GEOTECHNICAL INVESTIGATION REPORT

FOR THE PROPOSED

VERSHIRE TOWN GARAGE

VERSHIRE, VT

PREPARED FOR: Town of Vershire
6894 VT Route 113
Vershire, VT 05079

PREPARED BY: M & W Soils Engineering, Inc.
PO Box 1466
Charlestown, NH 03603

September 15, 2020

M&W Soils Engineering, Inc. PO Box 1466, Charlestown, NH 03603 ph: 603-826-5873
fax:603-826-4210

September 15, 2020

Town of Vershire
6894 VT Route 113
Vershire, VT 05079
attn: Gene Craft

re: Geotechnical Report
Proposed Vershire Town Garage

Dear Gene,

Thank you for the opportunity to provide Geotechnical Engineering services on the above referenced project. Work to be performed was described in a proposal dated June 16, 2020, addressed to the Town. We were asked to work directly for the Town following acceptance of our proposal.

Project Information

We were asked to oversee the performance of test borings for a proposed Town Garage and associated sand shed on a former residential property, located at 815 Vershire Center Road. We had originally discussed doing a field investigation with test pits or Geoprobe borings, but after meeting at the site it was determined that shallow test borings using a traditional rotary drill rig would provide the most useful information.

Site Description

The proposed garage site is a former residential property, with a house, garage, and outbuildings still present. There is quite a bit of cleared area around the house, it appears that the former owner used quite a bit of the cleared area as storage. The area to the west of the existing house, between the house and Vershire Center Road, is lawn and garden, with the proposed Town Garage roughly centered on the garden area. The proposed sand shed would be in a cleared area to the northwest of the house.

The surrounding surface topography drops off to the north. The area between the house and the road is relatively flat, and there is a large field with a gradual uphill slope to the south of the house and drive. The grade drops off slowly from the house toward the sand shed location, and then more rapidly to the north and northeast beyond that area.

Subsurface Conditions

We proposed five to six total boring locations, five were ultimately done once drilling conditions were found to be fairly uniform. Borings were split between three around the perimeter of the garage location and two at opposite corners of the sand shed. Approximate locations of both buildings had been staked out by the Garage Committee. I contacted Dig-Safe, the Town arranged for an electrician to mark out the know underground service line from the road to the house. Our office contracted with T&K Drilling of Troy, NH to do the drilling. I met the drill crew at the site on the morning of June 25, 2020.

Test borings performed by T&K were completed using a truck mounted drill rig. 4-1/4" i.d. hollow stem augers were used. I selected boring depths and sampling schedules, prepared field logs and selected the soil samples to be retained for future inspection. Approximate test boring locations, based on a Google Earth Image, are located in Appendix A. Field Boring Logs are presented in Appendix B. We were sent an electronic site plan with a proposed facility layout, but the locations did not line up with what had been staked in the field.

Standard Penetration Tests (SPT) are the standard method of obtaining blow count values (N-values) and representative soil samples for classification and laboratory testing. 2-inch outside diameter split spoon samplers were used to obtain the blow counts and soil samples. N-values are directly proportional to soil density, densities are provided on the boring logs. Sampling was conducted through the hollow stem augers. Representative soil samples from each split spoon were transferred to sealed sample jars.

We did not have specific boring depths or sampling intervals determined prior to beginning drilling. I directed the drill crew to perform continuous soil sampling from the surface to 8 feet at the three garage locations, as this was the expected range of footings. An additional sample was taken beginning at 10 feet in the two locations where the augers reached that depth. Refusal was encountered at B-1 (11.33') and B-2 (9.33'), both are likely cobbles or boulders in the underlying dense till, although we don't know enough about the surrounding area to rule out bedrock. Boring B-3 was stopped at 12 feet in dense till. There had been some concern expressed about fill in this area, as some surface fill is noted on the nearby bank to the north, but other than shallow disturbance due to landscaping or the garden there was no fill noted. At the two sand shed borings, sampling was conducted from 0 to 4', and then at 5' and 7'. Native soils were very dense below 7 feet in each location, sampling was halted at 8.5 and 9 feet at these borings.

