ARROWWOOD ENVIRONMENTAL
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Vernal Pool Data Collection and Assessment Protocol
Hermitage Inn Real Estate Holding Co. LLC
May 7, 2014

The following protocol for Vernal Pool Assessment was developed to provide a standardized approach to vernal pool survey methods for use at Haystack Mountain Resort (project area). This protocol is designed to gather all the relevant information about each site in order to determine the quality, condition, and functioning of the pool. The protocol is separated into two sections, the Data Collection Protocol and the Pool Assessment Protocol. The proposed Vernal Pool Data Form is also included at the end of the protocol descriptions.

Data Collection Protocol

Time of Visit

Potential pools in the project area will be visited during the spring, from April 30th to May 30th, 2014 Site visits in the spring when egg masses are present are the preferred time-period because they give a good indication of the amount of use by amphibians. Surveying during this time period is also critical for making a judgment on the hydroperiod length.

Data Collection

The Vermont Fish and Wildlife Vernal Pool Data Form will be used to collect and record all data on potential vernal pools during 2014 in the project area. All fields will be filled out when conducting a vernal pool assessment.

Survey Methods

Pool Characteristics Inventory

When visiting a potential vernal pool, the surveyor will walk the perimeter of the entire pool to determine if there are any inlets or outlets and ascertain the full extent of the pool. In some cases, isolated vernal pools may have ephemeral surface water inputs or outputs. In most cases, these inputs and outputs lack any defined channel and only support flow for limited times during spring rains and snowmelt. Nature of the inlet and outlet (if present) will be determined based on date visited, flow conditions and the presence and nature of a defined channel.

Vernal pool size will be visually estimated to fill out the Vernal Pool Data Form in the field, with pool boundaries subsequently surveyed using sub-meter GPS. Determination of pool depth will be made at the deepest point in the pool at the time of the survey using a measuring device. This may require the surveyor to enter the pool.

In order to determine the nature and condition of the surrounding habitat, the surveyor will examine aerial photographs of the site as well as walk the area within 700'. Data on composition and condition of the habitat will be taken on the Vernal Pool Data Form. Any disturbance to the pool or the surrounding habitat will be noted on the data form.

Indicator Species Inventory

Surveying the potential vernal pool for the presence of egg masses will involve conducting visual counts of egg masses present for each species (see list of Indicator Species below). This may require the surveyor to enter the pool. If visibility or depth of pool prevents visual confirmation of egg masses or larvae, long-handled nets will be employed to assist the surveyor. A complete count of egg masses will be attempted for each site. If pool factors prevent a complete count, notes will be made on the Vernal Pool Data Form accordingly. Polarized sunglasses will be used when appropriate to aid in the detection of egg masses in the pool. Egg mass counts will not take place during periods of heavy rain.

Amphibian inventories will include documenting the presence or absence of tadpoles and/or larvae of indicator species. This typically requires employing a small net and cup to capture and examine specimens.

In the event of a seemingly productive pool lacking any indicator species, a follow-up visit may be required to verify absence. A single site visit is sufficient if it is timed such that wood frog eggs have not hatched and mole salamander eggs have been laid.

Pool Assessment Protocol

The following criteria will be collected to determine if a site is a viable vernal pool:

Presence of Indicator Species
Sufficient Hydroperiod
Woodland Setting
Lack of Fish
Hydrologically Isolated
Natural Feature

Presence of Indicator Species

The following species are considered "indicator species" for vernal pools:

- Jefferson Salamander (*Ambystoma jeffersonianum*)
- Blue-spotted Salamander (*A. laterale*)
- Spotted Salamander (*A. maculatum*)
- Wood Frog (*Rana sylvestris*)
- Fairy Shrimp (*Eubranchipus spp.*)

Evidence of breeding activity (breeding adults, egg masses, larvae or recently metamorphosed adults) in a pool for any of the above amphibians would fulfil the indicator species criteria of this assessment protocol.

Sufficient Hydroperiod

The following data will be collected to determine if the hydroperiod is sufficient to support successful reproduction of breeding amphibians:

- Nature of inlet and outlet (if present)
- Pool size
- Pool depth
- Date of visit
- Seasonal snow melt and recent precipitation
- Nature of substrate

Woodland Setting

An assessment of the surrounding habitat is made to determine the nature and extent of the surrounding habitat.

Lack of Fish

Presence or absence of fish will be determined during the site visit. Visual inspection of the site as well as nets may be used to determine fish presence/absence.

Hydrologically Isolated

Data on inlets and outlets to the potential vernal pool will be collected to determine if the site is hydrologically isolated.

Natural Feature

Notes on human-caused disturbance to each site will be taken. In addition, notes on whether or not the site originated from human disturbance will be taken.

Send completed data forms to:

Vermont Fish & Wildlife Department
1 National Life Drive, Davis 2
Montpelier, VT 05620-3702

☐ Data from this form entered in online database
www.vtecostudies.org/VPMP/dataentry.html
by:______________________________

Vermont Vernal Pool Data Form v0.2

1a) Observer Information

Date of Visit (mm/dd/yyyy):

Name:		Address:	
Phone:			
Email:			

1b) Credentials (please check all that apply)

- ☐ Professional Biologist/Ecologist
- ☐ Natural Resource Professional (forester, land manager, etc)
- ☐ Educator
- ☐ Trained Citizen Scientist
- ☐ Self-informed Naturalist
- ☐ Other

2a) Vernal Pool Location Information

What navigation method was used? (check one)

☐ GPS ☐ Map & Compass ☐ Prior Knowledge
☐ Other:

VT Vernal Pool Mapping Project ID:

Town:

County:

Brief directions to pool:

Location Comments:

2b) GPS Location of Pool

Preferred format is Decimal Degrees (for example:Latitude: 44.764322 Longitude: -72.654222)

Format from GPS unit: ☐ DD- Decimal Degrees ☐ DM- Decimal Minutes ☐ DMS- Deg. Min. Sec. ☐ UTM-Zone:

Latitude/Northing: Longitude/Easting:

If you cannot provide GPS coordinates, please attach USGS Topo map or Aerial photo with pool clearly marked

2c) Landowner Contact Information

Are you the landowner? ☐ YES ☐ NO

If no, was landowner permission obtained for this survey? ☐ YES ☐ NO

Landowner's contact information (if known) Name:

Address: Phone:

Pool Diagram

Provide Grid Scale (eg. 1 sq. = 10'):

draw north arrow

3. Vernal Pool Field-Verification Information

3a) Pool Type (select one)

- ☐ Isolated Forest Depression
- ☐ Isolated Non-Forest Depression
- ☐ Floodplain Depression
- ☐ Pool within a larger wetland complex
- ☐ Manmade(impoundment, quarry,
- ☐ Other (describe):

Is This a Vernal Pool?

