Belleayre Mountain Ski Center UMP-DEIS

Appendix L
Snowmaking Pond - Engineers Report

April, 2011

Prepared by:

New York State Department of Environmental Conservation
Division of Operations – Bureau of Design & Construction
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BELLEAYRE SNOWMAKING POND
DESIGN REPORT

Prepared by:
Tom Lincoln
NYS Dept. of Environmental Conservation
Division of Operations
Bureau of Design and Construction
April 2011

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BELLEAYRE SNOWMAKING POND
CONSTRUCTION PROJECT DESCRIPTION

Site Information

The New York State Department of Environmental Conservation, Division of Operations, is applying for a permit to construct a new dam at Belleayre Mountain. The project site is located in Shandaken, NY in Ulster County at N 42D 08.56' and W 74D 29.90'. A map of existing downstream structures and contours of the watershed area are shown in Appendix A. This project establishes an impoundment and dam that satisfy New York State Dam Safety criteria for spillway capacity and stability.

Hazard Classification

The proposed dam is a small class C, high hazard dam. This is based on a sunny day dam breach model showing a depth of water exceeding two feet for the structure downstream of the dam located at 97 Bonnie View Road. The breach was modeled using TR-60 parameters based on dam geometry and impoundment elevation. Since there is a downstream structure impacted by a sunny day breach, the dam is considered to be high hazard. The surface area of the pond is 8.1 acres at normal pool, 1926.5. The 126 acre-foot storage volume is well below the 1000 acre-foot threshold of a large high hazard dam. Breach parameters and calculations are discussed further in the Hydrology and Hydraulics section.

Existing Soil Conditions

The site for the pond and dam is to the south of the Belleayre Ski Center Maintenance Building. In September 2008, five soil borings were drilled and three test pits were excavated in the pond and embankment area. A geotechnical report from Empire Geo Services, Inc. describes the on-site soils as generally sands and gravels with trace to some amounts of silt to depths of 19 to 24 feet. This is underlain by glacial till down to sandstone bedrock. Bedrock depths generally rose from south to north from 33.5 to 23.8 feet. Most soil samples are classified as SM-GM based on the Unified Soil Classification System. Cobbles and boulders were also noted in the test pit logs. STATSGO soil maps for the pond watershed area show all soils are Vly Group C. Soil for the PMF watershed is 50% Vly Group C and 50% Halcott Group C. A Boring Location Plan and Geotechnical Report are attached as Appendix B.

Proposed New Structure

The principal inflow to the pond arrives from the west via a proposed concrete diversion structure in Crystal Brook. The structure contains a notched weir that allows all flow up to 0.5 cfs to continue through the brook, while higher flows can be diverted to the pond if desired. A

sluice gate mounted to a side vault provides control over whether any of the excess flow is directed towards the pond. To avoid recirculation of water, the outflow from the pond re-enters Crystal Brook downstream of the diversion structure.

The proposed spillway is a fifteen foot long concrete weir. A stone-lined outlet channel conveys the outflow back into Crystal Brook. The proposed dam varies in height from zero to 54 feet above the downstream toe, with upstream and downstream slopes of 2.5H:1V. The crest is at elevation 1929.2 with a width of 11 feet. The normal pool depth varies from 26.5 feet to 16.5 feet with a normal pool elevation of 1926.5. The impoundment floor slopes from elevation 1900 at its west end up to 1910 at the east limit. The area near the proposed snowmaking piping intake also drops to 1902 and continues to the outlet location.

Borrow material for the new dam will be excavated from within the footprint of the new embankment. Stages of embankment in ten-foot increments are identified on the Snowmaking Pond Erosion Control Construction Sequence drawings. Material will be pushed with scrapers to the intended location and raked to remove stones greater than six inches in diameter. Excavation spoils from the screening operation will be spread downstream of the toe of the new dam while maintaining drainage, then seeded and mulched if they are not gravel size or larger materials. The prepared subgrade will be inspected to ensure stones larger than six inches are removed prior to placement. Any bedrock exposed while excavating near the pump house intake will be monitored and grouted if necessary to reduce the likelihood of water entering any fractures. Should additional embankment material be required to complete the dam, the cross slope of the impoundment floor will be flattened in the middle portion.

Hydrology and Hydraulics

As part of the hazard classification process, two drainage areas were considered for the project. The first is for the area that drains to the pond itself. The second is for the area upstream of the first house impacted by a sunny day failure (referred to as the PMF drainage area). Multi Resolution Land Cover (MRLC) data was used to determine the curve numbers for both watersheds. Data are shown in Appendix C, along with time of concentration calculations. Based on the small size and typical shape of the drainage areas, neither was sub-divided into separate basins.

The drainage area for the pond is .06 square miles. Its curve number is 72. The land is composed of grass, brush, trees, and existing road, building and paved parking area. It includes the site of proposed parking as part of the future development. Its time of concentration and SCS lag time are 0.3 and 0.18 hours respectively. This is the drainage area used to size the spillway for the impoundment.

The PMF drainage area is 1.71 square miles. Its curve number is 72. The watershed includes some of the existing downhill ski trails, undeveloped wooded areas, and the existing paved roads to the lodges. The time of concentration and SCS lag time of 0.6 and .36 hours respectively. This is the drainage area utilized when determining the design storm in an Incremental Design Flood (IDF) analysis.

Using NOAA's Hydrometerological Report 52 (HMR-52), the Probable Maximum Precipitation was calculated based on the drainage area and location. No adjustment was necessary for storm orientation as the entire drainage area falls within the A-Isohyet. A plot of the 1/6/12/24 hour precipitation values was used to produce a smooth depth-duration curve from which the 5/15/30 minute and 1 through 6-hour precipitation values were determined in conjunction with Figures 36-38 of HMR-52. The hourly rainfall values are then arranged as a Probable Maximum Storm Distribution based on the distribution prescribed in Figure 7 of HMR-52. This 72-hour storm distribution is entered into HEC-HMS, which produces the Probable Maximum Flood (PMF). This hydrograph is then entered into HEC-RAS, scaled down 50% and routed through the existing stream channel. The water surface profile and corresponding velocities are evaluated throughout the reach.

The New York State Department of Environmental Conservation Dam Safety Section Guidelines require new, small, high-hazard dams to pass the ½ PMF event with at least one foot of freeboard. They also allow an incremental damage assessment where the design storm is determined by starting with the ½ PMF event and then modeling fractions of that event as it is routed through the existing stream channel geometry. A dam failure is incorporated with the reduced storm event, and if that results in less than a two foot rise in the water surface at downstream structures, the design storm can be reduced further. Hydrographs of the 50% and 40% fractions of the PMF at the first impacted structure are shown in Appendix D. The 2.25 x the 100 year storm event is a slightly greater flow than the 40% PMF fraction event for the PMF watershed. Both result in less than a two foot rise in the water surface at the impacted structures. However, 2.25x the 100 year storm is the design storm for intermediate hazard dams, therefore no reductions are permitted. The other requirement is that the design storm duration be greater than the time of concentration for the watershed. The six-hour NOAA frequency storm satisfies this criteria. Routing this event produces a peak outflow of 86 cfs from the impoundment, with one foot of freeboard along the dam. This corresponds to a maximum water surface elevation of 1928.2 feet. A hydrograph for the design storm at the pond outlet is shown in Appendix D.

