting: Naskeag, Peacham

Proposed Use: **Road** and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: Soil limiting factor is high ground water table. Brayton is a hydric (wetland) soil. Areas within the Brayton soil series mapping unit may be jurisdictional wetland, if hydrology and wetland vegetation co-exist, and subjected to wetland impact regulations. Roadway and associated development will need to avoid these areas which are designated wetlands, or property addressed with the wetland impact requirements.

B.2 CHESUNCOOK (Typic Haplorthods)

CHESUNCOOK (Typic Haplorthods)

SETTING

Parent Material: Coarse-loamy glacial till.

Landform: Glaciated uplands.

Position in Landscape: Side slope.

Slope Gradient Ranges: **(B)** 3-8% **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Moderately well drained, with a perched water table 1.5 to 3.0 feet beneath the existing soil surface March through May and during periods of excessive precipitation.

Typical Profile Description:

Surface layer: Dark reddish brown organic, 0-3"

Subsurface layer: Light gray, dark reddish brown to reddish brown and yellowish brown silt loam and loam, 3-14"

Subsoil layer: Olive brown to grayish brown, gravelly loam, 14-24"

Substratum: Olive gravelly loam, 24-36"

Hydrologic Group: Group C

Permeability: Moderate in the solum, moderately slow or slow in the compact substratum.

Depth to Bedrock: Very deep, greater than 60 inches.

Hazard to Flooding: None

Erosion Factors:

0 - 8"	K (.24 - .28)
8 - 21"	K (.32)
21 - 65"	K (.32)

INCLUSIONS

(Within Mapping Unit)

Similar: Dixfield, Berkshire

Contrasting: Telos, Monson, Elliotsville (less than 40" to bedrock)

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The limiting factor for proposed development is *wetness*, which imposes moderate limitations due to potential frost action. Proposed road ditching is necessary in these areas.

B.3 COLONEL (Aquic Haplorthods)

COLONEL (Aquic Haplorthods)

SETTING

Parent Material: Compact loamy glacial till.

Landform: Glaciated uplands.

Position in Landscape: Intermediate positions on landform.

Slope Gradient Ranges: **(A)** 0-3% **(B)** 3-8% **(C)** 8-20%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Somewhat poorly drained, with a perched water table 1.0 to 1.5 feet beneath the soil surface from November through May or during periods of excessive precipitation.

Typical Profile Description:

Surface layer:	Grayish brown fine sandy loam, 0-2"
Subsurface layer:	Dark reddish brown fine sandy loam, 2-12"
Subsoil layer:	Light olive brown gravelly fine sandy loam, 12-18"
Substratum:	Olive gravelly fine sandy loam, 18-65"

Hydrologic Group: Group C

Surface Run Off: Moderate

Permeability: Moderate in solum and moderately slow or slow in the compact substratum.

Depth to Bedrock: Deep, greater than 40 inches.

Hazard to Flooding: None

Erosion Factors:

0 - 6"	K (.17 - .2)
6 - 17"	K (.24)
17 - 65"	K (.20)

INCLUSIONS (Within Mapping Unit)

Similar: Dixfield, Colonel (Variant)

Contrasting: Brayton

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limiting factor for the proposed development is wetness, which imposes severe limitations due to frost action. Proper road ditching is essential to address limitation.

B.4 COLTON (Typic Haplorthods)

COLTON (Typic Haplorthods)

SETTING

Parent Material: Glacio-fluvial deposits.

Landform: Terraces, kames, eskers, and outwash plains.

Position in Landscape: Upper portions of landforms.

Slope Gradient Ranges: **(B)** 3-8% **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Excessively drained, with no observed water table within 6 feet of the soil surface.

Typical Profile Description:
Surface layer: Grayish brown gravelly loamy sand, 0-7"
Subsurface layer: Dark reddish brown gravelly loamy sand, 7-11"
Subsoil layer: Reddish brown gravelly loamy sand, 11-16"
Substratum: Yellowish brown and pale brown very gravelly sand, 16-70"

Hydrologic Group: Group A

Surface Run Off: Slow

Permeability: Rapid or very rapid in the solum, very rapid in the substratum.