- ☐ YES
- ☐ NO
- ☐ Unsure

3b) Presence of Inlet and/or Outlet

Type of Inlet (an inlet is a seasonal or permanent channel providing water into pool)

☐ No Inlet ☐ Ephemeral/Seasonal Inlet ☐ Permanent Inlet (channel between well-defined banks)

Type of Outlet (an outlet is a seasonal or permanent channel draining water from pool)

☐ No Outlet ☐ Ephemeral Outlet ☐ Permanent Outlet (channel between well-defined banks)

3c) Surrounding Habitat (within 250 feet of pool)

Surrounding Forest

Deciduous ________%

Coniferous ________%

☐ Early Successional

☐ Evid. of Recent Logging

Surrounding Land Cover

Forest	________%	Light Development	________%
Wetland	________%	Intensive Development	________%
Agriculture/Open field	________%	Roads	________%
Powerline Right-of-Way	________%	Other(________________)	________%

Surrounding Habitat Comments:

4. Pool Characteristics

(at time of survey)

4d) Approximate size of pool (at maximum capacity)

Avg. Width: ______ feet Avg. Length: ______ feet

4a) Approximate Maximum Pool Depth

- ☐ Ankle-deep (<6")
- ☐ Hip-deep (2-3 ft)
- ☐ Shin-deep (6-12")
- ☐ Chest-deep (3-4ft)
- ☐ Knee-deep (12-24")
- ☐ Deeper than 4 ft

4e) Water Level

- ☐ Full
- ☐ More than 50%
- ☐ Less than 50%
- ☐ Dry

4f) Veg. in Pool

Trees: ________%

Shrubs: ________%

Emergent: ________%

Floating: ________%

Canopy Cover

Trees: ________%

Shrubs: ________%

Total ________%

4b) Substrate ☐ Firm ☐ Mucky

4c) Hydroperiod (select the likely hydroperiod below)

☐ Permanent ☐ Semi-Permanent (drying partially all years / completely in drought yrs)

☐ Ephemeral (drying out completely during the growing season in most years)

4g) Pool Disturbance (check all that apply)

☐ Siltation ☐ Dumping ☐ Vehicle Ruts

☐ Ditching/draining ☐ Agricultural runoff ☐ Other

Hydroperiod Comments:

5. Indicator Species

Provide a photograph of the pool & each indicator species (or egg masses) observed

Species Observed	Adults	Tadpoles/ Larvae	Egg Masses Number	Egg Masses Estimated	Egg Masses Counted	Photos? Yes	Pool Area Surveyed
Wood Frog	☐	☐		☐	☐	☐	☐ Entire ☐ Partial
Spotted Salamander	☐	☐		☐	☐	☐	☐ Entire ☐ Partial
Jefferson Salamander	☐	☐		☐	☐	☐	☐ Entire ☐ Partial
Blue-spotted Salam.	☐	☐		☐	☐	☐	☐ Entire ☐ Partial
Fairy Shrimp	☐						
Fingernail Clams	☐						
Other (list below):							
	☐	☐					
	☐	☐					
	☐	☐					

Were Fish Observed? ☐ YES ☐ NO

Comments

Wetland and Vernal Pool Inventory Report

The Hermitage Club at Haystack Mountain

Master Plan

September 22, 2014

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Wetland and Vernal Pool Inventory Report
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Contents

1. Introduction

Arrowwood Environmental (AE) commenced a natural resources inventory within the Master Plan Project area in the summer of 2013. The inventory has included the identification and mapping of the following resources: wetlands and vernal pools, streams, rare, threatened and endangered plant species, and rare and irreplaceable natural areas. This preliminary report focuses on the wetland and vernal pool mapping efforts.

2. Wetland Delineation and Mapping

AE was retained to formally delineate and survey wetlands within the Master Plan project area. Field evaluations were conducted by AE in the field seasons of 2013 and 2014. Wetland boundaries within and adjacent to the proposed work were delineated and subsequently surveyed via sub-meter GPS. Representative wetland data sheets are being collected at the time of writing this report.

The protocols put forth in the *Corp of Engineers Wetlands Delineation Manual* (2009 Regional Supplement for the Northcentral and Northeast Region) were employed for delineating wetlands. This is a multiple parameter methodology that includes the use of vegetation, soil, and hydrology to delineate wetlands. Wetland boundaries were delineated in conformance with these requirements.

A Wetland Summary table providing wetland identification, size, wetland classification and natural community type is provided in the attachment. AE anticipates providing a comprehensive report including analysis of project impacts on specific wetlands in the fall/winter of 2015.

3. Vernal Pool Assessment

AE was retained to inventory and assess vernal pools within the Master Plan Project area. AE identified potential vernal pools during wetland delineation and mapping. Field evaluation of the potential pools was conducted during the spring of 2014. AE conducted a site visit with Ms. Marty Abair and Ms. Rebecca Chalmers to review the vernal pool inventory results.

3.a Site History

From 1970-1974, there was a planned development in the East Tract area. During that time, many roads were cleared and installed to sub-grade levels and road drainage was installed. In addition, approximately 2000 linear feet of 8″ gravity sewer lines and manholes were installed or partially installed. In some cases, excavations for the sewer line were made, but the sewer line not installed. This work was abandoned for economic reasons in 1974. Many of the wetlands and vernal pools present today are a direct result of this excavation and drainage work.

3.b Methodology

The methodology for collection of vernal pool data is outlined in the document Vernal Pool Data Collection and Assessment Protocol (May 7, 2014 Arrowwood Environmental). The Vermont Fish and Wildlife Vernal Pool Data Form was used to collect data on each pool. In order for a site to be considered a vernal pool, it had to meet the following 5 criteria: 1) presence of indicator species; 2) woodland setting; 3) lack of fish; 4) hydrologically isolated; and 5) season hydrology. These factors are explained in the Protocol document mentioned above. Only sites that met the five criteria were considered Vernal Pools and are included in sections 3.c.1 and 3.c.2 below. Some wetlands that are not vernal pool type wetlands may also offer breeding habitat to wood frogs and spotted salamanders. These wetlands are included in Section 3.c.3.

The vernal pool assessment occurred as part of a larger environmental assessment mapping all wetland types. Some vernal pools were initially visited in the summer of 2013. All potential sites were revisited in mid-May of 2014 to receive a full vernal pool assessment as outlined in the Protocol. All vernal pool assessments were conducted by Michael Lew-Smith of AE.

Confirmed Vernal Pools were also ranked as wetland natural communities using the Vermont Non-Game and Natural Heritage (NNHP) Vernal Pool Ranking Specifications (dated 1/27/09). This methodology uses a combination of community condition, landscape quality, pool size and use by amphibians to rank pools as natural communities. NNHP personnel make the final decision regarding state significant ranks. These ranks should therefore be considered preliminary until they are reviewed by NNHP personnel.

3.c Results

Section 3.c.1 includes vernal pools that occur on the Haystack Mountain property (east of Handle Road). Section 3.c.2 includes vernal pools in the Airport and East Tract properties. All data is summarized in Table 1.

