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February 14, 2014

Ms. Rhian M.J. Cull, Esq.
rcull@haslaw.com
Hinckley, Allen & Snyder LLP
28 State Street
Boston, MA 02109-1775

RE: Wolfeboro, New Hampshire Rapid Infiltration Basins

Dear Ms. Cull:

In our reports dated October 19, 2012 and February 8, 2013, Fuss & O'Neill opined that the Town of Wolfeboro's (the "Town") RIB Site cannot dispose of the design capacity, or indeed, anything remotely near that level of discharge without resulting in slope collapse, channelization of the wetlands and the creation of discrete discharges. Following the submittal of the Fuss & O'Neill Reports, Wright-Pierce hired Haley & Aldrich to produce a slope remediation plan and Field Geology Service to report on the wetlands. Wright-Pierce has maintained the position that the RIB Site, with certain remediation work, can dispose of an annual average of 600,000 gpd without violating Federal and State laws. We respectfully disagree with this assertion.

At your request, Fuss & O'Neill recently performed additional site investigation work at the RIB Site to determine how much, if any, effluent could be discharged to the RIB Site without damaging the RIB Site, producing discrete discharges, and violating local and federal regulations. The purpose of this letter is to summarize that recent work and to provide an update of our opinion on the ability of the RIB Site to accommodate the original permitted flow rate of 600,000 average annual gallons per day (gpd), or any lower flow rate without causing damage to the RIB Site or producing discrete discharges. This opinion is based upon both our historical knowledge of the RIB Site, which includes previous investigations by others and the recent subsurface explorations coordinated and observed by Fuss & O'Neill.

Over the past 11 months, 150,000 gpd of treated effluent has been discharged to RIBs 2 and 3 with about 83 percent of that flow breaking out to the ground surface (based on measurements obtained by the Town 3 or 4 times per week at two weirs constructed at the outlets of the two surface breakouts located in the Central and Western Wetlands areas, respectively). This break out has been measured by the Town at the outlets to the western and central discharge points by measuring the depth of flow through the weirs, converting the depth of flow in each weir to a daily flow rate. The Town has been advised by the NHDES that these break outs are considered to be discrete discharges, which are not permitted under Federal or State laws. The Town has been further advised by the NHDES that the only way to correct this condition and to enable the operation of

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the RIB Site to comply with Federal and State regulations is to reintroduce the breakout flow back into the ground and for the flow to travel to Nineteenmile Brook without further breakouts.

Based on topography, locations of wetlands, and locations of surface breakouts (reflected in Figure 2 of W-P Phase 3 Hydro Report), the area to the south and south west of the RIB basin can be divided into three logical groundwater discharge areas, similar to smaller watersheds within a larger watershed. These sub-areas have been labeled 1) the Western Groundwater Discharge area (from approximately Weir 7 at the Tuftonboro Sand Trap to the paved section of the access road; within this discharge area is the Western Wetland Area); 2) the Central Groundwater Discharge area (from the paved access road to Weir 6 at the Wolfeboro Sand Trap; within this area is the Central Wetland Area); and 3) the Eastern Groundwater Discharge Area (from Weir 6 to approximately the power line easement). In this report we will refer to these areas simply as Western, Central and Eastern discharge areas.

The topography and wetland soils in the Western and Central Discharge Areas limit their ability to transmit the effluent within the ground, reflected by the flow breakouts upgradient of and within these areas, creating soil piping, slope failures, sink holes and channelization of the breakout flow. The Eastern Discharge Area consists of more favorable topography without known pre-RIB construction seepage points. The Eastern Discharge Area is therefore the only area left on the site with any potential for reintroducing the breakout flow. Fuss & O'Neill recently performed further site investigations in this area, as discussed in detail below, our conclusion is that this area has **extremely** limited ability to accept effluent flow above the existing baseline groundwater flow and does **not** have the capacity to accommodate the flow from the existing discrete discharges at the existing 150,000 gpd in RIBs 2 and 3, and the existing 50,000 gpd at RIBs 4 and 5. **As described below, the maximum effluent flow rate that can be accommodated in the Eastern Discharge Area is only 8,900 gpd.**

Background

As part of Fuss & O'Neill's on-going review of the present and future potential capacity of the RIB Site, we noted that much of the previous investigations of the RIB Site (conducted by Wright Pierce and its subconsultants) focused almost entirely on the upper portions of the RIB Site, immediately below the RIB basins. Three test pit excavations were performed downgradient of the Western Wetland Area (TP-8, TP-9, and TP-10) as part of the Phase 3 Hydrogeologic Study, and a

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few test pit excavations were performed by Wright Pierce in 2006, the purpose of which was to evaluate the RIB Site as a borrow material source, Other than the 2006 test pits performed as part of the borrow study, there is no information concerning the soils nearer the lower portions of the RIB Site below an approximate elevation of 610 feet in the Eastern Discharge Area, (the only area remaining area on RIB Site available for discharge of treated wastewater). Of those excavations performed by Wright-Pierce in 2006 as well as TP-8, TP-9, and TP-10 from the Phase 3 Hydrogeologic Study, the logs of the test pits generally indicated silty sand, silt, and clay soil types, in other words, soils that are normally associated with low permeabilities. Indeed, the soil types described in Wright Pierce's 2006 test pit logs typically would not be thought of as conducive to groundwater discharge. It is unclear whether Wright-Pierce considered those logs as part of its Phase 3 Hydrogeologic Report. However, if they had been so considered, we would expect that the soil types described in those logs would have been confirmed, tested by Wright-Pierce and had wells installed to determine groundwater elevations to allow Wright Pierce to estimate the permeability of the soil in the Eastern Discharge Area. There is no evidence that Wright Pierce performed such a confirmation exercise. Further, these test pits were not discussed in the Wright Pierce Phase 3 Hydrogeologic Report, nor were the test pit logs included as part of the Report. We therefore assume that the results of these test pits were not considered during Wright-Pierce's evaluation of the RIB Site. Wright-Pierce's design of the RIB system was therefore made with no knowledge of the conditions of the lower half of the RIB Site: a major oversight.

SW Cole performed additional borings along the mid-slope of the Eastern Discharge Area (approximate elevations 600 to 610) during their study of the RIB Site in 2011 (which was jointly commissioned by the Town and Wright-Pierce). However, there remained a lack of information concerning the soils further downgradient of the SW Cole borings and their ability or inability to receive effluent flow discharged from the RIBs without the water discharging to the ground surface, resulting in discrete point source discharges to Nineteenmile Brook.

Recent documents prepared by Wright Pierce and their subconsultants, Haley & Aldrich dated – August 2013 and Field Geology Services dated December 26, 2013 were also reviewed by Fuss & O'Neill. The Haley & Aldrich report addresses repair of the seepage at one of the existing discrete discharges area of the RIB Site, focusing on improving slope stability and controlling migration of sand and fines from within the embankment at that location. The report produced by Field Geology Services provides a brief opinion concerning the repair of the damage done to the Western Wetland Area. Neither report was supported by detailed engineering or scientific design.

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Further, neither report addressed the underlying problems with the original Wright Pierce design of the RIB system or identified a solution to eliminate the discrete discharges.

To better understand the soil at these lower elevations in the Eastern Discharge Area, Fuss & O'Neill recently (December 13, 2013) coordinated a day of test pit excavations at elevations 610 and lower to observe the soil in the uppermost soil horizon, measure groundwater levels, and collect soil samples for testing.

Additional Investigations

1. Fuss & O'Neill coordinated a day of test pit excavations at the RIB site in the Eastern Discharge Area at approximate elevation 610 and lower. An excavator and operator were provided by the Town of Wolfeboro Department of Public Works (DPW) for the purpose of excavating test pits to observe the soil types and groundwater levels, and collect soil samples for laboratory testing.

2. Test pit excavations were observed and logged by a Fuss & O'Neill geotechnical engineer licensed in the State of New Hampshire and a Fuss & O'Neill hydrogeologist. Professor Jean Benoit of the University of New Hampshire was also present to observe the test pit excavations. Some of the work was also witnessed by Mr. Peter Cooperdock, a licensed soil scientist in the state of New Hampshire, who is familiar with the RIB Site from past work at the Site.

3. Soil samples were obtained from the test pit excavations and sent to a geotechnical testing laboratory, GeoTesting Express of Acton, Massachusetts, for grain size analysis and permeability testing.