Depth to Bedrock: Very deep, greater than 60".

Hazard to Flooding: None

Erosion Factors:

0 - 8"	K (.17 - .20)
8 - 22"	K (.17)
22 - 60"	K (.17)

INCLUSIONS

(Within Mapping Unit)

Similar: Hermon, Adams, Stetson
Contrasting: Duane, Croghan, Hermon, Waumbek

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limiting factor for proposed development is large stones, which offer 'moderate' limitation. Typically, larger excavators and associated heavy machinery easily overcome limitations:

B.5 DIXFIELD (Very Stony) (Typic Haplorthods)

DIXFIELD (Very Stony) (Typic Haplorthods)

SETTING

Parent Material:	Compact loamy glacial till.
Landform:	Glaciated uplands and drumlins.
Position in Landscape:	Upper portions of landform.
Slope Gradient Ranges:	**(B)** 3-8% **(C)** 8-20%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class:	Moderately well drained, with a perched water table 1.5 to 2.5 feet beneath the existing soil surface from November through April and during periods of excessive precipitation.	
Typical Profile Description:	**Surface layer:**	Grayish brown and dark brown fine sandy loam, 0-6",
	Subsurface layer:	Strong brown and dark yellowish brown fine sandy loam, 6-19"
	Subsoil layer:	Light olive brown gravelly fine sandy loam, 19-24"
	Substratum:	Light olive brown gravelly sandy loam, 24-65"
Hydrologic Group:	Group C	
Permeability:	Moderate in the solum, moderately slow or slow in the compact substratum.	
Depth to Bedrock:	Very deep, greater than 60".	
Hazard to Flooding:	None	
Erosion Factors:	0 - 6" K (.17 - .20) 6 - 24" K (.24) 24 - 65" K (.20)	

INCLUSIONS

(Within Mapping Unit)

Similar: Hermon, Skerry, Becket
Contrasting: Colonel, Tunbridge (20-40" to bedrock)

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed use is wetness, which imposes potential frost action problems. Proper road ditching is required to overcome limitation.:

B.6 HERMON (Typic Haplorthods)

HERMON (Typic Haplorthods)

SETTING

Parent Material:	Loose loamy and sandy glacial till.
Landform:	Glaciated upland plains, hills and ridges.
Position in Landscape:	Uppermost portions of landform.
Slope Gradient Ranges:	**(B)** 3-8% **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class:	Somewhat excessively drained, with a water table greater than 6.0 feet beneath the existing soil surface.	
Typical Profile Description:	**Surface layer:**	Pinkish gray sandy loam, 0-3"
	Subsurface layer:	Dark reddish brown, 3-9"
	Subsoil layer:	Strong brown & dark yellowish brown, 9-32"
	Substratum:	Light olive brown gravelly coarse sand, 32-65"
Hydrologic Group:	Group A	
Surface Run Off:	Slow to medium	
Permeability:	Moderately rapid or rapid in solum, rapid or very rapid in the loose substratum.	
Depth to Bedrock:	Very deep, greater than 60".	
Hazard to Flooding:	None	
Erosion Factors:	0 - 7" K (.10 - .17) 7 - 30" K (.10) 30 - 65" K (.10)	

INCLUSIONS
(Within Mapping Unit)

Similar:	Hermon (D slopes in C unit), Colton
Contrasting:	Stetson, Waumbek (moderately well drained)

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for the proposed use is large stones. Typically, larger excavators and bigger machinery are utilized to overcome limitation.:

B.7 LYMAN (Hollis) (Lithic Haplorthods)

LYMAN (Hollis) (Lithic Haplorthods)