Breach parameters were taken from FERC's 1987 published range of values for engineered compacted dams. They list the bounds for breach width, B, as a function of two to four times the dam height. The H:V slope of breach side slopes can range from .25H:1V to 1H:1V. The time of formation ranges from .1 to one hour. Since it is sloped, the average pond bottom elevation of 1905 was used as the average valley floor elevation. Selected Breach input parameters for the snowmaking pond were a height of water of 23 ft for the storm day and 21.5 ft for the sunny day event. Time of formation was .75 hours. Side slopes were conservatively taken as 1.5H:1V, somewhat flatter than the 1H:1V bound proposed by FERC. A complete summary of parameters for each breach is shown in Appendix D.

The peak storm day breach discharge is 3900cfs. This completely drains the reservoir from elevation 1928.2 in less than two hours. The breach is set to coincide with the storm peak to produce the greatest downstream inundation limits when the impoundment fails at its maximum volume. This breach is also used during the fractional PMF event as part of the IDF analysis. A storm day breach hydrograph is shown in Appendix D.

The peak sunny day discharge is 3250cfs. This completely drains the reservoir from elevation 1926.5 in less than two hours. The breach is entered into HEC-RAS with minimal baseflow to evaluate the impacts of a sunny day failure. A sunny day breach hydrograph is shown in Appendix D.

A proposed 1-ft diameter ductile iron pipe at an invert elevation of 1902.0 serves as the low level outlet for the impoundment. It leads to a seven foot square concrete drawdown vault where stop logs and a sluice gate regulate outflow from the impoundment. Two sides of the concrete vault act as an additional overflow weir in storm events, however this capacity is conservatively ignored since it is a fairly small component of the impoundment outflow relative to the spillway weir capacity. Another 12 inch diameter ductile iron pipe conveys water from the outlet of the drawdown vault and discharges to a weir structure and confined channel that leads to Crystal Brook. The weir helps distribute outflow and significantly reduces the outflow velocities during an impoundment drawdown. The outlet protection is shown on the Snowmaking Pond Drawdown Details sheet. Proposed spillway stage/discharge relationships and impoundment stage/storage/elevation data are tabulated in Appendix E.

Upstream and downstream of the spillway, the finished grade will be protected from erosion. The approach protection will consist of a 12-inch layer of Light Stone fill bedded with six inches of #1 stone. Approach velocities are less than 3 feet per second for the design storm. Downstream of the concrete weir, armoring consists of an 18-inch thick layer of Light Stone fill placed over six inches of #1 stone. Channel velocities downstream of the outlet are predicted to be in the 6cfs range using Manning's Equation for the proposed channel geometry. The limits of the stone fill and bedding are detailed on the outlet structure drawings. Filter criteria and outlet protection calculations are shown in Appendix F.

The NYS Guidelines recommend that the spillway should have sufficient discharge capacity to evacuate 75% of the storage at the design high water elevation (1928.2) and the spillway crest (1927) within 48 hours assuming no inflow. The new dam evacuates 75% of the storage in 18 hours and therefore satisfies the Guidelines.

The low-level outlet is required by the NYS Guidelines to have sufficient capacity to discharge 90% of the storage below the lowest spillway crest within 14 days, assuming no inflow to the impoundment. The 12-inch drawdown pipe removes this volume of storage in 6 days, which satisfies the requirements. HEC-HMS output for both drawdown conditions is shown in Appendix G.

Emergency Action Plan

After the final design of the pond is approved, and Emergency Action Plan will be assembled and provided to the appropriate local authorities. A map showing the approximate sunny day inundation limits for the dam is included in Appendix A.