Table 1. Vernal Pool Summary Data

WetID	Square Feet	Comments	# Wood Frog Egg Masses	# Spotted Salamander Egg Masses
105	6963	Old sewer line excavation; permanent water; fairly productive	24	17
145	509	Small sewer line excavation	18	32
146	415	Small sewer line excavation	6	19
200	16262	Very nice natural pool; diverse and productive	38	34
223	1770	Marginal habitat; shallow	0	4
389	2528	Very nice natural pool; diverse and productive	114	111
399	10623	Fairly productive natural pool	47	14
427	939	Small, deep sewer line excavation	0	14
501	3708	Trail through wetland; marginal habitat	33	10
500	517	Man-made wetland; permanent water	12	27
542	5256	Natural pool, marginal habitat	7	8
602	991	Man-made in ditch; marginal habitat	12	22
605	6678	Natural pool, good habitat	29	15
607	1046	Natural pool, some disturbance; moderately productive	10	12
545a	3541	Some flowing water; moderate habitat	10	17

The following table provides a summary of the natural community ranking for each vernal pool.

Table 2. Preliminary Vernal Pool Natural Community Ranking Summary

WetID	Community Condition	Landscape Condition	Amphibian Rank	Size Rank	EO Rank	State Significant	Rank Notes
105	C	C	A-B	A	B	N	Man-made, not state significant
145	C	C	B	C	C	N	Man-made, not state significant
146	C	C	B	C	C	N	Man-made, not state significant
200	A	C	A	A	A	Y	Nice natural pool
223	B	C	C	C	C	N	Marginal habitat
389	C	C	A	B	B	Y	Nice natural pool
399	BC	C	A	A	B	Y	Nice natural pool
427	C	C	B	C	C	N	Man-made, not state significant
501	C	C	B	C	C	N	Marginal habitat; not state significant
500	C	C	A	C	B	N	Man-made, not state significant
542	B	C	B	A	B	N	Marginal habitat; not state significant
602	C	C	A	C	B	N	Marginal habitat; not state significant
605	B	C	A	A	A	Y	Nice natural pool
607	C	C	B	C	C	N	Moderately productive; not state significant
545a	B	C	B	B	B	N	Marginal habitat; not state significant

3.c.1 Haystack Mountain Vernal Pools

Vernal Pool 500

Vernal Pool 500 is a human-made wetland of unknown origin. It sits in the floodplain of Cold Brook and consists of a deep excavation surrounded by piles of the gravel which was removed from the hole. This has created steep banks above as well as within the pool. The pool does not have any inlets or outlets and does not appear to regularly receive flood waters from the Cold Brook (though may under extreme flood events). The water is fairly deep, approximately 2' at its deepest and may fluctuate only with ground water levels.

At the time of the site visit in mid-May 2014, twelve wood frog and twenty-seven spotted salamander eggs were documented. Invertebrates include caddis flies, fingernail clams, mayflies, daphnia and *Odonata* larvae. The upland forest surrounding this pool consists of an early successional mix of hardwoods and softwoods. It is bordered on the west by Cold Brook and on the east by Handle Road. Though a human-constructed wetland, this site appears to be diverse and provides relatively stable breeding habitat for these amphibians.

Vernal Pool 501

Vernal Pool 501 is small, disturbed wetland near the banks of Cold Brook. It is functionally divided into 2 different areas by a woods road/trail which bisects it.

The northern section consists of a seepage wetland which lacks standing water. The southern section contains standing water and provides some limited vernal pool habitat. The standing water is likely a result of the trail construction; though the trail is culverted, it appears to have impeded drainage. This site has an ephemeral inlet and outlet.

In mid-May of 2014, a total of thirty-three wood frog and ten spotted salamander egg masses were documented. No invertebrates were recorded. The hydroperiod appears to be too short in most years to allow for successful reproduction of the amphibians that breed here. There is no permanent hydrological connection between this wetland and Cold Brook, though extreme flood events may allow fish to occupy this pool. Overall, this is a small, fairly disturbed pool that likely provides good breeding habitat for amphibians only in years with high precipitation.

3.c.2 East Tract Pools

Vernal Pool 105

This pool originated from an excavation for a sewer line in the 1970s. Unlike the other smaller excavations, this site is quite large, approximately 25' wide and 230' long. The depth of the pool is approximately 2-3 feet, because of its origins, the banks of the pool are quite steep. It appears to be a permanent water body and has an ephemeral inlet but lacks any outlet. Because of its permanent hydrology, this site has sufficient hydroperiod to support successful reproduction of the amphibians that breed here. It also, however, may draw green frogs and eastern newts, which can prey on salamander and wood frog eggs and larvae.

The amphibian habitat that this pool provides appears to be very good. Twenty-four wood frog and seventeen spotted salamander egg masses were counted during the field inventory. Because of the deep, tannic nature of the water at this site, however, it is likely that many more eggs masses were present that could not be observed. Overall, this is a human-created pool that appears to offer stable breeding habitat to a large number of amphibians.

Vernal Pool 145

This pool originated from a small sewer line excavation in the 1970s. The excavation appears to have encountered groundwater, which flows out of this pool and into the adjacent beaver wetland. The upland banks of this site are very steep and the pool appears to be 1-2' deep.

Despite its inauspicious origins, eighteen wood frog egg masses and thirty-two spotted salamander egg masses were documented here. Some wood frog tadpoles were present at the time of the survey, so it is likely that more wood frog egg masses were present. The hydrology appears to be either permanent or semi-permanent. In either case, the hydroperiod appears to be sufficient to support successful reproduction for both wood frogs and spotted salamanders in most years.

Vernal Pool 146

This site is very similar to Vernal Pool 145. It originated from excavations for a sewer line that was never completed. This site also appears to have encountered groundwater but, unlike VP#145, there is no outlet; this site is hydrologically isolated. Because of this, the site likely has a permanent hydroperiod. The excavations originally went fairly deep, yielding a pool that is 3-4' deep. At the time of the site visit in mid-May, 2014, six wood frog and nineteen spotted salamander egg masses were recorded. This site appears to function well as vernal pool, offering habitat to these amphibians as well as many invertebrates.

Vernal Pool 200

The entire wetland 200 includes a Seepage wetland in the northwestern end and a Vernal Pool wetland in the southeastern end. The northwestern end contains an ephemeral inlet and outlet and appears to lose any standing water early in the season (late May-early June). No vernal pool indicator species were documented in this northwestern section.

The southeastern section of this wetland, however, contains a natural vernal pool that is very productive and is in excellent condition. Standing water was recorded at 12"-16" in mid-May, 2014. Subsequent visits to the site later in the year indicate that the pool does dry during summer months, but the hydroperiod appears to be sufficient to support successful reproduction of wood frogs and spotted salamanders during most years. At the time of the site visit, thirty-eight wood frog and thirty-four spotted salamander egg masses were documented. Invertebrates such as fingernail clams, caddis flies and ostracods were also recorded. There are no disturbances to the vernal pool depression, though an old road does exist within 40′ of the southern edge of the pool. This pool is one of the more diverse and productive of the natural pools in the study area. Preliminary ranking has resulted in a state significant rank for this pool.

Vernal Pool 223

This wetland consists of an eastern section which is a sloping Seepage wetland and a western section which contains open water and may provide vernal pool habitat. The open water in this area, however, is shallow and offers only marginal habitat. At the time of the site visit in mid-May 2013, there was less than 6″ of water. A total of 4 spotted salamander egg masses and no wood frog eggs were documented. No invertebrates other than mosquito larvae were recorded. The hydroperiod is likely insufficient in all but the wettest of years to support reproduction of salamanders. During normal years, this wetland may act as a population sink (where eggs are produced but typically die). This is a natural wetland with no disturbance to the vernal pool depression or pool envelope.