SETTING

Parent Material:	Derived from glacial till.
Landform:	Rocky hills and high plateaus.
Position in Landscape:	Occupies the higher positions in the landscape on knolls, hills and mountains.
Slope Gradient Ranges:	**(B)** 3-8% **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class:	Somewhat excessively drained. Water table usually not present but may exist on top of the underlying bedrock in concave pockets in places during prolonged wet periods.	
Typical Profile Description:	**Surface layer:**	Black loam, 0-2"
	Subsurface layer:	Reddish gray fine sandy loam, 2-4"
	Subsoil layer:	Very dusky red, dark red to brown loam, 10-20"
Hydrologic Group:	Group C:	When bedrock is known to be cracked or impervious.
	Group D:	When bedrock is impervious or if soil is in the extremely rocky class.
Surface Run Off:	Slow to rapid depending on slope and bedrock exposure.	
Permeability:	Moderately rapid.	
Depth to Bedrock:	Shallow, 8-20".	
Hazard to Flooding:	None	
Erosion Factors:	0 - 6"	K (.20 - .28)
	6 - 17"	K (.32)

INCLUSIONS
(Within Mapping Unit)

Similar:	Tunbridge, 20-40" to bedrock, Dixfield (greater than 40" to bedrock)
Contrasting:	Rock outcrop, Naskeag

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed development is depth to bedrock. Filling is not a problem for this soil, however, areas of road alignment or buried underground electrical cables requiring blasting increases expense. Adjusting grades with filling, where possible, as opposed to blasting, is recommended to address bedrock concerns.

B.8 MAHOOSUC (Dysic Typic Borofolists)

MAHOOSUC (Dysic Typic Borofolists)

SETTING

Parent Material: Their organic materials overlying fragmental colluvium.

Landform: Steep mountain slopes.

Position in Landscape: Above 2,300 feet in elevation.

Slope Gradient Ranges: **(C)** 8-20% **(D/E)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Somewhat excessively drained.

Typical Profile **Surface layer:** Dusty red to black organic materials (needles, twigs and decomposed organic), 0 to 8 inches

Substratum: Fragmental materials consisting of stones, boulders and cobbles, 20 to 60 inches.

Hydrologic Group: A

Permeability: 20 inches/hour in upper horizon, 20 inches/hour in substratum

Depth to Bedrock: Deep, greater than 40 inches

Hazard to Flooding: None

Erosion Factors:

0 - 8"	K (none given)
8 - 65"	K (.05)

INCLUSIONS

(Within Mapping Unit)

Similar: None
Contrasting: Ricker, which is shallow to bedrock

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: Soil limitation for proposed development is the presence of large stones. Larger excavating equipment is typically employed to overcome this soil limitation.

B.9 MARLOW (Paxton)

MARLOW (Paxton)

SETTING

Parent Material: Loamy soils underlain by compact, loamy glacial till.

Landform: Drumlins and glaciated uplands.

Position in Landscape: Uppermost portions of landform.

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20+%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Well drained, with a perched water table 2.0 to 3.5 feet below the soil surface through March and April, and during periods of excessive rainfall.

Typical Profile Description:

Surface layer:	Dark gray and gray fine sandy loam, 0-6"
Subsurface layer:	Yellowish red fine sandy loam, 6-13"
Subsoil layer:	Light olive brown fine sandy loam, 13-17"
Substratum:	Olive and olive gray fine sandy loam, 17-65"

Hydrologic Group: Group C

Surface Run Off: Moderate

Permeability: Moderate in solum, and moderately slow to slow in the compact substratum.

Depth to Bedrock: Very deep, greater than 60".

Hazard to Flooding: None

Erosion Factors:

0 - 8"	K (.24)
8 - 31"	K (.32)
31 - 60"	K (.20)

INCLUSIONS
(Within Mapping Unit)

Similar: Becket
Contrasting: Dixfield, Skerry

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: Soil limitation for proposed use is wetness, which has the potential to cause frost action. Proper road ditching is required to overcome limitations.

B.10 MONADNOCK (Frigid Typic Haplorthods)

MONADNOCK (Frigid Typic Haplorthods)

SETTING

Parent Material: Deep loamy mantle underlain by sandy glacial till

Landform: Upland hills, plains, or mountain sideslopes

Position in Landscape: Sideslopes in glaciated uplands

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Well drained

Typical Profile

Surface layer:	Brown, fine sandy loam, 0-3"
Subsurface layer:	Light brownish gray sandy loam, 3-5"
Subsoil layer:	Reddish to yellowish brown fine sandy loam, 5-23"
Substratum:	Olive gravelly loamy sand, 23-65"

Hydrologic Group: B

Permeability: Moderate in solum and moderately rapid in substratum

Depth to Bedrock: Very deep, generally greater than 60"

Hazard to Flooding: None

Erosion Factors:

0 - 5"	K (.24 - .28)
5 - 23"	K (.28)
23 - 60"	K (.17)

INCLUSIONS

(Within Mapping Unit)

Similar: Marlon
Contrasting: Peru, Colonel

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: Soil limitation for proposed development is the presence of large stones in the soil profile. Employing large excavating equipment and associated heavy machinery is utilized to overcome soil limitations.