Native soils in the area around the proposed Town Garage were fairly uniform, consisting of loose to medium dense olive silty sand to at least 6 feet, and then dense silty sand with some weathered gravel or rock (a blend commonly referred to as glacial till) below that. As noted above, refusal was encountered in two of the locations. Considering the depths of refusal were well below what we anticipate being reached for this project, we did not perform additional borings in these areas. Soils between 2 and 6 feet were described as moist to damp, but no evidence of a groundwater table was found. There is likely a "perched" water table in the spring, when water may accumulate in the looser soils above the underlying dense till. The steep bank on the north side of the garage would tend to draw down any groundwater flow.

Soil conditions were similar in the proposed sand shed footprint, with very dense soils reached by 5.5' at B-4 and 7 feet at B-5. No refusal was encountered. There were a number of boulders scattered on the surface, so some rock can be expected in the subgrade.

Soils Laboratory Testing

Soil gradations were performed by our lab on four discrete soil samples obtained during the drilling process. Soil gradations can be found in Appendix C. Samples were selected to represent soils that is expected to be at or below expected footing depths. All four samples were identified as Silty Sand, with very similar silt contents (42.8-47.8%). These results compare favorably to the visual soil descriptions provided on the boring logs.

Recommendations for Design and Construction:

1) This site will have an IBC Seismic Site Class of "C", per the 2015 IBC. The liquefaction potential for the underlying native soils is low, based on soil composition and density.

2) We do not have a final site plan or building plans to work from, so assumptions will be made that will cover the range of expected conditions.

Viewing the current ground surface around the proposed garage site, my guess in the field was that the garage slab would be .5' or so above the grade at B-1. The ground at B-2 and B-3 appeared to be 1 to 2 feet lower than at B-1. Conventional frost wall footings will need to bear 5' below final grades, in accordance with the State building code amendment for frost protection. Based on my grading assumptions, footings should bear

between 3 and 4.5 feet below existing grades. These rough elevations are the basis for my recommendations, as they are based on soils expected to be encountered below footing grades. Once a final site plan and building elevations are set, these recommendations should be reviewed.

Footings will bear in silty sands. These soils will be easily excavated. Little rock should be encountered at these shallow depths, a smooth excavator bucket would be recommended to avoid disturbance below footing subgrade. My recommendations for prepping the site for foundations would be as follows;

a) Strip off the surface layer of any loamy materials and remove all portions of the existing garden.

b) Excavate perimeter footings to 3" below footing subgrade. If any soft or organic soils are still present, continue excavating to a base of firm native soils. Excavation should be continued to 12" on either side of the footing.

c) Place 3" of ¾" crushed stone beneath footings. Where excavation has gone further than 3", use crushed stone to fill the excavation to footing subgrade. This crushed stone layer will protect the soil subgrade in the event of rainfall while the subgrade is exposed.

d) If there are interior haunched slab footings or isolated column footings, they must bear on undisturbed native soil or ¾" crushed stone fill that bridge to native soils. Add a minimum of 3" of ¾" crushed stone beneath all interior footings.

Provided the recommendations provided above are followed, foundations may be designed for an allowable bearing capacity of 2,000 psf. This bearing capacity may be increased if footings are deeper than what I am anticipating.

The sand shed may be a pole barn or a foundation, and the grading is more complicated than the garage site due to the existing slopes. The same basic recommendations should be followed for a foundation system. A pole barn type foundation may require additional recommendations, we can say that soils are very dense below 7 feet and that cobbles and boulders may be encountered anywhere in the subgrade.

3) The excavated soils will have a high silt content and may be too wet to work with if exposed to rainfall or snowmelt. If they are found to be workable, I would not object to

the Town using them as interior backfill for budget purposes. They will be identical to the soils left beneath the interior of the building. On the building exterior, and for any replacement fill needed inside the building, I would recommend a clean granular backfill. Materials meeting VT AOT 704.04A (with a 4" maximum aggregate size) or 704.08A would be recommended.

All fill shall be placed in maximum 12" thick compacted lifts, and compacted to a minimum of 95% of the maximum dry density determined by ASTM D1557. Exterior backfill under walks, pavement or slabs should be placed to the same standard, exterior backfill under landscaped areas should be placed at a minimum of 90% of this standard.