<u>Vernal Pool 389</u>

Vernal Pool 389 is a natural vernal pool depression which may have been impacted by surrounding land-use. This site sits right along the existing road access to the proposed development in the East Tract and the current access to the Cold Brook Pump House. While this pool currently has no inlets or outlets, there is a broken culvert beneath the pump house access road. This culvert and drainage area may have acted as a natural outlet prior to disturbance, but does not seem to be functioning at this time. The blocking of this outlet may have resulted in a deeper pool with a longer hydroperiod. At the time of a site visit in mid-May, 2014, the water level was around 12" deep. A subsequent visit in mid-June revealed the water level to be deeper (12"-24" range). The hydroperiod for this pool, therefore, appears to be sufficient in most years to support successful reproduction of vernal pool amphibians.

During the May site visit, one-hundred fourteen wood frog and one-hundred eleven spotted salamander eggs were documented. Invertebrates such as ostracods, caddis flies and oligochaete worms were also recorded. Some clearing of trees on the north and northeastern sides of this pool was conducted in association with the construction of the Cold Brook pump house. Overall, this is a very productive and diverse natural vernal pool which appears to be functioning well despite disturbance in the vernal pool envelope. Preliminary ranking has resulted in a state significant rank for this pool.

Vernal Pool 399

Wetland 399 includes a sloping seepy southern end and a northern end with open water that functions as a vernal pool. This wetland has a seasonal outlet on the northern end which drains into Wetland 398. It is unclear if this is a natural drainage or was created/enhanced in the 1970s when the original development was being constructed. The open water in the northern part of this pool is fairly shallow, less than 6" deep in mid-May 2014. However, in the fall of 2013, water levels were in the 6"-12" range. In addition, the soils consist of mineral soils with a high organic content, suggesting that the hydroperiod may be longer than the May, 2014 site visit would suggest.

During that May visit, a total of forty-seven wood frog and fourteen spotted salamander egg masses were documented. Invertebrates such as fingernail clams, ostracods and daphnia were also observed. Overall, this is a fairly diverse vernal pool with a hydroperiod that appears to be sufficient in some years. Preliminary ranking has resulted in a state significant rank for this pool.

Vernal Pool 427

Vernal Pool 427 is a human-made wetland which was created during the excavation for the sewer line in the 1970s. This site is small, approximately 930 square feet, but very deep. Actual depth is not known, but at its deepest, the pool is greater than 4' deep. Though there are ephemeral inlets and outlets to this pool, these are situated high enough that a depth of >4' is maintained throughout the year. This permanent hydroperiod and lack of fish has provided what appears to be a stable wetland habitat for wood frog and spotted salamander reproduction.

At the time of the site visit in mid-May 2014, two wood frog and fourteen salamander egg masses were recorded. However, given the depth of this pool, it is likely that many more were present that could not be detected. Overall, this is a man-made wetland which appears to offer good habitat for the amphibians that use it.

Vernal Pool 542

This pool is a natural, shallow basin which contains open water and provides some limited vernal pool habitat. The open water area of this wetland is relatively shallow; recorded at <6" in mid-May, 2014. At this time, seven wood frog and eight spotted salamander egg masses were documented. This pool has no inlets or outlets. There is a small amount of disturbance on the east end from fill associated with a trail, though this does not appear to have altered the hydrology of the pool. It appears that the hydroperiod of this site is too short to provide time for successful reproduction of wood frogs and spotted salamanders in most years. Overall, this is a natural wetland which provides only marginal vernal pool habitat.

Vernal Pool 545a

Wetland 545a is located at the outlet of a much larger pond/marsh (Wetland 233). The main part of this wetland receives flow from Wetland 233 and has an intermittent channelized outlet. The northeastern arm of this wetland, however, appears to be somewhat isolated from the flow of the drainage.

During the site visit in mid-May of 2014, ten wood frog and seventeen spotted salamander egg masses were documented in the wetland as a whole. Fingernail clams, ostracods and caddis flies were also present. The hydroperiod appears to be ephemeral. While it was very shallow (<6" deep) during the May site visit, the previous fall the site was much deeper (6"-12"). Other amphibians such as green frogs and eastern newts may visit this wetland from the adjacent wetland and prey on developing wood frog and salamander eggs and larvae.

The inlet to this wetland (outlet to Wetland 233) appears to have been modified during the original development and now consists of a woods road composed of stone and gravel fill. Drainage from Wetland 233 flows over, and to some extent through, this road. The overall effect of this change on the nature and extent of these wetlands is unclear. It does appear that Vernal Pool 545a was a natural wetland and, other than the inlet, it lacks any sign of disturbance. Overall, this pool offers moderate quality habitat to vernal pool amphibians.

Vernal Pool 602

Vernal Pool 602 appears to have been created during the development activity of the 1970s and is located in a ditch alongside a road. A poorly placed culvert appears to have blocked flow from the area, creating ponding and vernal pool habitat. During a site visit in May of 2014, twelve wood frog and twenty-two spotted salamander egg masses were documented. Green frogs were also seen at this pool, likely visiting from other wetlands in the vicinity. The water level in mid-May was in the 6"-12" range. It is unlikely that this site holds water long enough for successful reproduction of wood frogs and spotted salamander during a year with average precipitation. Given its origins and likely hydroperiod, this site offers only marginal amphibian habitat.

<u>Vernal Pool 605</u>

Vernal Pool 605 is a natural wetland depression that appears to be largely free from any ground-disturbance. The only disturbance is in the form of shrub and tree cutting in the pool and surrounding area associated with survey work. This pool has an ephemeral hydroperiod; water level in mid-May of 2014 was in the 6"-12" range. However, in late June of 2013, the site also contained a similar amount of water. The substrate in this pool consists of mineral soils with high organic content. Given this data, it is likely that the site retains water long enough in most years for successful reproduction of vernal pool amphibians.

In 2014, a total of twenty-nine wood frog and fifteen spotted salamander eggs were documented. Caddis flies and ostracods were also noted. Overall, this appears to be a moderately productive, natural vernal pool. Preliminary ranking has resulted in a state significant rank for this pool.

<u>Vernal Pool 607</u>

Vernal Pool 607 sits alongside an existing road. This wetland does not appear to have been created by the road, though may have been partially filled during road construction. There are no inlets or outlets to this pool and this pool has an ephemeral hydrology. Water level in mid-May of 2014 was approximately 12"-14" deep; water level in late June of 2013 was approximately 10" deep. Given this information and the overall size of this pool, it is likely that it has a sufficient hydroperiod during years of average precipitation.

In 2014, a total of ten wood frog and twelve spotted salamander egg masses were documented. Fingernail clams and caddis flies were also recorded. Overall, this natural pool appears to provide moderately good vernal pool habitat.