4. Logs and records of past subsurface explorations performed by other firms engaged in the design and review of the work at the RIB Site were reviewed. These included work performed by the designer of the RIB system, Wright Pierce (including the test pits performed in December 2006), and SW Cole.

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Direct Observations

Fuss & O'Neill visited the RIB Site on June 15, 2010 and again on July 15, 2010. At those times, the slope failure had already occurred upgradient of the Central Wetland Area and soil piping from points upgradient of both the Central and Western Wetlands Areas was active. Significant sand deposition in the form of deltas had formed in the wetlands and seepage flow was cutting channels through the wetlands, washing sand through the existing wetlands toward Nineteenmile Brook. At that time the RIB system was discharging at a rate of approximately 330,000 gallons per day (gpd) into RIBs No. 1, 2, and 3. During our site inspection, we noted that the ground surface was saturated at elevations higher than those of the wood road cutting across the downgradient slope in the southwest to northeast direction. These observed groundwater breakouts were well above the elevations and outside the discharge areas where breakouts were predicted by Wright-Pierce in its Phase 3 Hydrogeologic Report for the designed and permitted 600,000 gpd average annual loading rate. During our site visits in 2010, the water was seeping to the surface in such quantities that it was channeling down the wood road, and flowing to water bars constructed by the Town along the road. The water bars were constructed in 2009 to mitigate erosion damage from groundwater breakout and to prevent the wood road from being washed out.

SW Cole, in their 2011 study, depicted groundwater breakout zones in the Eastern Discharge Area on their figures at elevations of 600 and 605 feet for a loading rate of 500,000 gpd, also well above the elevations and groundwater discharge area depicted by Wright Pierce in their Phase 3 Hydrogeologic Report.

On May 10, 2011, Peter Cooperdock, CSS of Fernstone Associates in Tamworth, New Hampshire inspected the RIB Site downgradient of the RIBs in the Eastern Discharge Area and delineated a zone of groundwater surface breakout on the slope downgradient of RIBs 2 and 3 and east of the Central Wetland Area. The location of the observed limit of ground surface saturation is indicated on the attached site plan. As can be seen on the attached site plan, surface saturation at that time also extended well upgradient of the wood road. The steady state flow rate to RIBs no. 2 and 3 at the time was 250,000 gpd, less than half the permitted average annual rate of 600,000 gpd.

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Test Pit Excavations

Fuss & O'Neill observed and logged 15 test pit excavations at the RIB Site on December 13, 2013. The purpose of these test pits was to confirm soil types in boring and test pit logs previously performed by others, and to collect samples for laboratory testing. Previous laboratory testing were concentrated on soils obtained from borings and test pits performed in the upper portions of the slope, and the lower slope soil types were largely unconfirmed and untested. At the time of the Wright Pierce Phase 3 Hydrogeologic Report, the only subsurface explorations completed on the slopes in the Eastern Discharge Area were soil boring B-7 and test pit excavations TP-10, TP-11, TP-12, TP-29, TP-30, TP-31, and TP-32. The latter four test pits were not shown on any of the Phase 3 study plans and the logs were not included in Wright-Pierce's Phase 3 Hydrogeologic Report. Only the information from B-7, TP-10, TP-11, and TP-12 appears to have been considered in the Wright-Pierce's Phase 3 Hydrogeologic Report. No field or laboratory testing was performed on the soils from B-7, TP-10, TP-11, and TP-12, so data used to support Wright Pierce's modeling input parameters for groundwater elevations and permeabilities of the soil in the Eastern Discharge Area were based solely on descriptions of the soil in the logs of the explorations, without any field or laboratory testing.

The December 2013 test pits observed by Fuss & O'Neill were located on the lower slope downgradient of RIB basins 2 and 3 as indicated on the attached site plan. The test pits were performed at elevations between approximately 610 and 550, all north of Nineteenmile Brook. At the time of our test pits, the loading rate to RIBs 2 and 3 was 150,000 gpd, and in the RIB system had been operating at that flow rate for over 230 days.

Test pits were excavated by the Town's Department of Public Works using a tracked excavator. Depths of the test pits ranged from approximately 5 feet to 14 feet. Excavation depths were limited by boulders and/or bedrock encountered that could not be penetrated, and/or by the collapse of the excavation sidewalls due to groundwater seepage. Several excavations were left open to allow the groundwater level to equlibrate prior to measuring groundwater depths at the end of the day.

The TP-101 series of test pits were performed at approximate elevations 600 to 610 in the vicinity of the SW Cole monitoring well MW-35. Soil conditions observed in the TP-101 series test pit excavations generally consisted of light brown fine sand and silt to the bottom of the test pits. Boulders were occasionally encountered intermixed with the sand and silt. In the majority of the

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test pits, faint stratification of the sand was visible, but no distinct layers of silt or gravel were observed. Groundwater depths ranged from approximately 8 feet to 12 feet below ground surface. Excavator refusal was encountered at depths ranging from 8 to 14 feet below ground surface. Test pit logs are attached.

Soil conditions encountered in the TP-102 series along the wood road generally consisted of light brown sand and silt, with more boulders encountered. Groundwater levels observed in these test pits were approximately 4 to 6.5 feet below ground surface.

Soil observed in test pit excavations TP-103, TP-107, and TP-108 varied significantly from the light brown fine sand and silt observed in the other test pits. TP-103 was located adjacent to the power line easement approximately 75 feet upgradient of the unnamed brook. The color and consistency of the soil differed from other test pits in that it was coarser, darker and there was a distinct gravel layer with cobbles present. Test pits TP-107 and TP-108 were excavated on either side of the wood road where numerous large surficial boulders were located. Exposed boulders are visible at the ground surface along a line extending from the wood road northward at this location. There were numerous large boulders (one boulder was approximately 3 feet wide by 8 feet long) excavated at this location, and groundwater was observed flowing into the test pit at an approximate depth of 5.5 feet.

Test pits TP-104, TP-105, and TP-106 were excavated in the lower (elevations 550 to 570) flatter southern area of the Eastern Discharge Area closer to the wetlands north of Nineteenmile Brook. The soil particles appeared finer in these test pits, especially at TP-106. The soil in TP-106 consisted of silt and fine sand to the bottom of the test pit excavation at 10 feet. The soil in TP-104 and TP-105 consisted of a 2 to 3.5 foot thick layer of light brown fine sand and silt underlain by a 3 to 4 foot thick layer of coarser silty sand and gravel with cobbles. Below the silty sand and gravel the soil consisted of silty sand intermixed with cobbles and small boulders to the bottom of the test pits. Groundwater was encountered in these three test pits at depths ranging from 2 to 3.5 feet below ground surface.

Soil samples were obtained from five of the test pits for sieve analyses and laboratory permeability testing. Two samples from TP-102a and two samples from TP-106 were obtained from the side walls of the test pit excavations using a double-walled push tube sampler. The push tube sampler was used in test pits TP-102a and TP-106 to extract samples in a horizontal direction from the

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sidewalls of the test pit at approximately 3.5 feet below ground surface. Soil samples were obtained from the test pit sidewalls before the groundwater was able to rise to stabilized levels. (The time for the water to reach stabilized levels is a qualitative indication that the soils may have relatively low permeabilities.)The tubes were wrapped with plastic and taped for transport to the laboratory.

Laboratory Testing

Five soil samples were submitted to GeoTesting Express of Acton, Massachusetts for sieve analysis in accordance with ASTM D 422 (without hydrometer). The four tube samples were subjected to constant head permeability testing using a modified ASTM D 2434 testing method. The test method was modified in that the samples were tested in the tubes and not at the standard sample diameter and length. Although reasonable care was used to push the samplers in the sidewalls of the test pits and retract the filled tubes slowly, disturbance is inevitable in sampling saturated cohesionless soils. During extraction of the tubes, the soil demonstrated sufficient suction to keep the samples within the tubes. The soil appeared saturated. Measured saturation levels of the tube samples ranged from 95 to 97 percent. It should be noted that additional disturbance is likely during transport and specimen preparation for laboratory testing. For this reason, we had the laboratory reconstitute samples from each test pit excavation at similar densities to those measured in the tubes and test them again in strict accordance with ASTM D 2434 for comparison with the tube samples.

Summary of Testing

The following paragraphs summarize the test results and observations during the test pit program. The laboratory test results are attached.