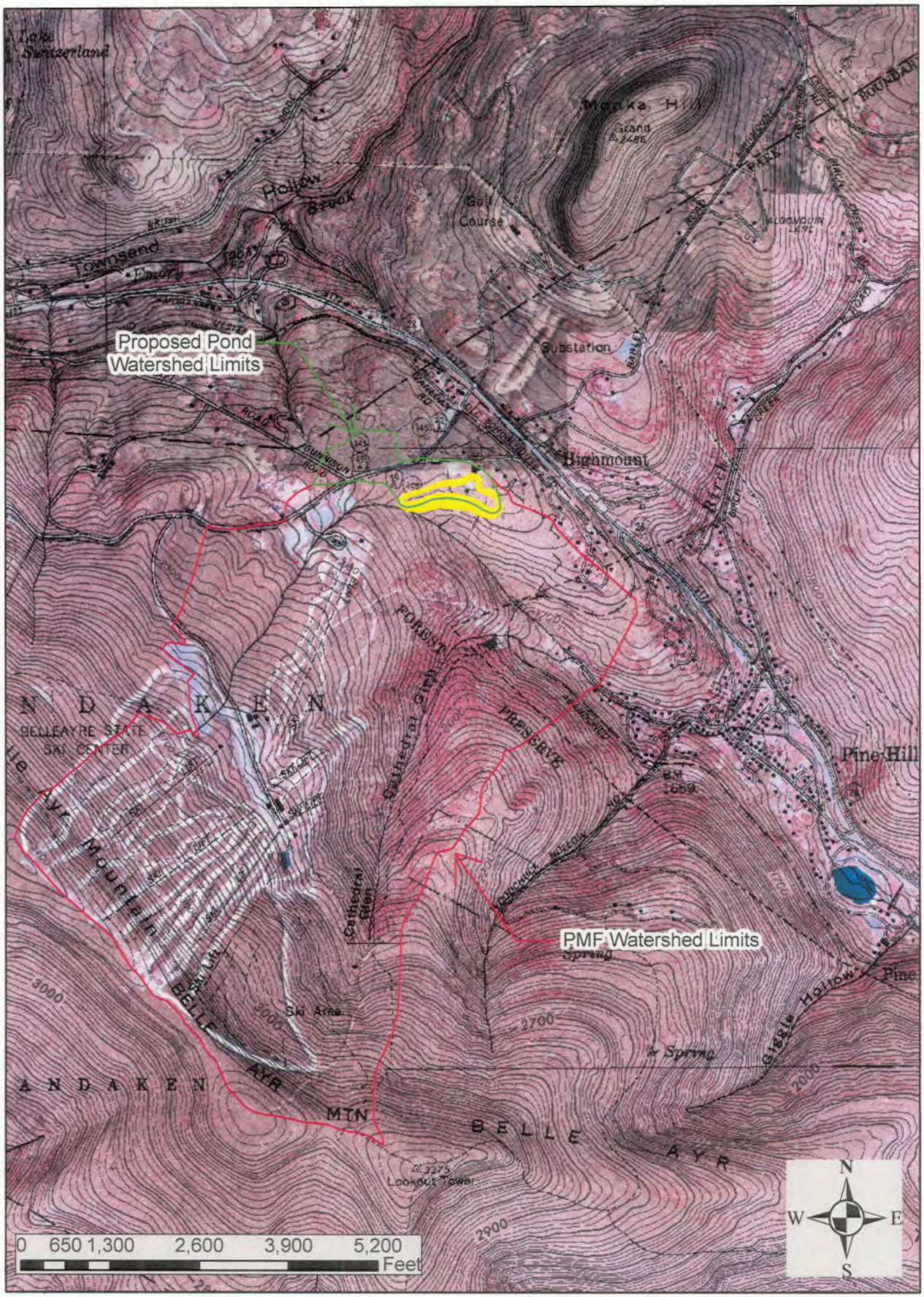
Construction Sequence

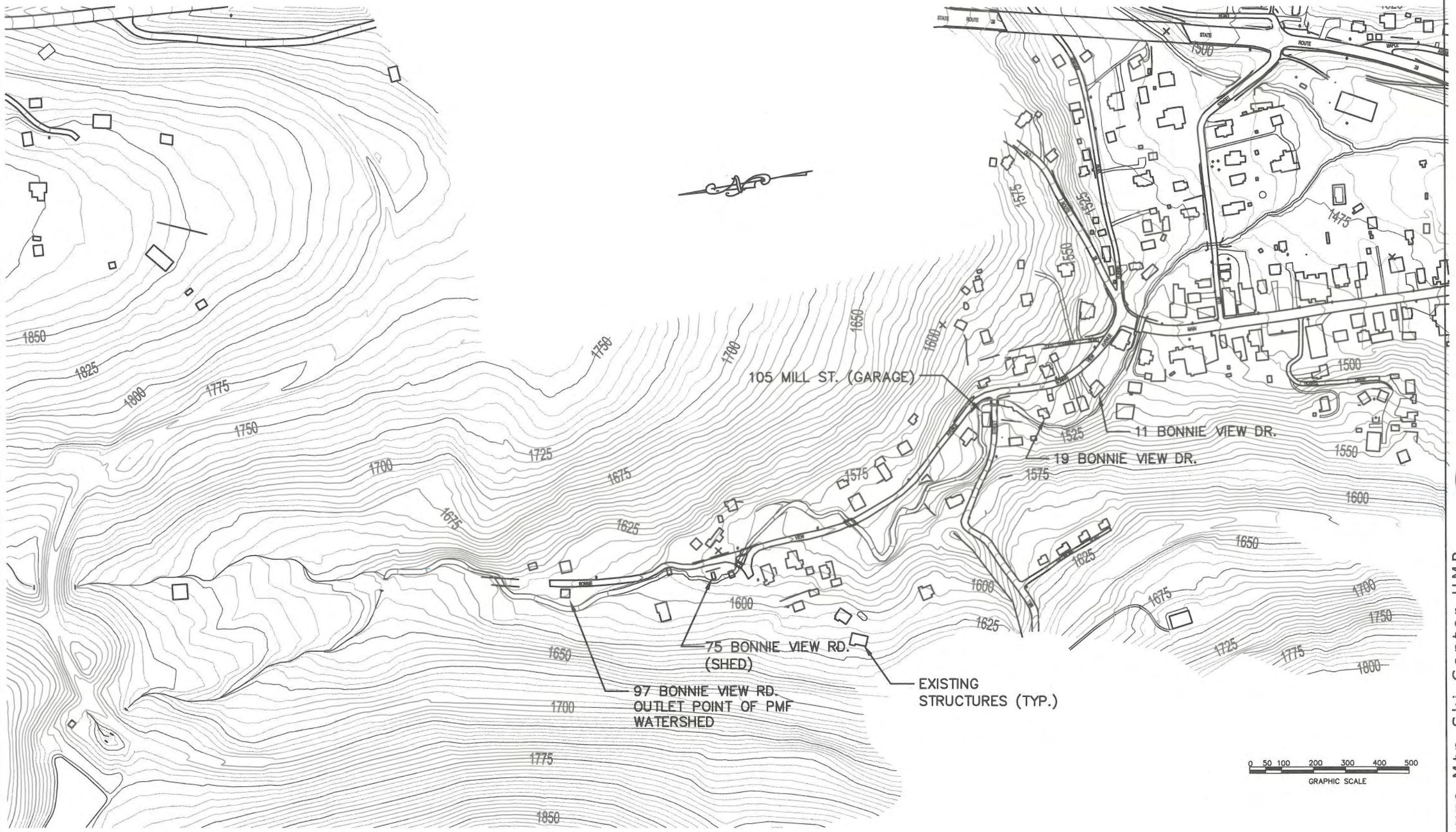
An overview and sequence of work to be performed is presented in the drawing titled 'Belleayre Snowmaking Pond Erosion Control Construction Sequence', sheets 1-3.

After a final inspection by Dam Safety and DEC Operations Staff and the issuance of a Permit to Fill, the Crystal Brook diversion gate will be opened. The impoundment will be slowly filled from direct runoff in rain events and any available excess Crystal Brook flow. If significant storm events are predicted, the diversion from Crystal Brook will be closed if necessary to avoid any rise in impoundment elevation by more than one foot per day.

APPENDIX A

Appendix A Belleayre Watershed Areas





NYS Department of Environmental Conservation
Bureau of Design & Construction

Belleayre Mtn. Ski Center UMP
Snowmaking Pond
Downstream Structures
Below Railroad Tracks

JANUARY 15, 2010

SM19X

APPENDIX B

EMPIRE GEO SERVICES, INC.

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November 14, 2008

New York State Department of Environmental Conservation
Bureau of Design and Construction
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Attn: Randall J. Passmann, P.E.

Re: Soil Boring & Sampling Services
Belleayre UMP
Town of Shandaken, New York
SJB Project No: AD-08-051

Dear Mr. Passmann:

Empire Geo-Services, Inc. is pleased to present this soils investigation report summarizing our findings from field work and laboratory analyses performed in support of the referenced project. The work was completed as outlined in the request for proposal and scope of work prepared by the New York State Department of Environmental Conservation (NYSDEC), and authorized by NYSDEC purchase order no. 011165.