Fine Crushed Gravel should be used beneath the interior slab, at a thickness of at least 12" due to the anticipated heavy equipment loads. This material should meet the gradation requirements of VT AOT 704.05B.

4) I do not see the need for a perimeter drain around the garage foundation. A vapor barrier should be installed beneath the slab.

5) The native silty soils are frost susceptible due to their high silt content. I would recommend that at least 24" of imported gravels be used under all pavement or exterior concrete pads.

Conclusion and Limitations

Soil conditions are assumed to be uniform between test boring locations, but this may not be the case. If soil conditions are found which vary significantly from those described in this report, please notify our office immediately so that we may make appropriate changes to our recommendations. The presence of a Geotechnical Engineer on site during footing excavation is recommended, some field decisions regarding the suitability of subgrade soils may be required.

No environmental sampling or analysis was performed as part of our investigation. We observed nothing of concern during the test borings.

Thank you for the opportunity to be of service on this project. We would appreciate the opportunity to perform follow up geotechnical inspection or consultation services as needed.

Sincerely,

Randall Rhoades, PE
Principal

APPENDIX A

Boring Location Map

Vershire Town Garage

Vershire, VT

Google Earth

feet 300
meters 100

APPROXIMATE TEST BORING LOCATIONS, 6-25-2020

APPENDIX B

Field Boring Logs

Vershire Town Garage

Vershire, VT

M&W SOILS ENGINEERING, INC
PO Box 1466 ° Charlestown, NH 03603 ° 603-826-5873

TO:	Town of Vershire 6894 Vershire Center Road Vershire, VT 05079	PROJECT NAME: LOCATION: MW JOB #:	Vershire Town Garage Vershire Center Road	SHEET: DATE: HOLE #: LINE & STA. OFFSET:	1 of 5 6/25/20 B-1

Ground Water Observations: Collapsed at 3', dry to there	Augers-Size I.D. Split Spoon Hammer Wt. Hammer Fall	4.25" 1.5" 140# 30"	Surface Elevation: Date Started: Date Completed: Boring Foreman: Inspector: Soils Engineer:	unknown 6/25/2020 6/25/2020 T&K Drilling Randy Rhoades

LOCATION OF BORING: SW corner of proposed garage

Sample Depths From/To (Feet)	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0-2	7/8/6/9		5"	Loam	1	24	24
				Loamy brown sand			
			1'6"	Dark olive silty sand, little gravel			
2-4	4/6/8/9		2'	Similar, some very weathered gravel exhibiting as clean sand pockets	2	24	20
		Moist					
4-6	10/11/7/11				3	24	22
6-8	17/22/40/65		6'	Till-dark grey silty sand, little gravel and weathered rock	4	24	24
10-11'4"	14/23/ 75 for 4"				5	16	16
			11'4"	Refusal to split spoon weathered rock in tip			

Ground Surface to 10' Used: 4.25" HSA then drove SS 16" to refusal

Earth Boring	11'4"
Rock Coring	0
Samples:	5
HOLE NUMBER	B-1

Proportions Used		Cohesionless Density (Sum of blow counts, 6-18")		Cohesive Consistency	
Trace	0 to 10%	0-10	Loose	0-4	Soft
Little	10 to 20%	10-30	Med Dense	4-8	Med Stiff
Some	20 to 35%	30-50	Dense	8-15	Stiff
And	35 to 50%	50+	Very Dense	15-30	V. Stiff

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TO:	Town of Vershire 6894 Vershire Center Road Vershire, VT 05079	PROJECT NAME: LOCATION: MW JOB #:	Vershire Town Garage Vershire Center Road	SHEET: DATE: HOLE #: LINE & STA. OFFSET:	2 of 5 6/25/20 B-2

Ground Water Observations: Collapsed 4', dry	Augers-Size I.D. Split Spoon Hammer Wt. Hammer Fall	4.25" 1.5" 140# 30"	Surface Elevation: Date Started: Date Completed: Boring Foreman: Inspector: Soils Engineer:	unknown 6/25/2020 6/25/2020 T&K Drilling Randy Rhoades