1. Field observations of the test pit excavations indicate that most of the observed soils close to the ground surface, which includes all the unsaturated soil zone above the current water table, are similar over much of the Eastern Discharge Area, especially among those test pits excavated to the east and west of monitoring well MW-35 and those located along the wood road. The five sieve test results from the TP-101 series, the TP 102 series and TP-106 reveal that all the samples had fines content (percent passing the No. 200 sieve) greater than 47 percent, except one with a fines content of 15 percent. The fines content of the TP-106 sample was 75 percent. These results are consistent with the soil descriptions in the

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logs of the test pits performed by Wright Pierce in 2006, with soils having high fines content and with the finest-grained soils observed in the area of TP-32 and TP-106. We believe the high fines content of the near surface soil layer we observed and tested on the slope downgradient of RIBs 2 and 3 in the Eastern Discharge Area is indicative of soil with lower permeabilities than those used in the modeling performed as part of the Phase 3 Hydrogeologic study.

2. Laboratory permeability testing of the four tube samples indicated permeabilities ranging of 3.1 feet/day and 7.6 feet /day in the TP-106 location, and 1.7 feet/day and 5.1 feet/day in the TP-102a location. When the samples were reconstituted to perform permeability test in a conventional permeameter, the tested permeabilities were 3.97 feet per day at the TP-106 location and 16.4 feet per day at the TP-102a location. These permeabilities appear consistent with expected order of magnitude permeabilities for these soil types.

3. Stabilized groundwater observations in the test pits indicated available unsaturated soil thickness of 4 to 5 feet along the wood road and approximately 3 feet in the low area south of the wood road. While the groundwater levels indicated the location of saturated soil levels, hand auger soil samples of soil within the upper 12 inches of the soil indicated very wet soil conditions, likely due to capillary action of the silt and fine sand. This reduces the volume of the unsaturated soil thickness available for additional treated wastewater to be introduced into the Eastern Discharge Area.

4. Based on direct observations, saturated surface soil and seepage breakouts were observed at elevations north of the wood road on the slope downgradient of RIBs 2 and 3 at flow rates of 250,000 gpd and 330,000 gpd.

Capacity Estimates

Using Darcy's flow equation, SW Cole in their 2011 report demonstrated that effluent discharged to the RIB Site at a rate of 600,000 gpd (assuming a 30-foot depth of unsaturated soil) will result in breakouts and surface discharge between approximate elevations 600 and 605 across an area spanning a distance MW-13 and MW-35, encompassing the Central Discharge Areas and part of the Eastern Discharge Area.

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1. Based on a similar analysis of the lower slopes of the Eastern Discharge Area, using Darcy's flow equation, Fuss & O'Neill performed a similar calculation for the soil along the wood road using data from the TP-102 series test pits and TP-102a in particular. For the calculation, Fuss & O'Neill used SW Cole's highest hydraulic gradient of 0.1667 and flow width of 700 feet. The calculation was also based on the existing available unsaturated soil thickness, 5 feet, and the highest tested permeability in the TP-102 series, 16.4 feet per day. The result indicates that the **maximum** effluent flow above the baseline groundwater flow that can be accommodated by the soil in the Eastern Discharge Area under these most favorable observed conditions is **71,570 gpd**.

2. Performing a similar analysis at lower elevations (elevation 550 to 570) in the Eastern Discharge Area, closer to the wetlands north of Nineteenmile Brook, reveals still lower capacity. Assuming the hydraulic gradient is a little steeper than the ground surface elevation of 5 to 6 percent, say 10 percent (or i=0.1), an available unsaturated thickness of 3 feet, and a tested permeability of 3.97 feet per day, and assuming the flow is able to spread laterally to a width of 1,000 feet (a line roughly parallel to the slope approximately along elevation contour 560 from the edge of the Central Wetland Area to the power line easement), the maximum effluent flow above the baseline groundwater flow that can be accommodated by the soil in the Eastern Discharge Area under the most favorable conditions is **8,900 gpd**.

   Please note that most of the assumptions used in the above calculations are very conservative in that they produce higher estimated flow capacity than would be realized in practice. For instance:

   - All tested soil samples have significantly higher fine contents than the sample from TP-102a used in the calculation, (16.4 feet per day, the only tested permeability greater than 7.6 feet per day), and thus likely have lower permeabilities than that used in the calculation.

   - The gradients on the lower flatter portions of the slope are likely closer to the ground surface slope and thus lower than that used in our calculation. A lower gradient would result in lower flow capacity of the soil.

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- The soil above the water table was wet during our test pit excavations, so the full unsaturated thickness is not available for additional flow, contrary to the assumption in our calculations. We assumed all the pore spaces between soil particles were available for additional flow. However, the unsaturated soil was quite wet and much of the space between the soil particles is already occupied with water, reducing the capacity for additional water to be introduced without breaking out at the ground surface.

Conclusions

The following two conclusions can be drawn from the above summaries:

1. The capacity estimates of the Eastern Discharge Area made by SW Cole and Fuss & O'Neill are significant in that they point clearly to a pre-existing limitation of the RIB Site that was previously not considered by Wright-Pierce. Although SW Cole showed that the capacity of the RIB Site was far less than indicated by Wright Pierce in its Phase 3 Hydrologic Report, a similar analysis at two elevations lower than the elevation analyzed by SW Cole indicates that the unsaturated thickness of soil available to transport effluent without surface breakout decreases **significantly** as it progresses down the slope. The available cross sectional flow area "pinches out" at the base of the slope. At any discharge greater than the current flow volume, subsurface water flow has no choice but to discharge to the surface before it reaches the low area south of the wood road. The effluent flow capacity of **8,900 gpd** should be considered the **maximum** limit that the Eastern Discharge Area can accommodate without resulting in discrete discharges. This limitation applies regardless of any efforts to correct slope instability or wetland damage in other parts of the RIB Site. This limitation also applied at the time of the Wright Pierce Phase 3 Hydrogeologic study, but was not considered.

2. It is clear from the capacity estimates of the Eastern Discharge Area that there is no way to collect the 130,000 gpd from the existing discrete point source discharges in the Central and Western Discharge Areas and to transport that water to the Eastern Discharge Area for subsurface disposal. The water will simply not stay in the ground and will take the form of discrete discharges again.

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The following conclusions can also be made based on Fuss & O'Neill's site investigations and additional calculations:

1. Based on estimates of flow capacity of the lower slopes of the Eastern Discharge Area, the Eastern Discharge Area is likely at its capacity for subsurface flow now. Any additional flow to this area will result in significant surface discharge of treated effluent to the ground surface north of the wetlands associated with Nineteenmile Brook.

2. Surface discharges that occur in the Eastern Discharge Area will very likely coalesce into multiple shallow concentrated flows, which are likely to further join to form discrete discharges before entering Nineteenmile Brook. Fuss & O'Neill does not believe there are any methods available to prevent this concentrated flow from developing into discrete surface discharges under sustained RIB loading rates higher than those currently in place.

3. Due to inevitable preferential groundwater flow paths, localized flow gradients could be higher than those indicated in monitoring wells. Increased seepage pressures under sustained RIB loads approaching current permitted flow rate limits could result in initiation of soil piping and slope failure in the Eastern Discharge Area.

In summary, based on directly observed responses to the introduction of high volumes of water to this RIB Site, and based on testing and analysis by SW Cole and Fuss & O'Neill, it is our opinion that this RIB Site was **never** able to accommodate the designed average annual flow rate of 600,000 gpd or even the current permit rates of 340,000 annual average gpd without creating significant discrete discharges across the slope downgradient of RIBs 2 and 3, including the Eastern Discharge Area. Discrete discharges collected from existing seepage points in the Central and Western Discharge Areas cannot be reintroduced to the Eastern Discharge Area because the Eastern Discharge Area is already very close to its capacity.

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In our opinion, there are **no** cost effective solutions that will make this RIB Site acceptable for disposal of treated effluent, at any but an insignificant loading rate. Continued operation of the RIB system at the RIB Site will result in continuing discrete discharges in violation of Federal and State regulations and permit requirements.