PROJECT DESCRIPTION

As we understand it, a water storage pond is to be constructed at a site along Ulster and Delaware Turnpike for use by the Belleayre Mountain ski area. Plans call for an impoundment facility about 1400 feet long and 200 feet or more wide, created through cuts and embankment fills of native soils. The proposed top of embankment elevation is 1929.0 feet, and the pond invert elevation is between 1905.0 and 1910.0 feet. Planned embankment side slopes are between 1V:2.5H and 1V:3H. Water will be sourced from an adjacent stream, whereby a portion of its flow will be diverted into the pond for storage, and via a transmission line from an existing nearby pond (Cathedral Glen). Plans also include pond outlet works and pumping facilities to transmit water to upper and lower mountain areas for use as needed.

METHOD OF INVESTIGATION

Field Testing:

Subsurface conditions at the site were investigated by our affiliated drilling and materials testing firm, SJB Services, Inc. (SJB). Five test borings (B-4, B-5, B-6, B-7 and B-8) and three test pits (TP-1, TP-2 and TP-3) were performed, as shown on the subsurface investigation plan (Attachment 1). A CME 550x all terrain vehicle mounted drill rig equipped with hollow stem augers, flush-joint casing and rock core tooling was used to complete the test borings. The test pits were excavated with a John Deere 410E rubber-tire backhoe furnished by others.

At locations B-4, B-5 and B-6, soils were sampled on a continuous basis to a depth of 12 feet and at standard five foot intervals thereafter in accordance with ASTM D1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils. At location B-7, soil characterization is based on a single split spoon sample at the 10 to 12 foot interval and the driller's observations, and at B-8, soils were characterized by the driller based on auger cuttings and other noted aspects of the drilling operation, along with a single split spoon sample taken at the boring termination depth.

Borings B-4 and B-8 were each augered to a target depth of 40 feet. At locations B-5, B-6 and B-7, auger refusal was encountered at depths of 33.5 feet, 23.8 feet and 25.0 feet respectively. Refusal material encountered in each hole was cored for a length of 5 feet in general accordance with ASTM D2113 - Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation, using an NQ size core barrel. Representative portions of the recovered split-spoon soil samples, and the recovered rock core in its entirety, were transported Empire's office for visual classification by a geotechnical engineer and/or geologist.

The test pits were excavated to depths of 10.5 to 12.5 feet, with each excavation observed and logged by a geologist. In order to obtain a representative sample of native materials for laboratory testing, two bulk samples were taken from each test pit, at discrete depth intervals of 6 to 7 feet and 9.5 to 12 feet. Oversize materials (approximately four inches or larger) were excluded. A single composite sample was prepared from those collected for use in the laboratory testing program described below.

An individual subsurface log was prepared for each of the test borings and test pits based upon the visual classifications and field records. The existing ground surface elevation at each boring and test pit location were furnished by the NYSDEC and are included on the logs. The logs are included in Attachment 2 together with a sheet which explains the terms and symbols used in their preparation. A photograph of the recovered rock core samples is presented in Attachment 3.

A total of three falling head permeability tests were performed, two at boring B-4 at depths of 19.0 and 34.0 feet, and one at B-7 at a depth of 12.5 feet. Prior to each test, three inch diameter flush-joint casing was installed and seated in the bottom of the borehole to facilitate its completion, and upon filling the casing with water, the drop in water level was recorded at intervals of one to five minutes over a 30 minute period. Results of the permeability testing are presented in Attachment 4.

Laboratory Testing:

Laboratory testing was conducted by SJB on the composite bulk sample collected from the test pits, as follows:

- ASTM D-422, Particle Size Analysis of Soils
- ASTM D-698-02, Laboratory Compaction Characteristics of Soil Using Method C Standard Effort
- ASTM D-5084, Measurement of Hydraulic Conductivity of Saturated Porous Material Using a Flexible Wall Permeameter
- ASTM D-3080, Direct Shear Test of Soils Under Consolidated Drained Conditions
- ASTM D-2216, Natural Water Content

Results of the field and laboratory testing program are presented in Attachment 4.

RESULTS OF INVESTIGATION

Subsurface Profile:

The site was generally found to be mantled with sands and gravels with trace to some amounts of silt to depths of 19 to 24 feet, this sequence being of a firm to compact relative density. Below this, very compact basal glacial till was encountered, as exhibited by coarser sands and gravels embedded in a matrix of silt and fine sand (in the test pits, the transition to till was interpreted as being shallower than that indicated by the test borings, generally at the depth at which color changed from orange-brown to brown or where digging became more difficult; for the purposes of this report, these upper soils are considered silty sands and gravels). Coarse augering, boulders and cobbles were commonly noted throughout the overburden soils, likely resulting in elevated blow counts in some instances. Underlying the till, sandstone bedrock was encountered at B-5, B-6 and B-7 at depths of 33.5 feet, 23.8 feet and 25.0 feet respectively, as evidenced by auger refusal and confirmatory rock coring at each location.

These findings are in general agreement with published information reviewed for this investigative summary. The Soil Survey of Ulster County, New York (U.S. Department of Agriculture, 1979) maps surficial soils (generally representative of the upper six feet) in the area as either Wellsboro and Wurtsboro very bouldery soils, gently sloping, or Lackawanna and Swartswood very bouldery soils, moderately steep. The survey describes these map units in terms of their sandy and gravelly loam (and bouldery) compositions, and as being moderately well to well drained. The soil survey also identifies certain limitations associated with each soil unit for selected uses, for consideration in site selection and design. In this regard, "large stones" are listed as a limitation with respect to the suitability of site soils for the construction of embankments, dikes and levees, while "slope" limits the use of the moderately steep Lackawanna and Swartswood unit in the construction of pond reservoir areas. The shrink-swell potential of these soils is listed as low, while soil erodibilty "K" factors range from 0.20 to 0.28, indicating low to moderate erosion potential.

Bedrock in the area, as mapped on the Geologic Map of New York State, Hudson-Mohawk Sheet (State Education Department, 1970), is described as shale and sandstone conglomerate of the lower Walton formation. All rock types exhibit a broad range of compressive strengths reflecting their heterogeneity in composition and structure; it is estimated that compressive strengths associated with the sandstone recovered in this investigation range from about 1,000 pounds per square inch (psi) to 15,000 psi or more, depending on the extent of weathering and other factors affecting its structural integrity.

Groundwater Conditions:

Groundwater was not encountered in significant quantity in the test borings. Recovered soil samples were for the most part damp or moist, and wet soils were not recovered. At most locations, water was introduced into the borehole for either permeability tests or rock coring, and some measurable residual water was therefore present in the borehole upon completion of sampling at these locations. No groundwater was noted in the test pits.