3.c.3 Wetlands Providing Amphibian Breeding Habitat

In addition to vernal pools, wood frogs and spotted salamanders can breed in a wide variety of wetlands including forested swamps, ponds (beaver ponds and man-made ponds), Alder Swamps, and edges of Shallow Emergent Marshes. Table 3 summarizes other wetlands that have documented breeding of these amphibians within the study area.

Table 3. Wetlands with Amphibian Habitat

WetID	Acres	Natural Community	Comments	# Wood Frog Egg Masses	# Spotted Salamander Egg Masses
103	0.23	Red Maple-Black Ash Seepage Swamp	Wet Swamp with standing water	108	6
207	0.23	Shallow Emergent Marsh	Wetland with open water	55	31
129	0.14	Alder Swamp	Partly excavated along margins	26	21
A17	0.03	Seep	Likely population sink; low area in trail	4	4
233	0.16	Shallow Emergent Marsh	Pond with permanent water	22	59
A16	0.01	Seep	Marginal habitat; likely population sink	0	2
131	0.04	Seep	Ditch with 1 egg mass; likely population sink	1	0
503	0.13	Alder Swamp	Some amphibian habitat on margins	21	10

These sites either 1) have not met all the criteria to be classified as a vernal pool or; 2) they are a different wetland natural community type which contains appropriate habitat within them. In some cases, these are stable habitats which may be very productive for breeding. In others, these are marginal habitats which may act as population sinks.

4. Summary

AE documented two vernal pools within the Haystack Mountain property and a total of thirteen vernal pools at the Airport/East Tract properties. Of the fifteen pools identified, it appears that seven are of natural origin. The remaining pools appear to have been created as a direct result of prior construction. Through the natural community ranking process, four of the natural vernal pools were given a preliminary State Significant ranking. In addition to the vernal pools, a total of eight different wetlands have documented amphibian breeding habitat.

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MEMORANDUM

November 12, 2014 From: Aaron Worthley

To: Hermitage Inn, Haystack Resort Re: Vt F&W Fish Sampling Site Visit, 10/27/2014

This memo is a summary of a site visit to the Haystack/Hermitage Club property in Wilmington and West Dover, Vt. Conducted by Lael Will of the Vt. Fish and Wildlife Department (Vt F&W), accompanied by Aaron Worthley of Arrowwood Environmental.

The visit occurred on Monday, October 27, 2014. The stated goal of the site visit was to evaluate streams within the Haystack Master Plan project area for fish presence, specifically to develop an understanding of the fish species composition and distribution with an emphasis on brook trout (*Salvelinus fontinalis*) within the streams potentially affected by the project.

Ahead of the visit, Vt F&W provided a list of target locations throughout the project area where stream crossings or stream buffer impacts are proposed in the current Master Plan under consideration by the Agency of Natural Resources. Arrowwood Environmental suggested several changes as to which of the targeted streams would be likely to flow perennially and actually hold fish.

The list was amended with nine sites identified for investigation for the presence of brook trout using Vt. Fish and Wildlife's backpack fish electro-shocking equipment. The sites were visited though the course of the day, with sampling conducted at multiple locations at each general site. The electro-shocking equipment was employed to gather a sample of the fish species present (or absent) at each site. Brook trout captures were documented for length and location; other species were noted but not counted or measured.

The following table lists each sample site location:

Stream Name	Site Name	Location	Lat	Long
Haystack Brook	Haystack 1	just upstream of existing bridge at powerline crossing	42.9166043	-72.88746477
Haystack Brook	Haystack 2	at proposed Siegel Pond withdrawl	42.9164333	-72.88643743
Oak Brook	Oak 1	Downstream of culvert under Fannie Hill Road	42.92553047	-72.88710676
Oak Brook	Oak 2	Downstream of culvert under work road, behind Chamonix townhomes	42.9239103	-72.89369843
Oak Brook	Oak 3	Downstream of culvert near maintenance area	42.9243363	-72.89571493
Oak Brook	Oak 4	upstream of culvert near maintenance area	42.9244003	-72.89610926
Oak Brook	Oak 5	upstream of culvert crossing trail west of maintenance area	42.92531147	-72.89702504
Unnamed*	ET 1	upstream of washed out culvert on East Tract road	42.9255288	-72.87636643
Unnamed*	ET 2	downstream of ATV trail crossing below washed out culvert above	42.9235713	-72.87623427

**unnamed tributary flowing north/south at the west end of the East Tract project area*

Summary findings at each site:

Site Name	**Species Observed**
Haystack 1	Brook Trout, Slimy Sculpin
Haystack 2	Brook Trout, Slimy Sculpin, Creek Chub
Oak 1	Brook Trout, Slimy Sculpin, Creek Chub
Oak 2	Brook Trout
Oak 3	No fish (perched culvert near Oak 2)
Oak 4	No fish
Oak 5	No fish
ET 1	Blacknose Dace
ET 2	Brook Trout, Creek Chub, Longnose Dace, Blacknose Dace

Of particular note was the identification of several undersized and perched culverts on Oak Brook, beginning at the Fannie Hill Road crossing. No brook trout were found above the culvert located north of the Chamonix Village townhomes under a work road between Fannie Hill Road and the Haystack base lodge. The culvert at this location is perched approximately 6-7 feet making fish passage impossible. Although the habitat conditions in Oak Brook above this location are quite good with hydraulic and bed characteristics suitable for brook trout, none were found.

Field review of select intermittent streams is scheduled to take place in the first week of November, 2014.

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MEMORANDUM

July 1, 2015 From:Aaron Worthley

To:Bob Harrington, Harrington Eng. Re: DEC Biomonitoring Site Visit

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Memo to File:

I met with Steve Fiske, DEC's aquatic biologist yesterday June 30, 2015 at Haystack, specifically to show him around on Oak Brook where he would like to establish some biomonitoring sites this fall.

We looked at the following locations:

1. Near the confluence with Cold Brook, just downstream from the culvert under Fannie Hill Road.
2. Downstream of the culvert under the road running between the Baselodge and Ski Maintenance Yard
3. The culverts near the base of the Oh No and Last Chance trails.
4. The location about 500' from the bottom of the Outcast trail where Oak Brook comes very close to the trail.
5. Just upstream of the new bridge on the Hermitage Trail under the Tage Lift.

Some chemistry samples and probe (conductivity, pH, temp, etc) measurements were collected at Site 1 and Site 4 above.
Of note, site 4 was found to be quite acidic; speculatively acid rain influenced, and may partially explain the lack of fish found when Lael sampled last fall.

In addition, Steve looked at the unnamed trib to Cold Brook that flows through the Hermitage ponds. He collected samples and probe measurements where this stream crosses the powerline near the confluence with Cold Brook, and we walked around the ponds and stretch of channel through the Hermitage yard.