B.11 RICKER (Dysic Lithic Borofolists)

RICKER (Dysic Lithic Borofolists)

SETTING

Parent Material: Thin organic deposits underlain by a thin mineral horizon over bedrock

Landform: On mountains and hills

Position in Landscape: Uppermost portions of landscape

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Well drained to excessively well drained

Typical Profile

Surface layer:	Dark reddish brown to black peat, 7-0"
Subsurface layer:	Dark bluish gray, very channery silt loam, 0-9"
Substratum:	Bedrock – micaceous schist

Hydrologic Group: A

Permeability: Moderately rapid in organic layers, moderate or moderately rapid on the mineral horizon

Depth to Bedrock: Very shallow to moderately deep, 0-40"

Hazard to Flooding: None

Erosion Factors:

0 - 4"	K (none given)
4 - 7"	K (none given)
7 - 9"	K (.49)

INCLUSIONS

(Within Mapping Unit)

Similar: Lyman, Tunbridge

Contrasting: Rock Outcrop, Naskeag

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed development is depth to bedrock. Filling is not a problem for this soil, however, areas of road alignment or buried underground electrical cables requiring blasting increases expense. Adjusting grades with filling, where possible, as opposed to blasting, is recommended to address bedrock concerns.

B.12 SADDLEBACK (Humic Lithic Cryorthods)

SADDLEBACK (Humic Lithic Cryorthods)

SETTING

Parent Material: Thin veneer of glacial till

Landform: High elevation, glaciated uplands

Position in Landscape: Uppermost portions of landscape

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Well drained

Typical Profile

Surface layer:	Very dusty red organic material, 5-0"
Subsurface layer:	Dark grayish brown fine sandy loam, 0-6"
Subsoil layer:	Dark reddish brown fine sandy loam, 6-12"
Substratum:	Reddish brown fine sandy loam, 12-19"
	Bedrock at 19"

Hydrologic Group: C/D

Permeability: Moderate

Depth to Bedrock: Shallow, 10-20"

Hazard to Flooding: None

Erosion Factors:

0 - 1"	K (.28)
1 - 14"	K (.28)

INCLUSIONS

(Within Mapping Unit)

Similar: Lyman, Tunbridge, Ricker
Contrasting: Rock Outcrop

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed development is depth to bedrock. Filling is not a problem for this soil, however, areas of road alignment or buried underground electrical cables requiring blasting increases expense. Adjusting grades with filling, where possible, as opposed to blasting, is recommended to address bedrock concerns.

B.13 SHEEPSCOT (Typic Haplorthods)

SHEEPSCOT (Typic Haplorthods)

SETTING

Parent Material: Very deep soils formed in glacio-fluvial deposits.

Landform: Nearly level to strongly sloping outwash plains, terraces and deltas.

Position in Landscape: Upper and midsloping areas on outwash plains, terraces and deltas.

Slope Gradient Ranges: **(B)** 0-3% **(C)** 3-8% **(D)** 8-20%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Moderately well-drained.

Typical Profile Description:

Surface layer:	Light gray fine sandy loam, 0-5"
Subsurface layer:	Dark reddish to yellowish brown sandy loam, 5-19"
Subsoil layer:	Light olive brown gravelly sand, 19-27"
Substratum:	Olive coarse sand, 27-65"

Hydrologic Group: Group B

Surface Run Off: Slow

Permeability: Moderate or moderately rapid in the loamy cap and rapid or very rapid below.

Depth to Bedrock: Very deep, greater than 65".