Field and Laboratory Testing:

Permeability testing indicates that the upper sand and gravel soils exhibit hydraulic conductivity on the order of 10^{-4} to10^{-5} centimeters per second (cm/sec), while that of the deeper basal till soils is on the order of 10^{-6} cm/sec. These values represent relative permeabilities in the range of semi-pervious to impervious (Bear, 1972).

Natural water contents of the individual test pit samples ranged from 4.6 to 7.6 percent. Testing of the test pit composite sample indicates its maximum dry density is 129.0 pounds per cubic foot (pcf) at an optimum moisture content of 9.2 percent. Based on mechanical analysis of the sample, its USCS classification is SM, and its uniformity coefficient (D_{60}/D_{10}) is 466. The direct shear test indicates a peak friction angle of 35 degrees, and peak cohesion of 0.1 pounds per square inch (psi). Published reference material indicates the reported angle of internal friction is within the range of expected values for this type of material (NAVFAC DM 7.01). Note that the laboratory permeability and direct shear results were obtained on samples compacted to a target dry density of 122.6 pcf, approximately 95 percent of maximum dry density.

CONCLUSIONS AND RECOMMENDATIONS

Soil Properties and Design Parameters:

It appears that cuts up to 25 feet and fills upwards of 28 feet will be necessary to establish the proposed grades. Where cuts are required, the displaced material should generally consist of silty sands and gravels (as represented by the composite laboratory sample) which are suitable for re-use as embankment fill, with some limitations. Most notably, re-use of the prevalent cobbles and boulders in this material should be avoided. In order to achieve proper compaction of the embankment materials as they are placed, oversize material (larger in any dimension than the specified compacted lift thickness) must be removed. We would recommend that lift thickness does not exceed 12 inches; depending on the size and effectiveness of the compaction equipment used,

smaller lift thickness may be necessary. The natural moisture content of excavated materials should allow them to be adequately compacted as they are placed, although some adjustment to moisture content may be necessary depending on prevailing weather conditions at the time of construction.

Deeper cuts (in excess of 20 feet or so) will likely encounter basal till materials, to some extent. These soils, while quite dense in their natural condition, may prove more difficult to work with in their re-use as embankment fill, as they consist of a greater fractional component of fines as compared with the upper soils. As such, they will likely exhibit greater moisture sensitivity, thereby limiting the ease in which proper compaction can be achieved. Additionally, the parameters derived from the laboratory testing program are not necessarily representative of this material. If these till soils are encountered in significant quantity, and if their re-use as embankment fill is intended, additional laboratory testing should be performed to establish parameters specific to this material. Such testing should include ASTM D-422, Particle Size Analysis of Soils and ASTM D-698-02, Laboratory Compaction Characteristics of Soil Using Method C Standard Effort, at a minimum.

At location B-6, it is noted that the planned finished grade is near in elevation to where the bedrock surface was found, at elevation 1906.8 feet. While the need for extensive rock excavation across the site is not anticipated, the preceding example demonstrates that bedrock may be encountered near or above planned grades in places. The publication *Guidelines for Design of Dams* (NYSDEC, 1985; revised 1989) cautions against exposing pervious soils or fissured rock at borrow areas within proposed reservoir areas, and recommends that any such areas encountered be sealed with at least two feet of compacted impervious material.

Based on our findings, the following soil parameters can be used for design of the earthen embankment dam, cognizant of the limitations described above:

<u>Recommended Soil Parameters for Earthen Embankment Dam:</u>

- Angle of Internal Friction – 35 degrees
- Cohesion – 0.1 psi (negligible)
- Permeability – 1.0×10^{-4} cm/sec
- Uniformity Coefficient – 466
- Bearing Capacity – 10,000 psf*
- Coefficient of Friction – 0.7

* Nominal bearing capacity for generalized embankment foundation (min. 20 feet width)

The calculated uniformity coefficient of 466 indicates the silty sand and gravel overburden soils are well-graded. With respect to embankment construction, well-graded soils are preferable to soils having relatively uniform particle size, as the former are usually stronger, less susceptible to piping, erosion and liquefaction, and less compressible, other factors being equal (U.S. Army Corps of Engineers, 2004, publication EM 1110-2-2300).

Embankment Construction Considerations:

It should be noted that excavation of the coarse materials revealed in the subsurface investigation may be relatively difficult. Frequent boulders and cobbles were noted throughout the test borings and test pits. It is estimated that one-quarter to one-third of the excavated materials may be oversize and therefore not suitable for re-use as embankment fill. Plans should include a suitable borrow material/source if a net deficit is anticipated with respect to cuts and fills.

As embankment fill materials are placed, compacted layers should be firm, stable, and free of any oversize material, loose soil, mud, water or frost. It is not expected that generalized groundwater conditions will be encountered in excavations, although it is possible some localized perched or trapped seepage could be present depending on precipitation and seasonal conditions at the time of construction. Such conditions, if encountered, should be handled with conventional sump and pump methods to maintain construction in the dry.

CLOSURE

This report was prepared to assist in planning for design and construction of a water storage pond for the Belleayre Mountain ski area in the town of Shandaken, New York. The design parameters and recommendations were developed based on Empire's understanding of the project, as described herein, and through the application of generally accepted soils and foundation engineering practice. No other warranties, expressed or implied, are made. Should there be any changes in the planned construction, Empire should be notified to determine if revisions to the recommendations contained herein are required. Important information regarding the use and interpretation of this report is attached.

Sincerely,
Empire-Geo Services, Inc.