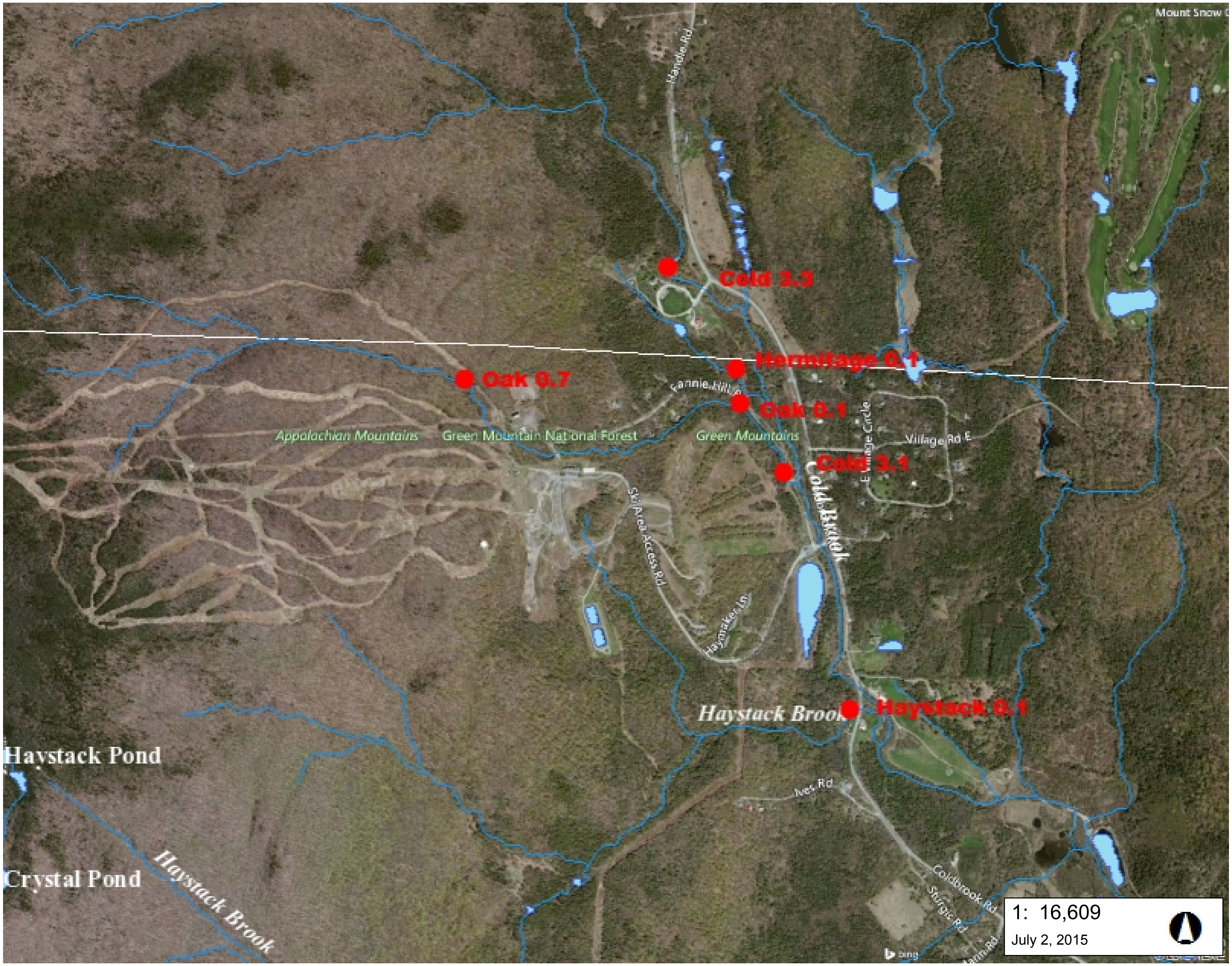
When asked, Steve noted that at first glance he thought it was probably unlikely that the Hermitage ponds were having that much impact on water temp given their small size. He noted that it would be easy to find out by placing temp loggers upstream and downstream of the ponds for a period of time. It was also suggested that a few trees planted along the banks of the ponds would have as much, if not more, positive effect than a project to take the ponds off-stream.

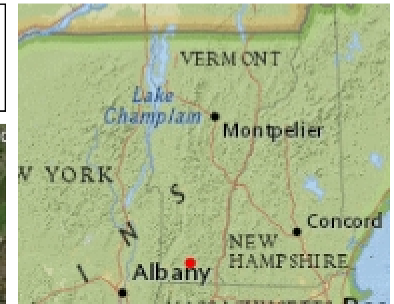
If desired, Arrowwood can initiate getting some temp loggers installed in that stream to see if there is any real temperature impact from the ponds as they are now.

Natural Resources Atlas

Vermont Agency of Natural Resources

vermont.gov





LEGEND

- Waterbody
- Stream
- Town Boundary

844.0 | 0 | 422.00 | 844.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

1" = 1384 Ft. 1cm = 166 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

NOTES

Map created using ANR's Natural Resources Atlas

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MEMORANDUM

May 8, 2015

To: Lael Will, Vt Dept. of Fish & Wildlife

From: Aaron Worthley,

Re: Haystack Stream Buffer Analysis

An Analysis of Cumulative Stream Buffer Encroachments at the Haystack Mountain/Hermitage Inn Site.

In a memorandum to Elizabeth Lord, Esq. and Jennifer Mojo, ANR Regulatory Policy Analyst dated 4/15/2015, Vt. Department of Fish and Wildlife Fisheries Biologist Lael Will provided comments on the Hermitage Club September 2015 Master Plan Amendment to LUP 700002.

In the comments, Ms. Will provided the following request: *"There are many existing riparian buffer encroachments within the project area. In order to accurately evaluate cumulative impacts related to the overall project, please provide a layer that shows existing riparian buffer encroachments, as well as the area (ft2) of the encroachment. The assessment should include buffer impacts associated with all existing ski trails, roads, walking/snowmobiling/ATV trails, existing infrastructure, stream crossings etc."* This request is consistent with comments made by Ms. Will during a site visit with Aaron Worthley on Thursday, April 23rd, 2015. At the site visit, Ms. Will and Mr. Worthley discussed an analysis that would illustrate and quantify historic stream buffer encroachments at the site, as well as stream buffer encroachments proposed under the Master Plan.

In April and May, 2015, Arrowwood Environmental (AE) undertook an analysis of historic, existing and proposed buffer conditions in order to address the comments and questions posed by Ms. Will. This document describes the analysis.

Ms. Lael has suggested an analysis that begins with buffer conditions prior to any development under Act 250 jurisdiction since the law's inception in the early 1970's through today. For both practical and analytical reasons highlighted below, a review going back this far appears unnecessary and impractical.

1. The analysis needs to rely on a consistent repeatable comparison of forest conditions within stream buffers over time. The first digital orthorectified aerial imagery with consistent coverage of the Haystack Mountain area was collected in the year 2000 by the State of Vermont. Subsequent imagery of similar quality was procured in year 2010. Additional imagery of higher resolution is available in years since 2010. Obtaining, orthorectifying and interpreting aerial imagery prior to the year 2000 would be costly and would not provide an equal point of comparison with modern imagery standards.
2. Prior to 2000, and realistically more recently than that, the Vt. Department of Fish and Wildlife did not comment and the Act 250 Commissions did not seek information relating to stream buffer conditions during review of projects. It is likely

that some buffer encroachments present in the early years have since re-vegetated. Iterative accounting of stream buffer impacts going back to the early days of Act 250 regulation would therefore be fairly unsupportive of the analysis goals. Buffer encroachments associated with past development can be reasonably captured by interpretation of the 2000 imagery.