Sincerely,

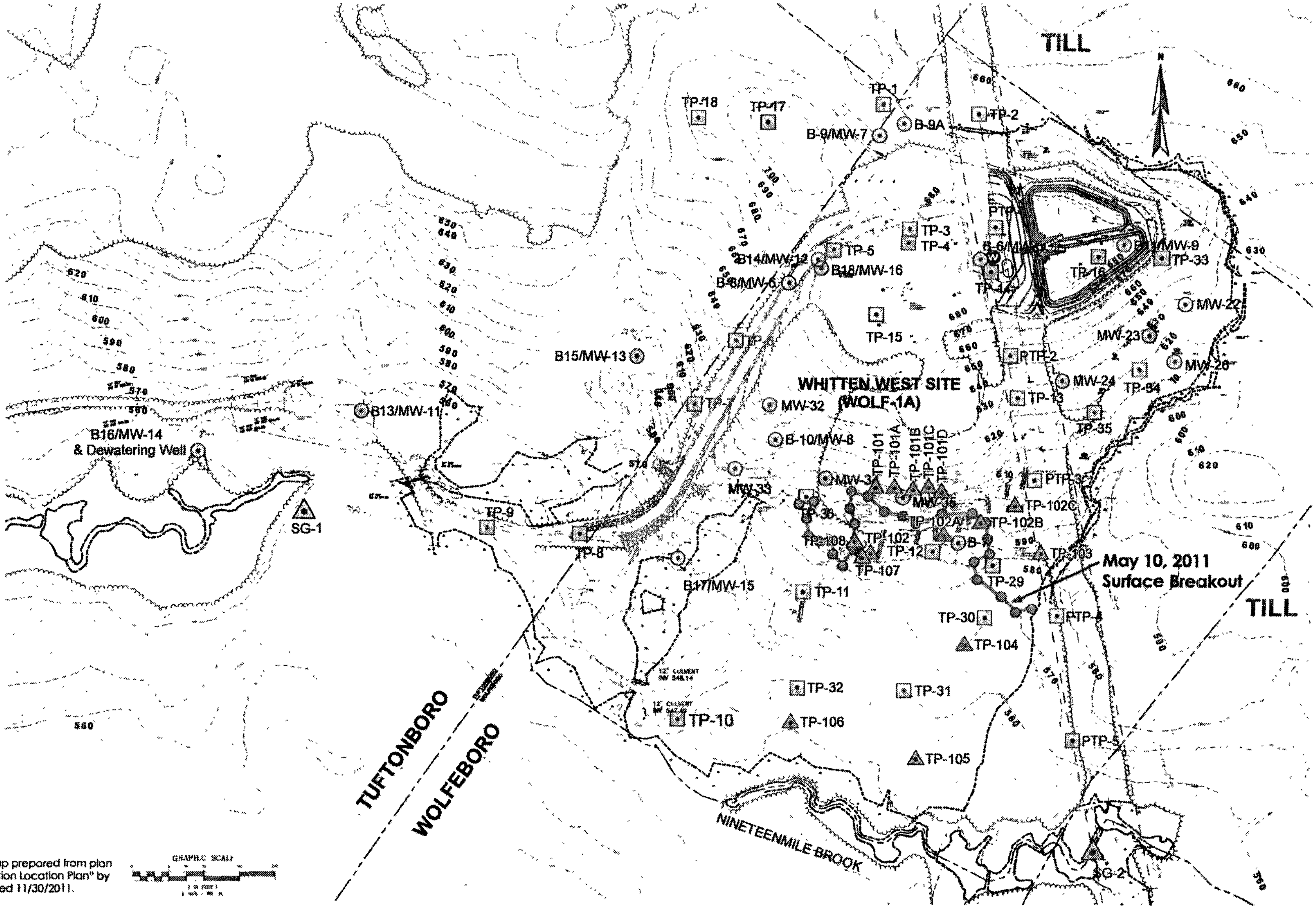
Christopher J. Cullen

Christopher J. Cullen, P.E.
Project Manager

/ndt

Attachments: Test Pit Logs
Subsurface Exploration Plan
Laboratory Test Results

c: David Ford, Town of Wolfeboro



Note: Base map prepared from plan titled "Exploration Location Plan" by S.W. Cole, dated 11/30/2011.

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Exploration Location Plan – Wolfeboro, New Hampshire

JANUARY 7, 2014

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Test Pit No. 101

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND and SILT (dry)	
2'		
3'		
4'		
5'		
6'		
7'		
8'		
9'		
10'		1
11'	Bottom of test pit at 10 feet (no refusal)	
12'		
13'		
14'		
15'		

Remarks: 1. No groundwater encountered.

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Test Pit No. 101a

Project: Wolfeboro RIB Site
Technician: C Cullen
Location:

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'	Light brown fine SAND and SILT	
4'		
5'		
6'		
7'		
8'	∇	1, 2
9'		
10'		
11'		
12'		
13'	Excavator refusal at approx. 12 feet	
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 8 feet.

2. Boulders encountered at approx. 8 feet. (One 24" diam. Several 12" diam.)

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Test Pit No. 101b

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan; ~6' west of MW-35

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'		
4'	Light brown fine SAND and SILT	
5'		
6'		
7'		
8'		1, 2
9'	Excavator refusal at approx. 8 feet	
10'		
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Moist at approx. 8 feet.

2. Boulders or bedrock encountered at approx. 8 feet.

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Test Pit No. 101c

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan; ~6' east of MW-35

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'		
4'		
5'	Light brown fine SAND and SILT	
6'		
7'		
8'		
9'		
10'		
11'		
12'	∇	1, 2
13'	Excavator refusal at approx. 12 feet	
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 12 feet.

2. Excavator bucket scraping across rock at approx. 12 feet. Very large boulder or bedrock.

FUSS & O'NEILL

Test Pit No. 101d

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan; ~50' east of MW-35

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND and SILT (iron staining at ~8 feet)	
2'		
3'		
4'		
5'		
6'		
7'		
8'	∇	1
9'		
10'		
11'		
12'		
13'		
14'		2
15'	Excavator refusal at approx. 14 feet	

Remarks: 1. Groundwater encountered at approx. 8 feet.

2. Excavator scraping on rock at 14 feet. Very large boulder or bedrock.

FUSS & O'NEILL

Test Pit No. 102

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND and SILT	1
2'		
3'		
4'		
5'	∇	2
6'		
7'	Excavator refusal at approx. 6.5 feet	
8'		
9'		
10'		
11'		
12'		
13'		
14'		
15'		

Remarks: 1. 3-foot diam. boulder, several 6-inch diam. boulders just below ground surface.

2. Groundwater encountered at approx. 5 feet.

FUSS & O'NEILL

Test Pit No. 102a

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND, little Silt	
2'		1
3'		
4'	▽	2
5'		
6'		
7'		
8'		3
9'		
10'	Caving sidewalls, bottom of test pit at approx. 9 feet	
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Iron staining at approx. 2 feet.

2. Groundwater encountered at approx. 4 feet.

3. Difficult excavation through boulders at approx. 8 feet.

FUSS & O'NEILL

Test Pit No. 102b

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'		1
4'	Light brown fine SAND, some Silt	
5'		
6'		
7'		
8'		
9'		
10'		
11'		
12'	∇	2
13'	Caving sidewalls, bottom of test pit at approx. 12 feet	
14'		
15'		

Remarks: 1. Boulders encountered at approx. 3 feet.

2. Groundwater encountered at approx. 11.5 feet. (Unstabilized: Test pit backfilled immediately)

FUSS & O'NEILL

Test Pit No. 102c

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND and SILT	
2'		
3'		
4'		
5'		
6'		
7'	∇	1
8'		
9'		2
10'		
11'		
12'	Caving sidewalls, bottom of test pit at approx. 11 feet	
13'		
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 6.5 feet.

2. Boulders encountered at approx. 9 feet.

FUSS & O'NEILL

Test Pit No. 103

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND, little Silt	
2'		
3'	▽	1
4'	Brown fine to coarse SAND and GRAVEL, trace Silt	
5'	Red-brown fine to medium SAND, little Gravel, trace Silt. Cobbles	
6'		
7'		
8'		
9'		
10'		
11'	Caving sidewalls, bottom of test pit at approx. 10 feet	
12'		
13'		
14'		
15'		

Remarks: 1. Groundwater encountered at approx.3 feet.

FUSS & O'NEILL

Test Pit No. 104

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND and SILT	
2'		
3'	∇	
4'		1
5'	Red-brown fine to coarse SAND, some Gravel, little Silt. Cobbles, boulders	
6'		
7'		
8'	Gray fine SAND, little Silt. Cobbles	
9'		
10'	Caving sidewalls, bottom of test pit at approx. 9.5 feet	
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 3.5 feet.

FUSS & O'NEILL

Test Pit No. 105

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND, some Silt	
2'	∇	1
3'	Brown fine to coarse SAND, some Gravel, little Silt. Cobbles.	
4'	Brown fine SAND, little Silt. Cobbles, boulders.	
5'		
6'		
7'	Caving sidewalls, bottom of test pit at approx. 6 feet	
8'		
9'		
10'		
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 2 feet.