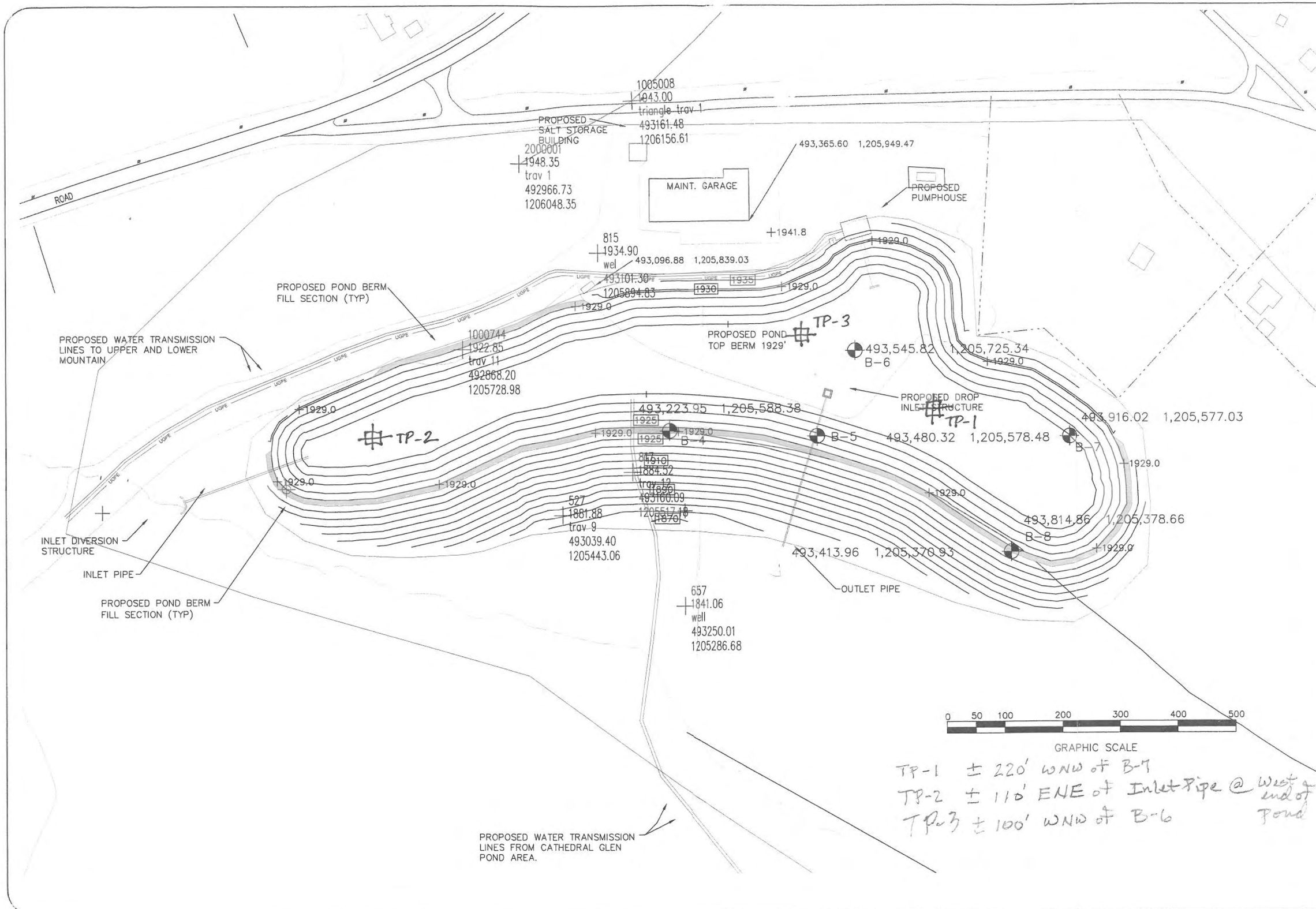
John S. Hutchison, P.E.
Geotechnical Engineer

John Danzer

John J. Danzer, P.E.
Senior Geotechnical Engineer
and Project Reviewer

ATTACHMENT 1

Subsurface Investigation Plan



TP-1 ± 220' WNW of B-7
TP-2 ± 110' ENE of Inlet Pipe @ West end of Pond
TP-3 ± 100' WNW of B-6

Belleayre Mtn. Ski Center UMP
Proposed Pond

NYS Department of Environmental Conservation
Bureau of Design & Construction

ATTACHMENT 2

Subsurface Logs

DATE:
START 9/18/2008
FINISH 9/18/2008

SHEET 1 OF 2

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-4
SURF. ELEV. 1900.58'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
	1	2	3	3	4	6	1.0	TOPSOIL, roots, organics +/- 0.6'	Driller reports coarse auger advance from surface; augered through or past boulder 6' - 7.3'. Becomes less coarse thereafter.
	2	10	21	23	27	44	1.7	Brown fine SAND, some Silt, little coarse sand and gravel (Moist - Loose) +/- 2.0'	
5	3	12	35	100/.1	-	-	0.9	Brown SAND and GRAVEL, trace silt (Dry - Compact) - Similar; becomes Reddish Brown, gravel portion more angular. (Dry - Very Compact)	
	4	100/.2	-	-	-	-	0.1	Brown Gray SAND and SANDSTONE boulder fragments (Dry - Very Compact)	Falling head permeabilty test performed @ 19.0'; no measureable ground-water prior to performing test.
	5	14	13	15	14	28	1.8	Reddish Brown SAND and GRAVEL, trace to little silt (Damp - Firm)	
10	6	12	16	18	23	34	1.7	- Similar (Damp - Compact)	
15	7	24	17	21	30	38	1.9	Reddish Brown SAND and GRAVEL, Some Silt (Moist - Compact)	Driller reports augering through boulder @ 26' to 28'.
								USCS: SM-GM +/- 19.0'	Falling head permeabilty test performed @ 34.0'.
20	8	17	35	48	63	83	2.0	TILL: Reddish Brown SILT and fine SAND w/embedded coarser sands, gravel (Moist - Very Compact)	Water level @ 23.3' upon completion of sampling (drill water).
25	9	34	41	62	94	103	1.9	- Similar; sandstone boulder fragments in shoe	
30	10	19	44	65	100/.4	109	1.8	- Similar; w/boulder fragments in shoe	
35	11	22	37	49	91	86	1.8	- Similar	
40								USCS: SM-GM	

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell

DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers, 3" FJ Casing

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/18/2008
FINISH 9/18/2008

SHEET 2 OF 2

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-4
SURF. ELEV. 1900.58'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
	12	29	40	69	100/.1	109	1.5	TILL: Reddish Brown fine SAND, some Silt w/embedded coarser sands, gravel (Very Moist - Very Compact)	
								End of Boring @ 41.6'	
45									Hole backfilled with bentonite chips 41.6' to 34.0', then tremie grout w/ bentonite slurry to surface.
50									
55									
60									
65									
70									
75									
80									