Four temporal stages of buffer conditions can be analyzed using the following imagery acquisitions:

Table 1. Source imagery for clearing delineation

Imagery Date	Imagery Type	Source	Project Status
Spring 2000	1:5000 panchromatic .5 meter pixel	Vt Dept. of Taxes, now managed by VCGI	Early ski area development
Spring 2010	1:5000 panchromatic .5 meter pixel	VCGI	Development under prior resort ownership
Late Summer 2014	NAIP true color 1 meter pixel	National Agricultural Imagery Program, USDA	Development to date under current owner

Analysis of these three snapshots of buffer conditions provide a comparison on relatively equal basis of clearing associated with stream buffers throughout the project area associated with historic ski resort development, the prior landowner's activities and development activities to date under the current landowner and Master Plan applicant. We can further identify stream buffer encroachments proposed in the Master Plan in light of these existing impacts from past activity.

Considerations

Generally, stream buffer impacts are understood to be any impacts associated with human activities within the designated buffer of a stream. In order to identify historic, current and proposed stream buffer impacts in a comparable way using available remote sensed data (aerial imagery, interpreted visually), buffer impacts in this analysis were identified on the basis of tree clearing only, as that is most discernable from aerial imagery. Where a canopy is visible on an aerial image, it was assumed that the protective features of forested stream buffers were being met. The analysis was limited by the resolution of the imagery, and the canopy conditions present. Some small openings within larger forest cover may have been missed, however attempts were made to make up for visual impediments in the imagery with personal knowledge of the site. If known canopy openings were not visible, in the imagery, they were none the less approximated in the mapping exercise.

In some areas of the project, an existing treeline has been identified through ground surveying. However, ground surveys have been conducted over a considerable timeframe spanning the benchmark dates used for this analysis. In addition, the entire project area has not been covered by ground surveys, and some areas that have been ground surveyed did not include treelines. For these reasons, surveyed treeline was not considered a reliable defining feature in this comparative analysis. The proposed Master Plan site plans include a delineation of anticipated proposed clearing in most project areas. These boundary lines were used to define proposed clearing, augmented in a few cases when proposed treelines did not appear on the plans associated with proposed development.

While every effort has been made to be reasonably accurate with forest clearing delineation for this project, it must be understood that for consistency existing and proposed clearing numbers may not match exactly those calculated for the purposes of permit acquisition. Where specific project impacts have been calculated by the project engineers for the purposes of permitting, those should be considered the most accurate available on a per project component basis. This analysis is global in scale, intended to look broadly at overall buffer condition change project-wide.

Study Area

As of late summer 2014, AE has conducted natural resource inventories over a wide swath of the subject property. Included in this inventory has been a comprehensive mapping of wetland boundaries, stream channels and forest community types. This analysis utilizes only the area within which the AE inventory has been conducted as its study area. The reason for limiting the scope to the AE study area is that during the inventory, small intermittent and ephemeral stream channels are frequently detected and mapped that other sources fail to identify. By limiting to the study area, we can be reasonably assured that all streams are accounted for and measured in a comparable manner.

Buffer Identification

The Vt. Department of Fish and Wildlife has published guidance on stream buffer identification[1]. This guidance details the identification methods to be used in determining top of bank or top of slope (TOB/S). Under this guidance, stream buffers are measured 50 feet laterally (perpendicular to stream channel) from the TOB/S point and include all area between the stream channel and this outer boundary. AE has conducted detailed TOB/S surveys in areas where development has been proposed. These surveys have entailed identification of the stream channel, TOB/S and field measurements of the TOB/S line using professional total station surveying equipment. In only a couple of instances, sub-meter grade or better GPS technology was employed to locate the TOB/S for mapping purposes.

Because the TOB/S identification and measurement has not been conducted throughout the study area, a method was necessary to approximate stream buffer boundaries in areas where

[1] GUIDANCE FOR AGENCY ACT 250 AND SECTION 248 COMMENTS REGARDING RIPARIAN BUFFERS, Vt ANR, December 9, 2005

the measurements are not available. Buffer widths can vary widely across individual streams due to the natural variability of channel widths and drainage area. In addition, being determined on the basis of TOB/S which is primarily determined by the surrounding landscape through which a given stream flows, buffer widths can vary along the length of a given stream as well. The AE field inventory identified the flow regime of each stream encountered (perennial, intermittent, and ephemeral). In reviewing streams where TOB/S had been identified and accurately mapped, it was apparent that approximate buffer width could be correlated to stream flow regime accurately enough to give a general average of buffer widths based on stream types. For areas without TOB/S accurately mapped, the following distances from mapped channel centerline were used to approximate the total stream buffer. Where TOB/S is available, the stream buffer was measured from that point.

Table 2. Approximated buffer distance by flow regime

Stream Flow	Buffer distance from centerline
Perennial	100’
Intermittent	75’
Ephemeral	50’

These distances are assumed to, on average, encompass the actual stream buffers, and in many cases may be an over-estimation.

Process

For this analysis, clearing areas within the study area were mapped for each of the three imagery periods using visual on-screen digitization by an experienced interpreter. Boundaries of visible or known clearings were drawn by hand using geographic information software with the geographically correct image as a basemap and foundation.

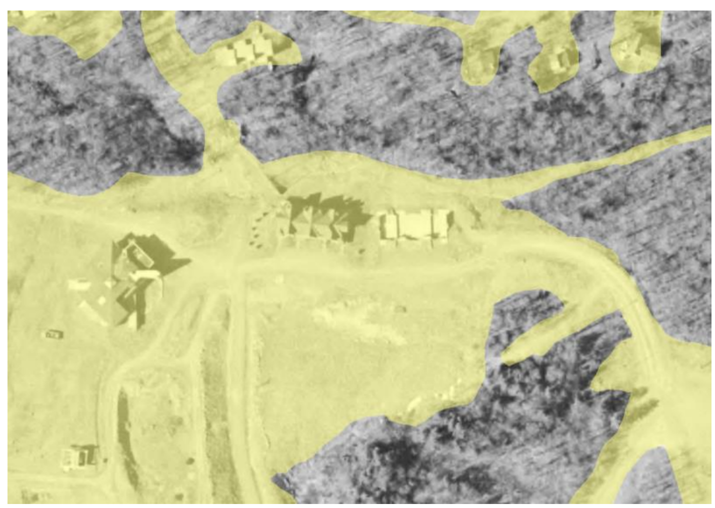

Figure 1. Mapped clearing over 2010 aerial imagery

Buffers were computer generated on the basis of stream flow regime from the mapped centerlines as determined to date by the AE field inventory. Where buffers based on known and accurately mapped TOB/S were present, the approximated buffers above were discarded in favor of the more accurate defined as 50’ from the TOB/S line. Transitions between approximated buffers and field surveyed TOB/S buffers were manually adjusted for smooth transitions.