FUSS & O'NEILL

Test Pit No. 106

Project: Wolfeboro RIB Site
Technician: C Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'	∇	1
4'		
5'	Light brown SILT, some fine SAND	
6'		
7'		
8'		
9'		
10'		
11'	Bottom of test pit at approx. 10 feet	
12'		
13'		
14'		
15'		

Remarks: 1. Groundwater encountered at approx. 3 feet.

FUSS & O'NEILL

Test Pit No. 107

Project: Wolfeboro RIB Site
Technician: C. Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'		
2'		
3'	Red brown fine SAND, trace Silt. Boulders.	1
4'		
5'		
6'	∇	2, 3
7'	Excavator refusal at approx. 6 feet	
8'		
9'		
10'		
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Boulders at 3 feet (3-foot diam.)

2. Groundwater encountered at 6 feet.

3. Excavator scraping along top of rock at 6 feet. Refusal on large boulder or bedrock.

FUSS & O'NEILL

Test Pit No. 108

Project: Wolfeboro RIB Site
Technician: C. Cullen
Location: See plan

Date: Dec. 13, 2013
Project No.: 20100161.A49
Contractor: Town of Wolfeboro DPW

Depth	Soil Description	Remark No.
1'	Light brown fine SAND, trace Silt. Cobbles, boulders.	
2'		1
3'		
4'		
5'		
6'	∇	2, 3
7'	Excavator refusal at approx. 6 feet	
8'		
9'		
10'		
11'		
12'		
13'		
14'		
15'		

Remarks: 1. Boulders near surface (2-foot diam.)

2. Groundwater encountered at approx. 5.5 feet.

3. Excavator scraping along top of rock at 6 feet. 36" by 84" boulder encountered.

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Geotechnical Test Report

1/6/2014

GTX-301314
Wolfeboro RIBs

Wolfeboro, NH

Client Project No.: 20100161.A49

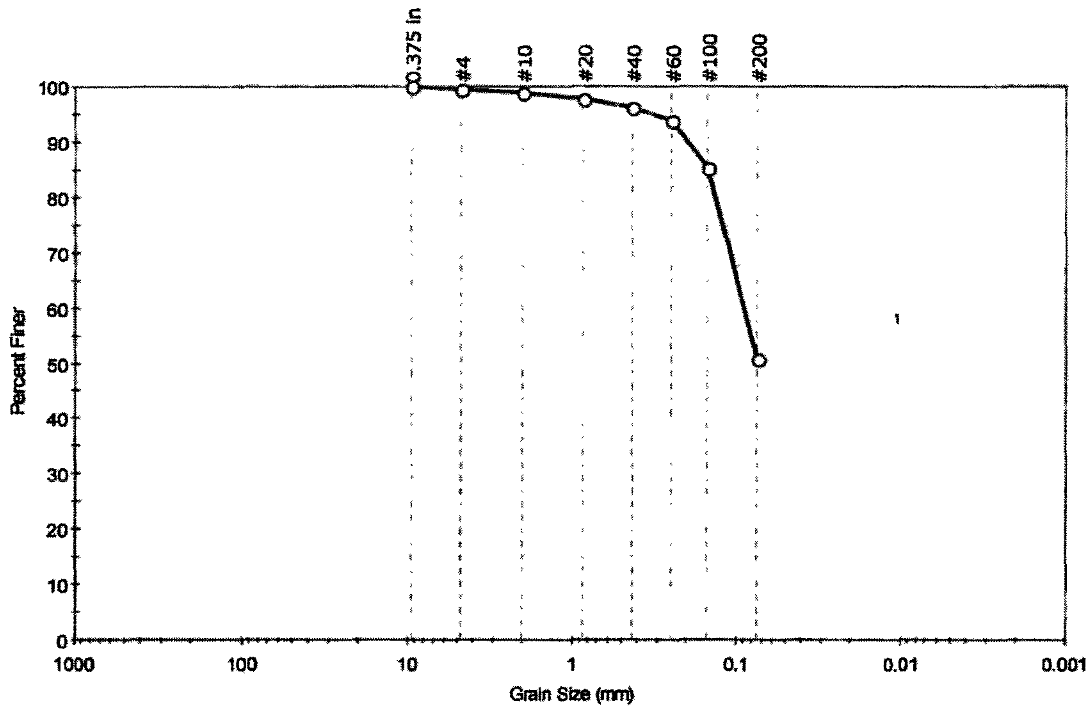
Prepared for:

Fuss & O'Neill, Inc.

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.				
Project:	Wolfeboro RIBs				
Location:	Wolfeboro, NH			Project No:	GTX-301314
Boring ID:	TP-101a	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	12/23/13	Checked By:	jdt
Depth :	9'	Test Id:	285789		
Test Comment:	---				
Sample Description:	Moist, olive brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	48.7	50.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	94		
#100	0.15	85		
#200	0.075	51		

Coefficients

D_{85} = 0.1488 mm	D_{30} = N/A
D_{60} = 0.0904 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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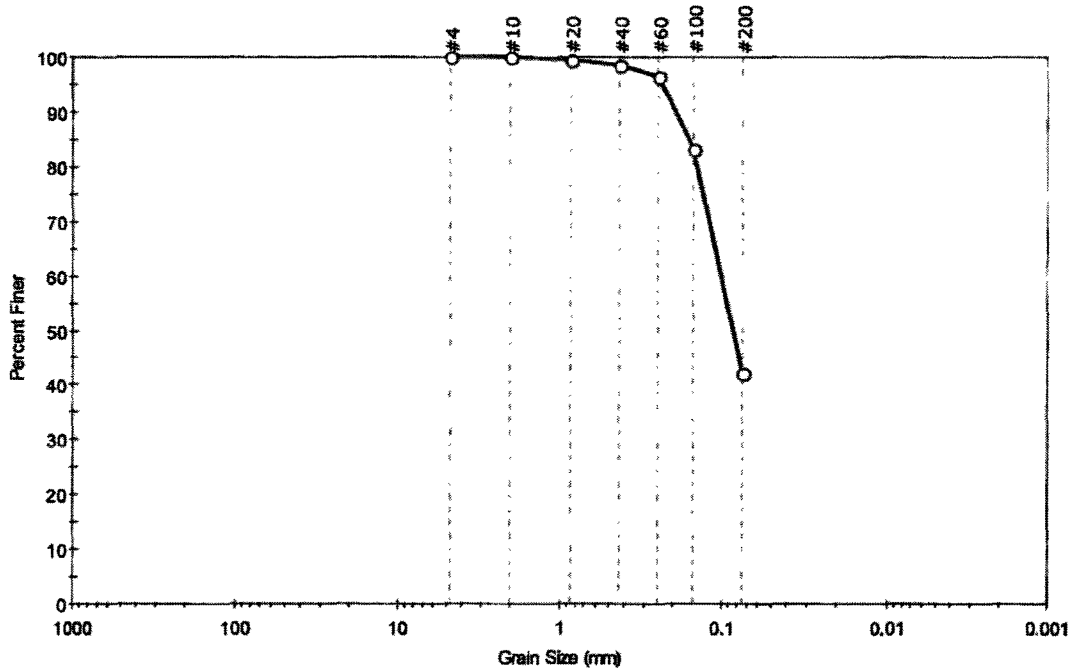
GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.				
Project:	Wolfeboro RIBs				
Location:	Wolfeboro, NH			Project No:	GTX-301314
Boring ID:	TP-101d	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	12/23/13	Checked By:	jdt
Depth :	13'	Test Id:	285790		

Test Comment: ---
Sample Description: Moist, light olive silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	57.9	42.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	97		
#100	0.15	83		
#200	0.075	42		

Coefficients

D_{85} = 0.1610 mm D_{30} = N/A
D_{60} = 0.1014 mm D_{15} = N/A
D_{50} = 0.0857 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