Hazard to Flooding: None

Erosion Factors:

0 - 3"	K (.17)
3 - 25"	K (.10)
25 - 65"	K (.05)

INCLUSIONS

(Within Mapping Unit)

Similar: Hermon, Colton
Contrasting: Naumburg, Au Gres

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed use is wetness, which imposes potential frost action problems. Proper road ditching is required to overcome limitation.:

B.14 SISK (Mixed Humic Cryorthods)

SISK (Mixed Humic Cryorthods)

SETTING

Parent Material: Deep soils formed in glacial till

Landform: Strongly sloping to very steep sideslopes

Position in Landscape: Uppermost portions of mountainside, tops

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Well drained

Typical Profile

Surface layer:	**Dusky** red silt loam, 0-5"
Subsurface layer:	Yellowish brown loam, 5-16"
Subsoil layer:	Light olive brown gravelly loam, 16-22"
Substratum:	Brown gravelly fine sandy loam 22-65"

Hydrologic Group: C

Permeability: Moderate in solum, moderately slow to very slow in substratum

Depth to Bedrock: Very deep, over 65"

Hazard to Flooding: None

Erosion Factors:

0 - 1"	K (.24 - .28)
1 - 20"	K (.32)
20 - 65"	K (.32)

INCLUSIONS

(Within Mapping Unit)

Similar: Monadnock, Marlow, Chesuncook
Contrasting: Colonel, Naskeag

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: Soil limitation for proposed use is wetness, which has the potential to cause frost action. Proper road ditching is required to overcome limitations.

B.15 SURPLUS (Mixed Typic Cryorthods)

SURPLUS (Mixed Typic Cryorthods)

SETTING

Parent Material: Dense glacial till

Landform: Mountainous sideslopes

Position in Landscape: Gently to steeply sloping soils on mountain sideslopes

Slope Gradient Ranges: **(C)** 8-20% **(D)** 20%+

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Moderately well drained to somewhat poorly drained

Typical Profile

Surface layer:	Brown sandy loam, 0-11"
Subsurface layer:	Dark reddish brown fine sandy loam, 11-20"
Subsoil layer:	Yellowish brown o brown gravelly sandy loam, 20-33"
Substratum:	Light olive brown sandy loam, 33-65"

Hydrologic Group: C

Permeability: Moderate in solum and moderately slow to very slow in substratum

Depth to Bedrock: Very deep, over 65"

Hazard to Flooding: None

Erosion Factors:

0 - 4"	K (.24 - .28)
4 - 26"	K (.32)
26 - 65"	K (.32)

INCLUSIONS

(Within Mapping Unit)

Similar: Marlow, Chesuncook, Monadnock
Contrasting: Ricker, Lyman, Rock Outcrop, Naskeag

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed use is wetness, which imposes potential frost action problems. Proper road ditching is required to overcome limitation.:

B.16 TELOS (Frgid Aquic Haplorthods)

TELOS (Frgid Aquic Haplorthods)

SETTING

Parent Material: Sandy textured dense basal till.

Landform: Lower side slopes in glaciated uplands.

Position in Landscape: Nearly level to steeply sloping soils on upland till ridges.

Slope Gradient Ranges: **(B)** 3-8% **(C)** 8-20%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Somewhat poorly drained.

Typical Profile Description:

Surface layer:	Pinkish gray silt loam, 0-4"
Subsurface layer:	Dark reddish to yellowish brown silt loam, 4-15"
Subsoil layer:	Light olive brown silt loam, 15-20"
Substratum:	Olive gravelly silt loam, 20-65"

Hydrologic Group: Group C

Surface Run Off: Slow

Permeability: Moderate in the solum, and slow or very slow in the substratum.

Depth to Bedrock: Very deep, greater than 65".

Hazard to Flooding: None

Erosion Factors:

0 - 8"	K (.24 - .28)
8 - 18"	K (.32)
18 - 65"	K (.32)

INCLUSIONS

(Within Mapping Unit)

Similar: Chesuncook, Colonel
Contrasting: Brayton, Monarda

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limiting factor for the proposed development is wetness, which imposes severe limitations due to frost action. Proper road ditching is essential to address limitation.