LOCATION OF BORING: North side of proposed building, west of center

Sample Depths From/To (Feet)	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0-2	2/2/3/7			Brown loamy sand (garden area)	1	24	8
2-4	7/14/15/12		2.5'	Olive silty sand, few cobbles	2	24	4
		Moist					
4-6	6/7/9/9		4'	Olive silty sand, little gravel and weathered gravel	3	24	24
		Damp					
6-8	9/11/14/27				4	24	24
			7.5'	Olive grey till-silty sand, little gravel and weathered rock			
			9'3"	Refusal, large rock or bedrock			

Ground Surface to 9'3" Used: 4.25" HSA

Earth Boring	9.25'
Rock Coring	0
Samples:	4
HOLE NUMBER	B-2

Proportions Used		Cohesionless Density (Sum of blow counts, 6-18")		Cohesive Consistency	
Trace	0 to 10%	0-10	Loose	0-4	Soft
Little	10 to 20%	10-30	Med Dense	4-8	Med Stiff
Some	20 to 35%	30-50	Dense	8-15	Stiff
And	35 to 50%	50+	Very Dense	15-30	V. Stiff

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TO:	Town of Vershire 6894 Vershire Center Road Vershire, VT 05079	PROJECT NAME: LOCATION: MW JOB #:	Vershire Town Garage Vershire Center Road	SHEET: DATE: HOLE #: LINE & STA. OFFSET:	3 of 5 6/25/20 B-3

Ground Water Observations: Collapsed at 3.5', dry to there	Augers-Size I.D. Split Spoon Hammer Wt. Hammer Fall	4.25" 1.5" 140# 30"	Surface Elevation: Date Started: Date Completed: Boring Foreman: Inspector: Soils Engineer:	unknown 6/25/2020 6/25/2020 T&K Drilling Randy Rhoades

LOCATION OF BORING: Near center of east wall of building, offset 10' into building

Sample Depths From/To (Feet)	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0-2	3/4/6/6			Loam to Loamy sand	1	24	24
			12"	Olive grey silty sand, trace gravel			
2-4	3/5/7/13		2'	Same, some weathered gravel	2	24	24
		Moist					
4-6	3/6/7/11				3	24	24
6-8	10/26/31/29		6'	Same, some larger very weathered rocks	4	24	24
			7'	Very slow drilling			
		Drier		Olive grey till - silty sand, some weathered rock			
10-12	20/27/31/50				5	24	24
			12'	No refusal			

Ground Surface to 12' Used: 4.25" HSA

Earth Boring	12'
Rock Coring	0'
Samples:	5
HOLE NUMBER	B-3

Proportions Used		Cohesionless Density (Sum of blow counts, 6-18")		Cohesive Consistency	
Trace	0 to 10%	0-10	Loose	0-4	Soft
Little	10 to 20%	10-30	Med Dense	4-8	Med Stiff
Some	20 to 35%	30-50	Dense	8-15	Stiff
And	35 to 50%	50+	Very Dense	15-30	V. Stiff

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TO:	Town of Vershire 6894 Vershire Center Road Vershire, VT 05079	PROJECT NAME: LOCATION: MW JOB #:	Vershire Town Garage Vershire Center Road	SHEET: DATE: HOLE #: LINE & STA. OFFSET:	4 of 5 6/25/20 B-4

Ground Water Observations: Dry	Augers-Size I.D. Split Spoon Hammer Wt. Hammer Fall	4.25” 1.5" 140# 30"	Surface Elevation: Date Started: Date Completed: Boring Foreman: Inspector: Soils Engineer:	unknown 6/25/2020 6/25/2020 T&K Drilling Randy Rhoades

LOCATION OF BORING: SE corner proposed shed, in clearing

Sample Depths From/To (Feet)	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0-2	4/2/4/7		3”	Loamy sand, *	1	24	24
				Olive brown silty sand, little gravel			
2-4	6/8/8/12		2.5’	Olive grey silty sand, little gravel and weathered rocks	2	24	24
5-7	9/25/24/30				3	24	18
7-9	36/46/47/63				4	24	24
			9’	No refusal			
				*Some boulders scattered on surface			