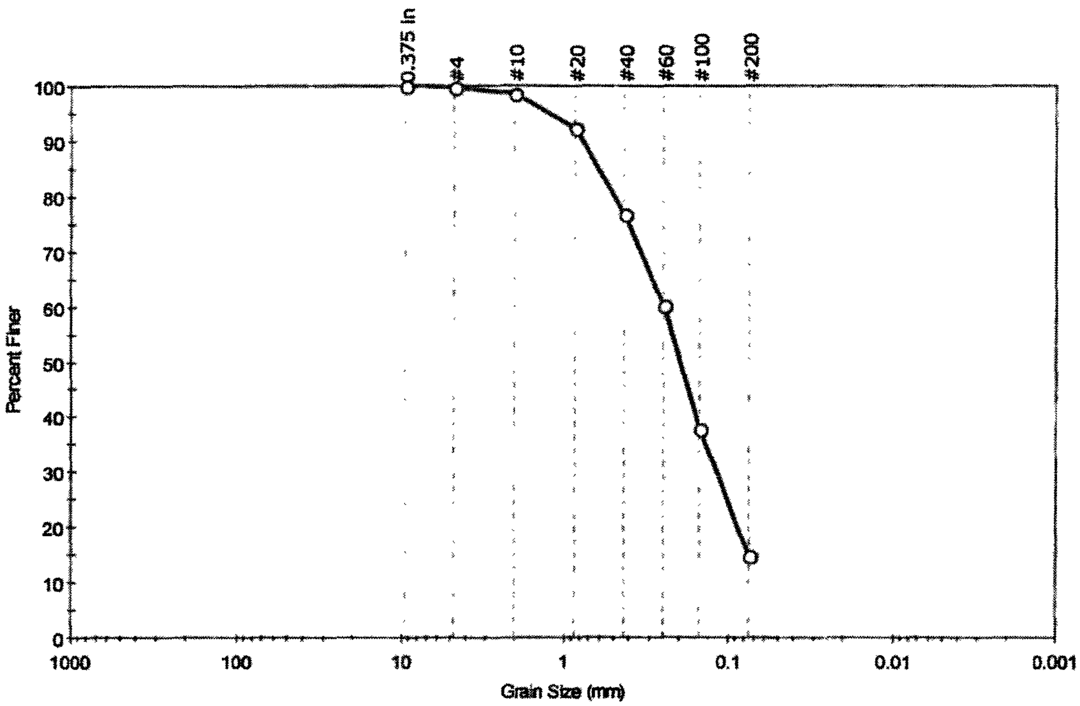
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client: Fuss & O'Neill, Inc.			
Project: Wolfeboro RIBs			
Location: Wolfeboro, NH		Project No:	GTX-301314
Boring ID: TP-102a	Sample Type: bag	Tested By:	jbr
Sample ID: ---	Test Date: 12/23/13	Checked By:	jdt
Depth : 3.5' (42")	Test Id: 285791		
Test Comment: ---			
Sample Description: Moist, olive brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	84.9	14.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	98		
#20	0.85	92		
#40	0.42	77		
#60	0.25	60		
#100	0.15	38		
#200	0.075	15		

Coefficients

D_{85} =0.6130 mm D_{30} =0.1189 mm
D_{60} =0.2487 mm D_{15} =0.0754 mm
D_{50} =0.1984 mm D_{10} =0.0648 mm
C_u =3.838 C_c =0.877

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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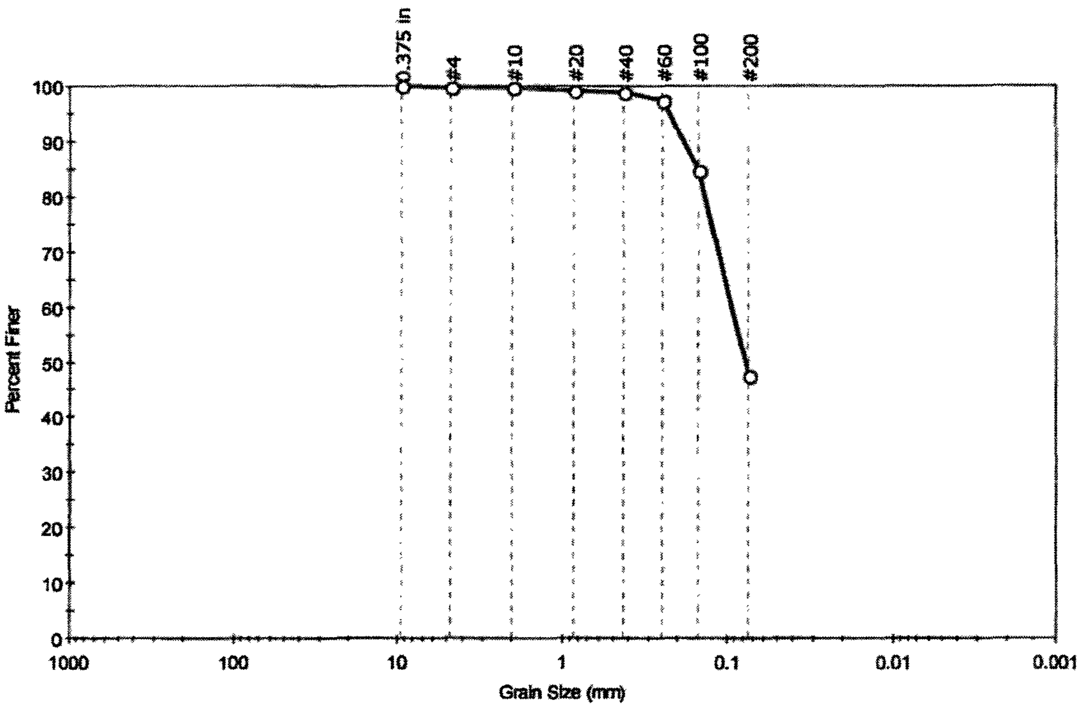
GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.				
Project:	Wolfeboro RIBs				
Location:	Wolfeboro, NH			Project No:	GTX-301314
Boring ID:	TP-102c	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	12/23/13	Checked By:	jdt
Depth :	10'	Test Id:	285792		
Test Comment:	---				
Sample Description:	Moist, olive silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	52.3	47.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	97		
#100	0.15	85		
#200	0.075	48		

Coefficients

D_{85} = 0.1526 mm	D_{30} = N/A
D_{60} = 0.0947 mm	D_{15} = N/A
D_{50} = 0.0785 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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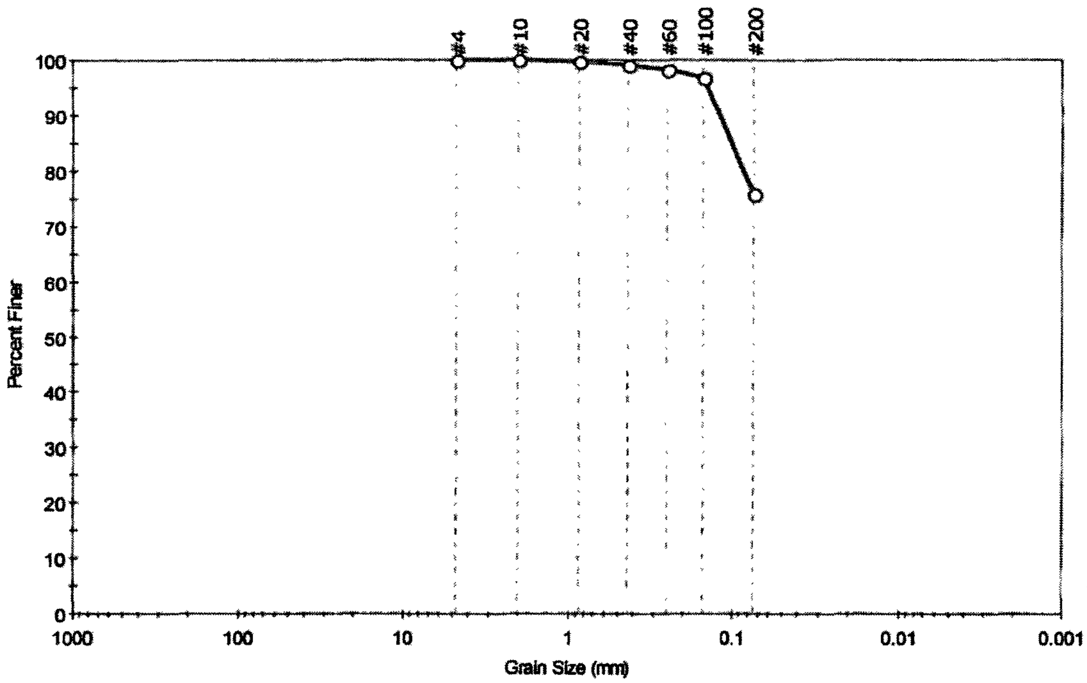
GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.				
Project:	Wolfeboro RIBs				
Location:	Wolfeboro, NH			Project No:	GTX-301314
Boring ID:	TP-106	Sample Type:	bag	Tested By:	jbr
Sample ID:	---	Test Date:	12/23/13	Checked By:	jdt
Depth :	3.5' (42")	Test Id:	285793		