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell

DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers, 3" FJ Casing

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/16/2008
FINISH 9/16/2008

SHEET 1 OF 1

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-5
SURF. ELEV. 1915.34'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
	1	3	6	8	10	14	1.2	TOPSOIL +/- 0.4'	Driller notes coarse material in upper 13'. Augered through or past boulder @ 9' - 10'. Becomes less coarse thereafter.
								Brown SAND and GRAVEL, little to some silt (Damp - Firm)	
	2	52	29	26	22	55	1.4	Red Brown GRAVEL and silty SAND to 2.5', then Brown SAND and GRAVEL, trace to little silt (Dry - Very Compact)	
5	3	17	23	24	52	47	1.6	- Similar; Gray Brown (Dry - Compact)	
	4	18	19	17	18	36	1.7	Brown Gray fine to coarse SAND, Some Gravel, trace silt	
	5	13	17	100/.2	-	-	0.8	Brown Gray SAND and GRAVEL, trace silt (Dry - Very Compact)	
10	6	21	100/.3	-	-	-	0.7	- Similar; becomes Reddish Brown	3" flushjoint casing installed to 33.5'; cleaned out with 2-15/16" roller-bit to 33.5'.
15	7	20	15	18	27	33	1.7	Brown fine to coarse SAND, little gravel and silt (Damp to Moist - Compact)	
20	8	19	13	14	16	27	1.6	- Similar; grades to Some Silt (Moist - Firm)	Driller notes change to hard augering @ 22.5' and auger refusal @ 33.5'.
								USCS: SM-GM +/- 24.0'	
25	9	40	24	31	38	55	1.8	Brown TILL: Reddish Brown SILT and fine SAND with embedded coarser sand, occasional gravel and rock fragments. (Moist - Very Compact)	Water level at 36.8' upon completion of rock coring, hole open to 38.5'.
30	10	65	31	45	50	76	1.6	TILL: Reddish Light Brown fine SAND and SILT, intermixed with coarser sand, gravel, rock fragments (Damp - Very Compact)	Hole backfilled w/ bentonite chips 38.5' to 33.5', then tremie grout w/ bentonite slurry to surface.
	11	100/.1	-	-	-	-	<0.1	Rock fragments in shoe (sandstone) (Dry - Very Compact)	Hole is dry before coring NQ Core Run
35								Gray SANDSTONE, medium hard to hard, weathered, thin bedded to bedded, occasional medium to high angle fractures noted with reddish clayey soil (thin seams) at	Run #1: 33.5' - 38.5' REC = 92% (4.6') RQD = 25% (1.25')
40								End of Boring @ 38.5'	

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell

DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers, 3" (NW) Casing w/Diamond Bit, 2-15/16" Roller Bit, and NQ Dual Tube Core Barrel

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/17/2008
FINISH 9/17/2008

SHEET 1 OF 1

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-6
SURF. ELEV. 1931.29'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
	1	4	6	9	21	15	1.7	TOPSOIL +/- 0.4'	Driller reports auger refusal at 23.8'. 3" flushjoint casing installed to 23.8'; 2-15/16" roller-bit to 24.5'.
								Brown SAND and GRAVEL, little silt, cobble pcs., fill? (Damp - Firm)	
	2	19	34	28	30	62	1.8	Gray Brown fine to coarse SAND and cobble/boulder fragments @ 2.5' (Dry - Very Compact)	
5	3	20	23	27	31	50	1.7	Brown SAND and GRAVEL, little silt (Moist - Compact)	No measureable ground-water in hole prior to
	4	35	29	30	33	59	1.9	- Similar; very compact	
	5	17	36	33	30	69	1.6	- Similar; grades to little to some silt	Water level at 22.5' upon completion of coring, hole open to 29.5'.
10	6	16	22	27	40	49	1.5	Brown fine to coarse SAND, little gravel and silt (Moist - Compact)	
15	7	15	10	13	15	23	1.7	- Similar; grades to some Gravel (Moist - Firm)	
								USCS: SM-GM +/- 19'	
20	8	21	37	36	34	73	1.8	TILL: Reddish Brown fine SAND and SILT intermixed with coarser sand, gravel, rock fragments (Damp - Very Compact)	
	9	50/.0	-	-	-	-	0.0	- No Recovery +/- 24.5'	
25								Gray SANDSTONE, medium hard to hard, lightly weathered, thin bedded to bedded, near vertical fractures noted from 26.5' to 27.5'.	NQ Core EL 1906.8 Run #1: 24.5' - 29.5' REC = 92% (4.6') RQD = 69% (3.45')
30								End of Boring @ 29.5'	Hole backfilled w/ bentonite chips 29.5' to 24.5', then tremie grout w/ bentonite slurry to surface.
35									
40									

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers, 2-15/16" Rollerbit, NQ Core

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/22/2008
FINISH 9/22/2008

SHEET 1 OF 1

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-7
SURF. ELEV. 1926.90'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
									Driller reports coarse augering from surface, ground up till in cuttings at 20'. Becomes very hard augering at 24'.
5									Driller reports auger refusal at 25'. No measureable ground-water in augers prior to coring.
10	1	22	27	31	38	58	1.8	Brown fine to coarse SAND, Some Gravel, little silt (Damp - Very Compact) USCS: SM-GM	Falling head permeability test performed at 12.5'
15									
								+/- 20'	
20									
								+/- 25.0'	
25								Gray SANDSTONE, medium hard to hard, lightly weathered to weathered at lower end of run, then soil seams noted at fracture noted at approximately 27'.	NQ Core EL 1901.9 Run #1: 25' - 30' REC = 100% (5.0') RQD = 62% (3.1')
30								End of Boring @ 30.0'	Water level at 22.0' upon completion of coring.
35									Hole backfilled w/ bentonite chips 30.0' to 24.0', then tremie grout w/ bentonite slurry to surface.
40									

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell

DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers, 3" FJ Casing, NQ Core

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/19/2008
FINISH 9/19/2008

SHEET 1 OF 2

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. **B-8**
SURF. ELEV. 1900.57'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
								TOPSOIL and roots. +/- 0.5'	Soil descriptions 0' - 40' by driller based on auger cuttings.
								Red Brown silty SAND and GRAVEL with occasional cobbles (Dry) USCS: SM-GM	
5									Driller notes coarse augering for length of hole with boulders encountered at: 7.5' - 9.5', 15.5' - 16.3', 26.2' - 28.1' 31.5' - 33.5', and 35.5' - 37.3'.
10									
15									
20									
25									
30									
35									
40								USCS: SM-GM	

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

DATE:
START 9/19/2008
FINISH 9/19/2008

SHEET 2 OF 2

SJB SERVICES, INC.
SUBSURFACE LOG

PROJ. NO. AD-08-051
HOLE NO. B-8
SURF. ELEV. 1900.57'
G.W. DEPTH See Below

PROJECT: Subsurface Investigation
Belleayre UMP

LOCATION: Town of Shandaken
Ulster County, New York

DEPTH (ft.)	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	REC. (ft.)	SOIL OR ROCK CLASSIFICATION	NOTES
	1	48	100/.2	-	-	-	0.4	Reddish Brown SAND, GRAVEL and Boulder (rock?) fragments, trace to little silt (Damp - Very Compact)	Hole backfilled w/ bentonite chips from 40.7' to 35.0', then tremie grout w/ bentonite slurry to surface.
								End of Boring @ 40.7'	
45									
50									
55									
60									
65									
70									
75									
80									

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFICATION: Visual by Geotechnical Engineer

DRILLER: Tom Farrell

DRILL RIG TYPE: CME 550x

METHOD OF INVESTIGATION: 4 1/4" Hollow Stem Augers

All recovered samples will be retained for approximately sixty (60) days, at which time the samples will be discarded unless directed otherwise.

Contract Drilling and Testing

SJB SERVICES, INC.