Ground Surface to 9’ Used: 4.25" HSA

Earth Boring	9’
Rock Coring	0
Samples:	4
HOLE NUMBER	B-4

Proportions Used		Cohesionless Density (Sum of blow counts, 6-18”)		Cohesive Consistency	
Trace	0 to 10%	0-10	Loose	0-4	Soft
Little	10 to 20%	10-30	Med Dense	4-8	Med Stiff
Some	20 to 35%	30-50	Dense	8-15	Stiff
And	35 to 50%	50+	Very Dense	15-30	V. Stiff

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PO Box 1466 ° Charlestown, NH 03603 ° 603-826-5873

TO:	Town of Vershire 6894 Vershire Center Road Vershire, VT 05079	PROJECT NAME: LOCATION: MW JOB #:	Vershire Town Garage Vershire Center Road	SHEET: DATE: HOLE #: LINE & STA. OFFSET:	5 of 5 6/25/20 B-5

Ground Water Observations: Dry	Augers-Size I.D. Split Spoon Hammer Wt. Hammer Fall	4.25” 1.5" 140# 30"	Surface Elevation: Date Started: Date Completed: Boring Foreman: Inspector: Soils Engineer:	unknown 6/25/2020 6/25/2020 T&K Drilling Randy Rhoades

LOCATION OF BORING: NW corner of proposed sand shed

Sample Depths From/To (Feet)	Blows per 6" on Sampler	Moisture Density or Consist.	Strata Change Elev.	Soil Identification	Sample No.	Sample Pen. Inches	Sample Rec. Inches
0-2	4/3/8/9			Loamy sand	1	24	24
			12”	Olive sand, little silt and gravel			
2-4	10/9/11/12				2	24	20
			3’	Olive silty sand, little fine gravel, some very weathered rock			
5-7	6/7/6/18	Moist			3	24	18
7-8.5’	26/38/65				4	18	10
			8.5’	No refusal, very dense till			

Ground Surface to 8.5’ Used: 4.25" HSA

Earth Boring	8.5’
Rock Coring	0
Samples:	4
HOLE NUMBER	B-5

Proportions Used		Cohesionless Density (Sum of blow counts, 6-18”)		Cohesive Consistency	
Trace	0 to 10%	0-10	Loose	0-4	Soft
Little	10 to 20%	10-30	Med Dense	4-8	Med Stiff
Some	20 to 35%	30-50	Dense	8-15	Stiff
And	35 to 50%	50+	Very Dense	15-30	V. Stiff