Test Comment: ---
Sample Description: Moist, olive brown silt with sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	24.2	75.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	97		
#200	0.075	76		

Coefficients

D_{85} = 0.1017 mm D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---

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GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/30/13	Tested By:	rvm/djc
End Date:	12/31/13	Checked By:	jdt
Boring #:	TP-102a		
Sample #:	---		
Depth:	3.5' (42")		
Visual Description:	Moist, olive brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

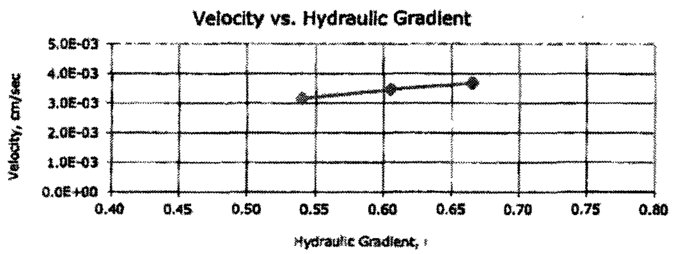
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D 2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted to a target density of 95.1 pcf (average of TP-102A Sample A and B tube densities) at air-dried moisture content.

Parameter	Initial	Final
Height, in	3.67	3.67
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	45.7	45.7
Mass, g	1141	1448
Bulk Density, pcf	95.2	121
Moisture Content, %	0.3	27.3
Dry Density, pcf	94.9	94.9
Degree of Saturation, %	---	97.3
Void Ratio, e	---	0.74

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/30	1	5.1	20	0.25	0.54	5.9E-03	19.0	1.025	6.0E-03
12/30	2	5.1	20	0.25	0.54	5.8E-03	19.0	1.025	6.0E-03
12/30	3	5.1	20	0.25	0.54	5.8E-03	19.0	1.025	6.0E-03
12/30	4	5.5	20	0.28	0.61	5.7E-03	19.0	1.025	5.8E-03
12/30	5	5.5	20	0.28	0.61	5.7E-03	19.0	1.025	5.9E-03
12/30	6	5.5	20	0.28	0.61	5.7E-03	19.0	1.025	5.9E-03
12/30	7	5.9	20	0.30	0.67	5.5E-03	19.0	1.025	5.7E-03
12/30	8	5.9	20	0.30	0.67	5.5E-03	19.0	1.025	5.7E-03
12/30	9	5.9	20	0.30	0.67	5.5E-03	19.0	1.025	5.7E-03



PERMEABILITY @ 20 °C =

5.8×10^{-3} cm/sec

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/30/13	Tested By:	rvm/djc
End Date:	01/02/14	Checked By:	jdt
Boring #:	TP-106		
Sample #:	---		
Depth:	3.5' (42")		
Visual Description:	Moist, olive brown silt with sand		

Permeability of Granular Soils (Constant Head) by ASTM D 2434

Sample Type: Remolded

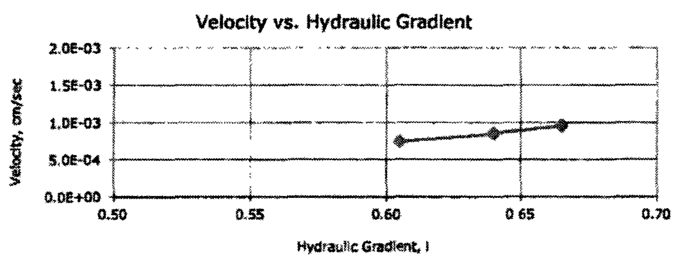
Sample Information:

Maximum Dry Density:	--- pcf
Optimum Moisture Content:	--- %
Compaction Test Method:	---
Classification (ASTM D 2487):	---
Assumed Specific Gravity:	2.65

Sample Preparation / Test Setup: Test specimen compacted to a target density of 83.1 pcf (average of TP-106 Sample A and B tube densities) at air-dried moisture content.

Parameter	Initial	Final
Height, in	3.74	3.74
Diameter, in	3.98	3.98
Area, in^2	12.4	12.4
Volume, in^3	46.5	46.5
Mass, g	1016	1375
Bulk Density, pcf	83.2	113
Moisture Content, %	0.5	35.9
Dry Density, pcf	82.8	82.8
Degree of Saturation, %	---	95.4
Void Ratio, e	---	1.00

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/31	1	1.2	20	0.06	0.61	1.2E-03	17.5	1.065	1.3E-03
12/31	2	1.2	20	0.06	0.61	1.2E-03	17.5	1.065	1.3E-03
12/31	3	1.2	20	0.06	0.61	1.2E-03	17.5	1.065	1.3E-03
12/31	4	1.4	20	0.07	0.64	1.3E-03	17.5	1.065	1.4E-03
12/31	5	1.4	20	0.07	0.64	1.3E-03	17.5	1.065	1.4E-03
12/31	6	1.4	20	0.07	0.64	1.3E-03	17.5	1.065	1.4E-03
12/31	7	1.5	20	0.08	0.67	1.4E-03	17.5	1.065	1.5E-03
12/31	8	1.5	20	0.08	0.67	1.4E-03	17.5	1.065	1.5E-03
12/31	9	1.5	20	0.08	0.67	1.4E-03	17.5	1.065	1.5E-03



PERMEABILITY @ 20 °C = 1.4×10^{-3} cm/sec

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/23/13	Tested By:	rvm
End Date:	12/27/13	Checked By:	jdt
Boring #:	TP-106		
Sample #:	Sample A		
Depth:	42"		
Visual Description:	Moist, brown and light brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434 - Modified

Sample Type: Intact

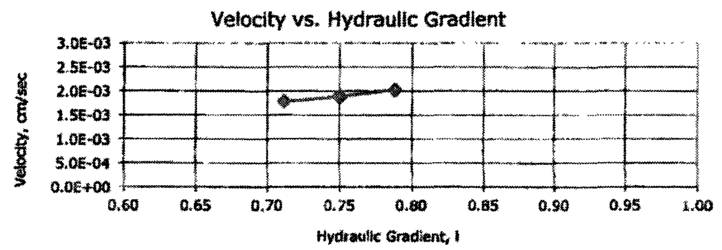
Sample Information: Assumed Specific Gravity: 2.65

Sample Preparation / Test Test performed in the tube provided at the as-received density and moisture content.

Deviations from ASTM D2434: Soil was not air-dried and reconstituted prior to testing.
A top plate and light spring pressure was not applied to the top of the specimen prior to testing.
The test specimen was not de-aired under vacuum prior to testing.
Diameter of tube sample provided was smaller than minimum recommended cylinder diameter.

Parameter	Initial	Final
Height, in	5.20	5.20
Diameter, in	1.40	1.40
Area, in^2	1.54	1.54
Volume, in^3	8.00	8.00
Mass, g	233	244
Bulk Density, pcf	111	116
Moisture Content, %	26.9	32.5
Dry Density, pcf	87.5	87.5
Degree of Saturation, %	---	96.6
Void Ratio, e	---	0.89

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/23	1	2.1	120	0.02	0.71	2.5E-03	17.5	1.065	2.7E-03
12/23	2	2.1	120	0.02	0.71	2.5E-03	17.5	1.065	2.7E-03
12/23	3	2.1	120	0.02	0.71	2.5E-03	17.5	1.065	2.7E-03
12/23	4	2.2	120	0.02	0.75	2.5E-03	17.5	1.065	2.7E-03
12/23	5	2.3	120	0.02	0.75	2.5E-03	17.5	1.065	2.7E-03
12/23	6	2.3	120	0.02	0.75	2.5E-03	17.5	1.065	2.7E-03
12/23	7	2.4	120	0.02	0.79	2.6E-03	17.5	1.065	2.7E-03
12/23	8	2.4	120	0.02	0.79	2.6E-03	17.5	1.065	2.7E-03
12/23	9	2.4	120	0.02	0.79	2.6E-03	17.5	1.065	2.7E-03



PERMEABILITY @ 20 °C = 2.7×10^{-3} cm/sec

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/23/13	Tested By:	rvm
End Date:	12/27/13	Checked By:	jdt
Boring #:	TP-106		
Sample #:	Sample B		
Depth:	42"		
Visual Description:	Moist, light brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434 - Modified

Sample Type: Intact

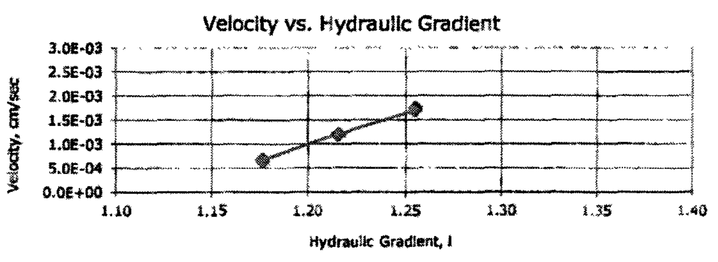
Sample Information: Assumed Specific Gravity: 2.65

Sample Preparation / Test Test performed in the tube provided at the as-received density and moisture content.