B.17 TUNBRIDGE (Typic Haplorthods)

TUNBRIDGE (Typic Haplorthods)

SETTING

Parent Material: Loamy glacial till.

Landform: Glaciated uplands.

Position in Landscape: Upper positions on landform.

Slope Gradient Ranges: **(B)** 3-8% **(C)** 8-20% **(D)** 20+%

COMPOSITION AND SOIL CHARACTERISTICS

Drainage Class: Somewhat excessively to well drained, with no evidence of a water table, or only inches from the bedrock surface during spring and during periods of heavy precipitation.

Typical Profile Description:

Surface layer:	Black and reddish brown loam and fine sandy loam, 0-4"
Subsurface layer:	Very dusky red loam, 4-6"
Subsoil layer:	Dark red loam, 6-10"
Substratum layer:	Dark brown to brown loam, 10-25". Bedrock at 25".

Hydrologic Group: Group C/D

Surface Run Off: Rapid

Permeability: Moderate or moderately rapid.

Depth to Bedrock: Moderately deep, 20-40".

Hazard to Flooding: None

Erosion Factors:

0 - 3"	K (.20)
3 - 14"	K (.20)
14 - 28"	K (.20)
28 – 65"	K (.20)

INCLUSIONS
(Within Mapping Unit)

Similar: Dixfield, Skerry
Contrasting: Lamoine, Lyman Variant, Naskeag, Adams

Proposed Use: Roadway and Turbine pad construction for a proposed electric generating facility utilizing wind turbines constructed along ridge lines of *Mount Redington* and *Black Nubble.*

Soil Limitations for Proposed Use: The soil limitation for proposed development is depth to bedrock. Filling is not a problem for this soil, however, areas of road alignment or buried underground electrical cables requiring blasting increases expense. Adjusting grades with filling, where possible, as opposed to blasting, is recommended to address bedrock concerns.

C

Letters of Correspondence

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Albert Frick SS, SE
James Logan SS, SE
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October 13, 2003

David Rocque
State Soil Scientist
28 State House Station
Augusta, ME 04333

Re: Endless Energy, Redington Township

Dear David:

We discussed the proposed Endless Energy project on October 10, 2003, with regards to soil mapping requirements. The following is a summary of our discussion:

- The project review will allow for a Class D of the overall area with Class B on the maintenance building and visitors center area.
- You are most interested in the details on how the project team proposes to build a roadway up the mountains, and specifically how it will be stabilized to handle runoff and prevent erosion on the soil types to be encountered
- You are concerned that the soils are *fragile* at the top of the mountain peak, and you expressed concern that the *Folist* soil and other mountain soils on steep slopes in high elevations will exhibit thixotrophic characteristics ("*smearing*"). Soil horizons on the high elevations with a seasonal high groundwater table may not exhibit soil redoximorphic features (i.e. soil mottling) due to highly oxygenated free water.

  The specific soil characteristics you want to be thoroughly addressed are:

  Steep slopes, cryic soils with a very short growing season, thixotrpohic tendency, large drainage sheds, as well as others that affect erosion and sediment controls.
- You are requesting engineering treatment in the form of specifications, typical cross-section, and construction practice to address the practical problems associated with the proposed road, and urged to tap into local specialized road construction knowledge when applicable.
- You would like to see treatment scenarios to address the soil characteristics, grades, and drainage sheds likely to be encountered.

Please contact me if my summary of our conversation does not include the main points discussed.

Respectfully,

Albert Frick

Albert Frick
AF/nd

cc. Bill Conners, Endless Energy
Bill Hoffman, DeLuca-Hoffman

D

Additional Photographs

Photo D-1: Saddleback soil exhibiting shallow to bedrock rock outcropping conditions. Photograph by A.F. 8/22/1994.

Photo D-2: Field review of proposed wind tower site on Redington Ridge by DEP and LURC. David Rocque, State Soil Scientists and Stephen Pelletier, Woodlot Alternatives, reviewing site conditions. Photographer A.F. 9/22/1994.

Photo D-3: Recently constructed forest harvesting road, Redington Ridge, 8/22/1994. Photographer A.F.

Photo D-4: Redington Ridge forest harvesting road at Station 2100' linear length. 8/22/1994.