APPENDIX C

Laboratory Soil Gradation Reports

Vershire Town Garage

Vershire, VT

M&W SOILS ENGINEERING, INC

SOILS AND CONCRETE LABORATORY

159 East Street
PO Box 1466
Charlestown,NH 03603
603-826-5873

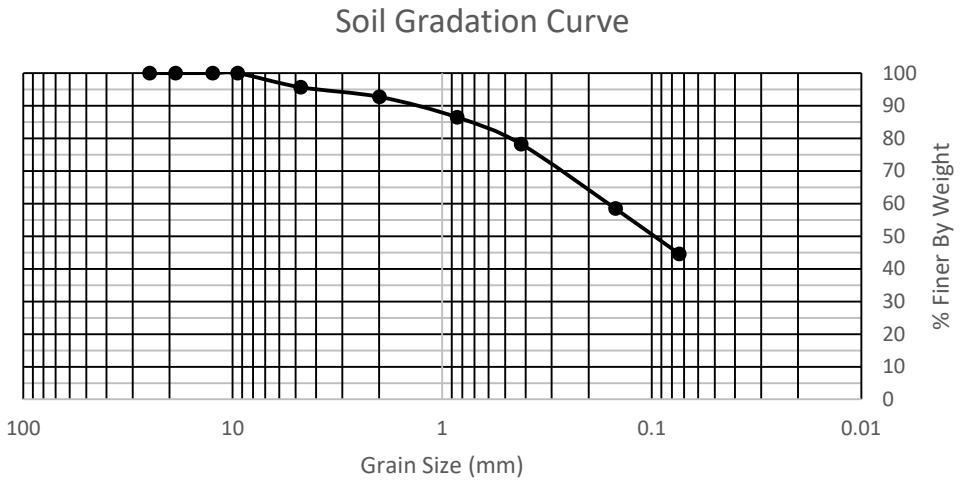
MECHANICAL ANALYSIS OF AGGREGATES AND GRANULAR MATERIAL

Project: **VERSHIRE TOWN GARAGE**

Type of Material:	Silty sand	Sample #:	B1_4to6ft
Source of Material:	Boring B-1	Date in Lab:	6-25-20
Sample from:	4-6' below grade	Date Tested:	8-27-20
Report To:	Town of Vershire	Technician:	L. Roy

Sieve	Weight	% Retained	Cumulative % Retained	Cumulative % Finer	Specification
1"	0	0.0	0.0	**100.0**	
3/4"	0	0.0	0.0	**100.0**	
1/2"	0.0	0.0	0.0	**100.0**	
3/8"	0.0	0.0	0.0	**100.0**	
4	7.8	4.3	4.3	**95.7**	
10	5.4	3.0	7.3	**92.7**	
20	11.3	6.2	13.5	**86.5**	
40	14.9	8.2	21.8	**78.2**	
100	35.8	19.8	41.5	**58.5**	
200	25.1	13.9	55.4	**44.6**	
pan	80.7	44.6	100.0	**0.0**	

Moisture Content: 17.8 %



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159 East Street
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Charlestown,NH 03603
603-826-5873

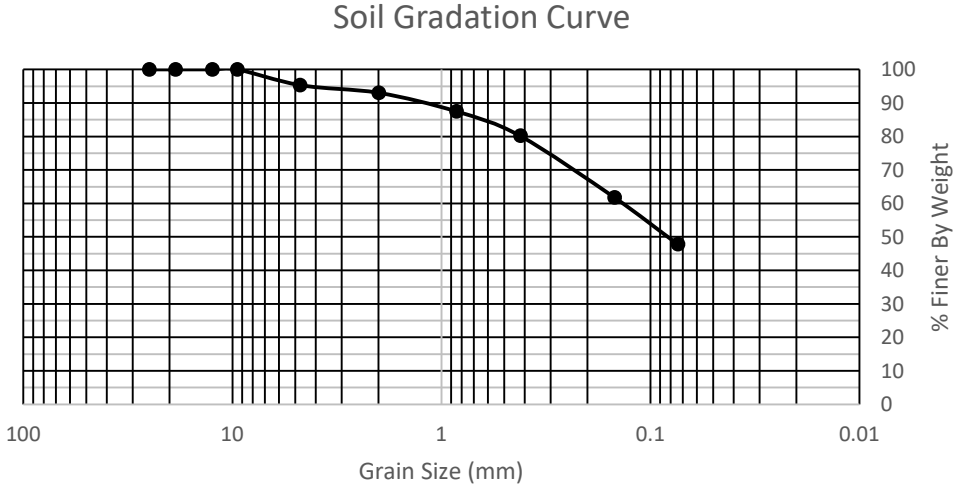
MECHANICAL ANALYSIS OF AGGREGATES AND GRANULAR MATERIAL

Project: **VERSHIRE TOWN GARAGE**

Type of Material:	Silty sand	Sample #:	B2_4to6ft
Source of Material:	Boring B-2	Date in Lab:	6-25-20
Sample from:	4-6' below grade	Date Tested:	8-27-20
Report To:	Town of Vershire	Technician:	L. Roy

Sieve	Weight	% Retained	Cumulative % Retained	Cumulative % Finer	Specification
1"	0	0.0	0.0	**100.0**	
3/4"	0	0.0	0.0	**100.0**	
1/2"	0.0	0.0	0.0	**100.0**	
3/8"	0.0	0.0	0.0	**100.0**	
4	7.8	4.7	4.7	**95.3**	
10	3.8	2.3	7.0	**93.0**	
20	9.2	5.5	12.5	**87.5**	
40	12.1	7.3	19.8	**80.2**	
100	30.5	18.4	38.2	**61.8**	
200	23.2	14.0	52.2	**47.8**	
pan	79.2	47.8	100.0	**0.0**	