Deviations from ASTM D2434: Soil was not air-dried and reconstituted prior to testing.
A top plate and light spring pressure was not applied to the top of the specimen prior to testing.
The test specimen was not de-aired under vacuum prior to testing.
Diameter of tube sample provided was smaller than minimum recommended cylinder diameter.

Parameter	Initial	Final
Height, in	5.10	5.10
Diameter, in	1.40	1.40
Area, in^2	1.54	1.54
Volume, in^3	7.85	7.85
Mass, g	210	227
Bulk Density, pcf	102	110
Moisture Content, %	30.0	40.0
Dry Density, pcf	78.6	78.6
Degree of Saturation, %	---	96.0
Void Ratio, e	---	1.10

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/23	1	0.8	120	0.01	1.18	5.4E-04	16.8	1.084	5.9E-04
12/23	2	0.8	120	0.01	1.18	5.8E-04	16.8	1.084	6.3E-04
12/23	3	0.8	120	0.01	1.18	5.7E-04	16.8	1.084	6.2E-04
12/23	4	1.4	120	0.01	1.22	1.0E-03	16.8	1.084	1.1E-03
12/23	5	1.4	120	0.01	1.22	9.9E-04	16.8	1.084	1.1E-03
12/23	6	1.4	120	0.01	1.22	9.9E-04	16.8	1.084	1.1E-03
12/23	7	2.0	120	0.02	1.25	1.4E-03	16.8	1.084	1.5E-03
12/23	8	2.1	120	0.02	1.25	1.4E-03	16.8	1.084	1.5E-03
12/23	9	2.1	120	0.02	1.25	1.4E-03	16.8	1.084	1.5E-03



PERMEABILITY @ 20 °C = 1.1×10^{-3} cm/sec

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/26/13	Tested By:	rvm/djc
End Date:	12/27/13	Checked By:	jdt
Boring #:	TP-102A		
Sample #:	Sample A		
Depth:	42"		
Visual Description:	Moist, brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434 - Modified

Sample Type: Intact

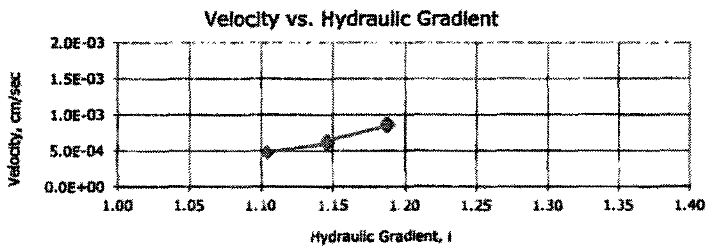
Sample Information: Assumed Specific Gravity: 2.65

Sample Preparation: Test performed in the tube provided at the as-received density and moisture content.

Deviations from ASTM D2434: Soil was not air-dried and reconstituted prior to testing.
A top plate and light spring pressure was not applied to the top of the specimen prior to testing.
The test specimen was not de-aired under vacuum prior to testing.
Diameter of tube sample provided was smaller than minimum recommended cylinder diameter.

Parameter	Initial	Final
Height, in	4.80	4.80
Diameter, in	1.40	1.40
Area, in^2	1.54	1.54
Volume, in^3	7.39	7.39
Mass, g	225	233
Bulk Density, pcf	116	120
Moisture Content, %	23.0	27.2
Dry Density, pcf	94.5	94.5
Degree of Saturation, %	---	95.9
Void Ratio, e	---	0.75

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/26	1	0.6	120	0.005	1.10	4.3E-04	17.5	1.065	4.6E-04
12/26	2	0.6	120	0.005	1.10	4.3E-04	17.5	1.065	4.6E-04
12/26	3	0.6	120	0.005	1.10	4.3E-04	17.5	1.065	4.6E-04
12/26	4	0.7	120	0.006	1.15	5.3E-04	17.5	1.065	5.6E-04
12/26	5	0.7	120	0.006	1.15	5.3E-04	17.5	1.065	5.6E-04
12/26	6	0.8	120	0.006	1.15	5.6E-04	17.5	1.065	5.9E-04
12/26	7	1.0	120	0.008	1.19	7.1E-04	17.5	1.065	7.6E-04
12/26	8	1.0	120	0.008	1.19	7.1E-04	17.5	1.065	7.6E-04
12/26	9	1.0	120	0.009	1.19	7.4E-04	17.5	1.065	7.8E-04



PERMEABILITY @ 20 °C = 6.0×10^{-4} cm/sec

GeoTesting EXPRESS

Client:	Fuss & O'Neill, Inc.		
Project Name:	Wolfeboro RIBs		
Project Location:	Wolfeboro, NH		
GTX #:	301314		
Start Date:	12/24/13	Tested By:	rvm
End Date:	12/27/13	Checked By:	jdt
Boring #:	TP-102A		
Sample #:	Sample B		
Depth:	42"		
Visual Description:	Moist, brown silty sand		

Permeability of Granular Soils (Constant Head) by ASTM D2434 - Modified

Sample Type: Intact

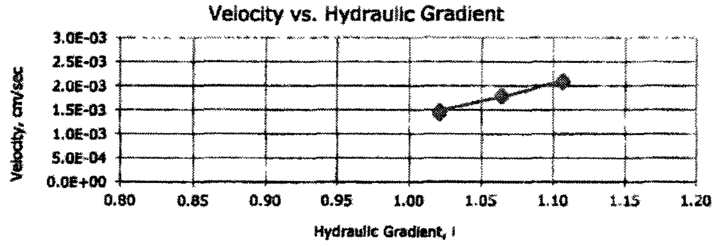
Sample Information: Assumed Specific Gravity: 2.65

Sample Preparation / Test: Test performed in the tube provided at the as-received density and moisture content.

Deviations from ASTM D2434: Soil was not air-dried and reconstituted prior to testing.
A top plate and light spring pressure was not applied to the top of the specimen prior to testing.
The test specimen was not de-aired under vacuum prior to testing.
Diameter of tube sample provided was smaller than minimum recommended cylinder diameter.

Parameter	Initial	Final
Height, in	4.70	4.70
Diameter, in	1.40	1.40
Area, in^2	1.54	1.54
Volume, in^3	7.24	7.24
Mass, g	217	230
Bulk Density, pcf	114	121
Moisture Content, %	19.6	26.4
Dry Density, pcf	95.7	95.7
Degree of Saturation, %	---	96.0
Void Ratio, e	---	0.73

Date	Reading #	Volume of Flow, cc	Time of Flow, sec	Flow Rate, cc/sec	Gradient	Permeability, cm/sec	Temp., °C	Correction Factor	Permeability @ 20 °C, cm/sec
12/24	1	1.7	120	0.01	1.02	1.4E-03	17.2	1.073	1.5E-03
12/24	2	1.7	120	0.01	1.02	1.4E-03	17.2	1.073	1.5E-03
12/24	3	1.8	120	0.01	1.02	1.4E-03	17.2	1.073	1.6E-03
12/24	4	2.1	120	0.02	1.06	1.7E-03	17.2	1.073	1.8E-03
12/24	5	2.2	120	0.02	1.06	1.7E-03	17.2	1.073	1.8E-03
12/24	6	2.1	120	0.02	1.06	1.7E-03	17.2	1.073	1.8E-03
12/24	7	2.5	120	0.02	1.11	1.9E-03	17.2	1.073	2.0E-03
12/24	8	2.5	120	0.02	1.11	1.9E-03	17.2	1.073	2.0E-03
12/24	9	2.5	120	0.02	1.11	1.9E-03	17.2	1.073	2.0E-03



PERMEABILITY @ 20 °C = 1.8×10^{-3} cm/sec