TEST PIT LOG

DATE: September 17, 2008

PROJECT: Subsurface Investigation
Belleayre UMP

CONTRACTOR: SJB Services, Inc.

FIELD GEOLOGIST: James Vincent, CPG

EXCAVATION EQUIP.: Rubber-Tire Backhoe John Deere 410E

TEST PIT NO.: TP-1

G.S. ELEVATION: 1927.30'

PROJECT NO.: AD-08-051

WEATHER / TEMP.: Sunny & Cool

DEPTH	SOIL DESCRIPTION	EXCAV. EFFORT
0 - 2'	Topsoil w/numerous roots & cobbles	Moderate - Compact
2' - 6'	Orange-Brown fine to medium SAND and GRAVEL, little silt w/numerous sandstone cobbles and occassional tabular sandstone boulders (length 2' - 3' and 2" - 8" thick)	Moderate - Compact
6' - 12'	GLACIAL TILL: Brown GRAVEL and fine to medium SAND, trace silt w/numerous tabular sandstone cobbles and boulders (approx 30% to 40%)	Hard - Very Compact

Contract Drilling and Testing

SJB SERVICES, INC.

TEST PIT LOG

DATE: September 17, 2008

PROJECT: Subsurface Investigation
Belleayre UMP

CONTRACTOR: SJB Services, Inc.

FIELD GEOLOGIST: James Vincent, CPG

EXCAVATION EQUIP.: Rubber-Tire Backhoe John Deere 410E

TEST PIT NO.: TP-2

G.S. ELEVATION: 1910.41'

PROJECT NO.: AD-08-051

WEATHER / TEMP.: Sunny & Cool

DEPTH	SOIL DESCRIPTION	EXCAV. EFFORT
0 - 1.5'	Topsoil w/numerous tree roots & occasional cobbles	Moderate - Compact
1.5' - 3.5'	Orange-Brown fine to medium SAND and GRAVEL, little silt w/numerous tabular sandstone cobbles	Moderate - Compact
3.5' - 10.5'	SANDY TILL: Brown GRAVEL and fine to medium SAND, trace silt w/numerous (+/- 30% - 40%) tabular cobbles and boulders (1' - 2' length and 2" - 8" thick).	Hard - Very Compact

Contract Drilling and Testing

SJB SERVICES, INC.

TEST PIT LOG

DATE: September 17, 2008

PROJECT: Subsurface Investigation
Belleayre UMP

TEST PIT NO.: TP-3

G.S. ELEVATION: 1932.22'

CONTRACTOR: SJB Services, Inc.

PROJECT NO.: AD-08-051

FIELD GEOLOGIST: James Vincent, CPG

WEATHER / TEMP.: Sunny & Cool

EXCAVATION EQUIP.: Rubber-Tire Backhoe John Deere 410E

DEPTH	SOIL DESCRIPTION	EXCAV. EFFORT
0 - 1.0'	Topsoil w/small roots	Moderate - Compact
1.0' - 12.5'	SANDY TILL: Brown GRAVEL and fine to medium SAND, trace silt w/numerous tabular sandstone cobbles and boulders (1' - 2' length and 2" - 6" thick); less silt noted from 11.0' - 12.5'.	Hard - Very Compact

DATE		SJB SERVICES, INC. SUBSURFACE LOG	PROJ. No.	AE-01-099
STARTED	7/29/01		HOLE No.	B-1
FINISHED	7/30/01		SURF. ELEV.	325.6
SHEET 1 OF 1			G.W. DEPTH	see notes

PROJECT _____ LOCATION _____

DEPTH (ft)	SAMPLES	SAMPLE No.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	BLOWS ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	3	3	4	8	7	10	3" TOPSOIL	Groundwater at 10' upon completion, and 5' 24 hrs. after completion
								15	Brown SILT, some Sand, trace clay, ML (Moist-Loose)	
								50/.5		
5									Gray SHALE, medium hard, weathered, thin bedded, some fractures	Run#1, 2.5'-5.0' 95% Recovery 50% RQD

1 2 3 4 5 6 7 (numbered features explained on reverse) 8 9 10

TABLE I

- Split Spoon Sample
- Shelby Tube Sample
- Geoprobe Macro-Core
- Auger or Test Pit Sample
- Rock Core

TABLE II

Identification of soil type is made on basis of an estimate of particle sizes, and in the case of fine grained soils also on basis of plasticity.

Soil Type	Soil Particle Size	
Boulder	>12"	Coarse Grained (Granular)
Cobble	3" - 12"	
Gravel - Coarse	3" - 3/4"	
- Fine	3/4" - #4	
Sand - Coarse	#4 - #10	
- Medium	#10 - #40	
- Fine	#40 - #200	
Silt - Non Plastic (Granular)	<#200	Cohesive
Clay - Plastic (Cohesive)		

TABLE III

The following terms are used in classifying soils consisting of mixtures of two or more soil types. The estimate is based on weight of total sample.

Term	Percent of Total Sample
"and"	35 - 50
"some"	20 - 35
"little"	10 - 20
"trace"	less than 10

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter.)

TABLE IV

The relative compactness or consistency is described in accordance with the following terms:

Granular Soils		Cohesive Soils	
Term	Blows per Foot, N	Term	Blows per Foot, N
Loose	<11	Very Soft	<3
Firm	11 - 30	Soft	3 - 5
Compact	31 - 50	Medium	6 - 15
Very Compact	>50	Stiff	16 - 25
		Hard	>25

(Large particles in the soils will often significantly influence the blows per foot recorded during the penetration test)

TABLE V

Varved	Horizontal uniform layers or seams of soil(s).
Layer	Soil deposit more than 6" thick.
Seam	Soil deposit less than 6" thick.
Parting	Soil deposit less than 1/8" thick.
Laminated	Irregular, horizontal and angled seams and partings of soil(s).

TABLE VI

Rock Classification Term		Meaning
Hardness	- Soft	Scratched by fingernail
	- Medium Hard	Scratched easily by penknife
	- Hard	Scratched with difficulty by penknife
	- Very Hard	Cannot be scratched by penknife
Weathering	- Very Weathered	Judged from the relative amounts of disintegration, iron staining, core recovery, clay seams, etc.
	- Weathered	
	- Sound	

Rock Classification Term		Meaning	
Bedding	- Laminated	(<1")	Natural breaks in Rock Layers
	- Thin Bedded	(1" - 4")	
	- Bedded	(4" - 12")	
	- Thick Bedded	(12" - 36")	
	- Massive	(>36")	

(Fracturing refers to natural breaks in the rock oriented at some angle to the rock layers)

ATTACHMENT 3

Rock Core Photograph

Photo of Rock Core Samples Collected from Test Borings B-5 (33.5' – 38.5'), B-6 (24.5' – 29.5'), and B-7 (25.0' – 30.0').