Moisture Content: 21.2 %



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603-826-5873

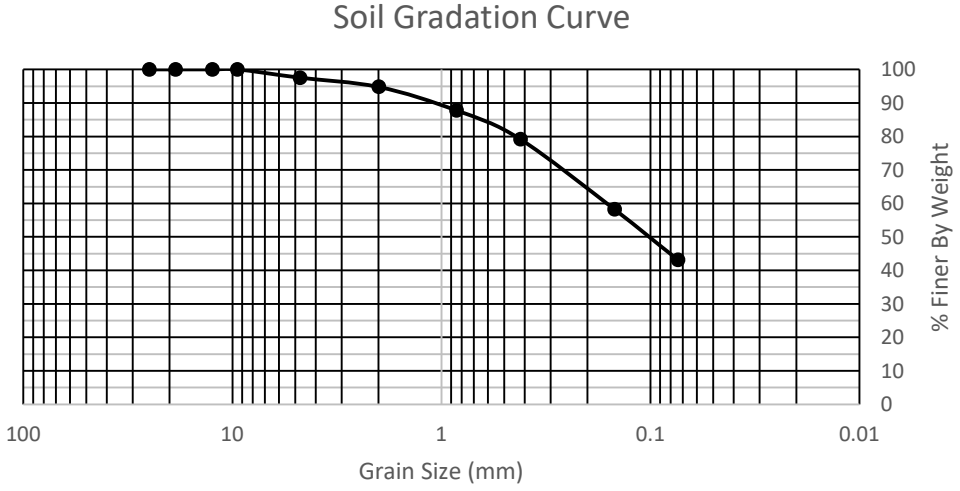
MECHANICAL ANALYSIS OF AGGREGATES AND GRANULAR MATERIAL

Project: **VERSHIRE TOWN GARAGE**

Type of Material:	Silty sand	Sample #:	B3_6to8ft
Source of Material:	Boring B-3	Date in Lab:	6-25-20
Sample from:	6-8' below grade	Date Tested:	8-27-20
Report To:	Town of Vershire	Technician:	L. Roy

Sieve	Weight	% Retained	Cumulative % Retained	Cumulative % Finer	Specification
1"	0	0.0	0.0	**100.0**	
3/4"	0	0.0	0.0	**100.0**	
1/2"	0.0	0.0	0.0	**100.0**	
3/8"	0.0	0.0	0.0	**100.0**	
4	5.0	2.5	2.5	**97.5**	
10	5.5	2.7	5.2	**94.8**	
20	14.2	7.0	12.2	**87.8**	
40	17.4	8.6	20.8	**79.2**	
100	42.4	21.0	41.8	**58.2**	
200	30.5	15.1	56.8	**43.2**	
pan	87.2	43.1	100.0	**0.0**	

Moisture Content: 12.5 %



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SOILS AND CONCRETE LABORATORY

159 East Street
PO Box 1466
Charlestown,NH 03603
603-826-5873

MECHANICAL ANALYSIS OF AGGREGATES AND GRANULAR MATERIAL

Project: **VERSHIRE TOWN GARAGE**

Type of Material:	Silty sand	Sample #:	B5_2.5to4ft
Source of Material:	Boring B-5	Date in Lab:	6-25-20
Sample from:	2.5-4' below grade	Date Tested:	8-27-20
Report To:	Town of Vershire	Technician:	L. Roy

Sieve	Weight	% Retained	Cumulative % Retained	Cumulative % Finer	Specification
1"	0	0.0	0.0	**100.0**	
3/4"	0	0.0	0.0	**100.0**	
1/2"	0.0	0.0	0.0	**100.0**	
3/8"	0.0	0.0	0.0	**100.0**	
4	8.1	4.6	4.6	**95.4**	
10	4.0	2.3	6.9	**93.1**	
20	11.1	6.3	13.2	**86.8**	
40	15.0	8.6	21.8	**78.2**	
100	37.2	21.2	43.0	**57.0**	
200	24.8	14.1	57.2	**42.8**	
pan	75.1	42.8	100.0	**0.0**	

Moisture Content: 15.7 %