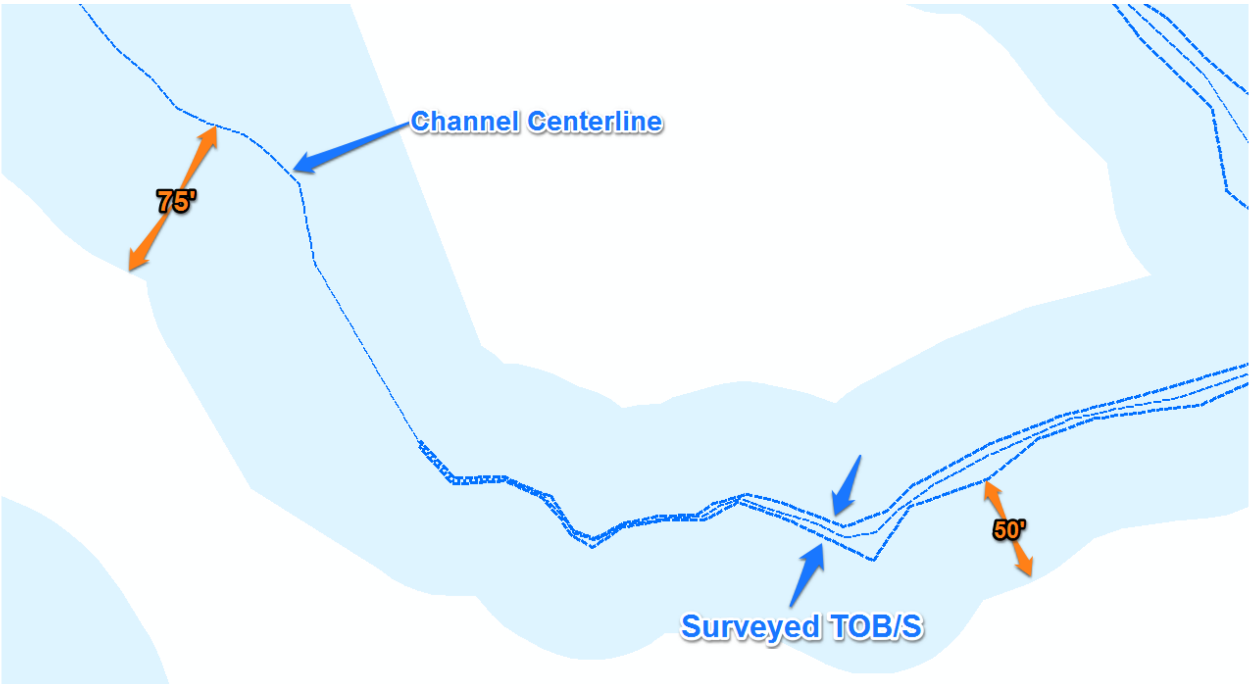

Figure 2. Buffer measurement along an intermittent stream. 50' from surveyed TOB/S, 75' from channel with no surveyed TOB/S

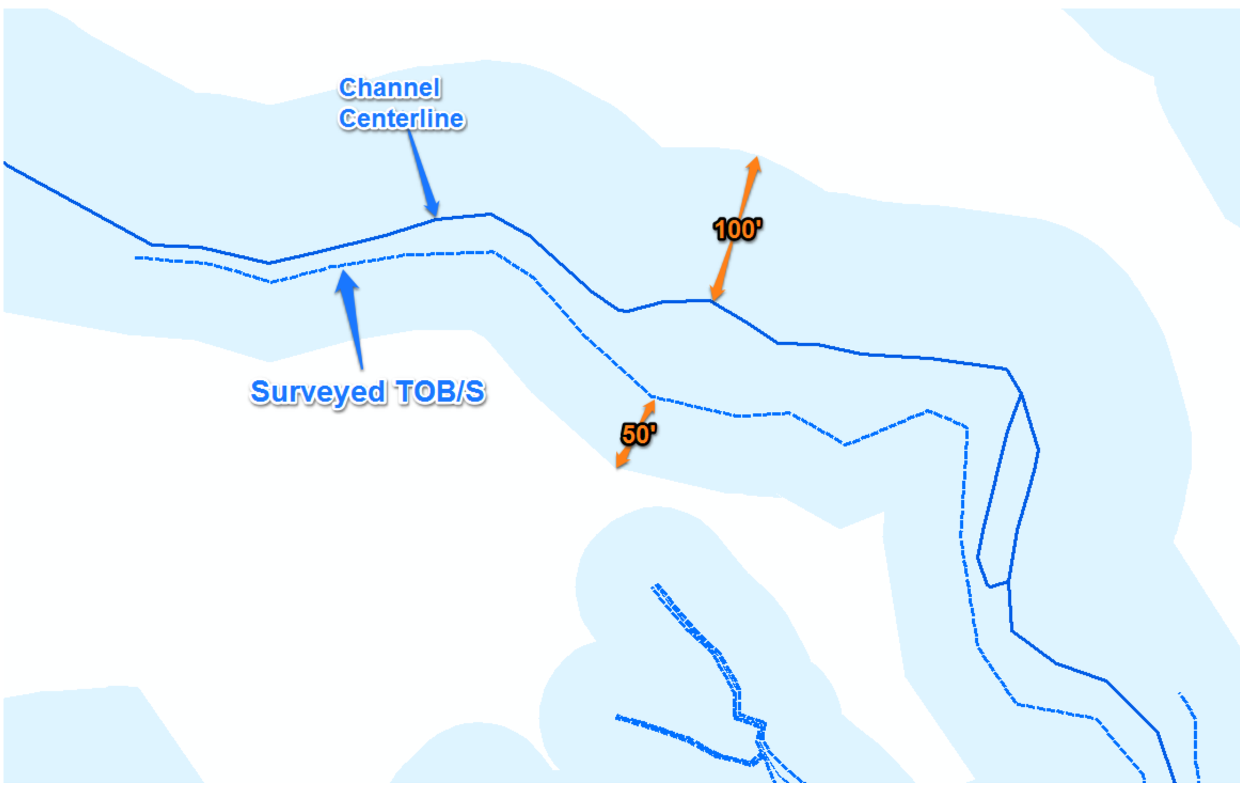

Figure 3. Buffer measurement along a perennial stream with surveyed TOB/S on one bank, but not the other.

Buffer areas were then intersected with clearing areas at each analysis interval. Areas of cleared buffer in each temporal iteration were calculated and displayed as a percentage of total available approximate buffer area.

Restoration Plantings

In the case of the proposed Master Plan scenario, some areas of stream buffer are proposed for replanting to provide forested stream buffer function after site grading and development is complete. These riparian restoration areas were calculated for the Master Plan scenario and included in the scenario as a stand-alone component. Several areas of the project property have seen unauthorized tree clearing and have been subsequently subject to restoration activities. These areas were not counted in either the cleared areas (2014 & Master Plan) or in the Master Plan restoration planting areas.

Results

Results of the analysis are presented in the graphics below. The majority of buffer clearing within the study area (~35 acres, or 55% of all buffer clearing) was done prior to the year 2000 when the Vt. Agency of Natural Resources and Dept. of Fish and Wildlife did not regulate or comment on stream buffer encroachments or even have a method for measuring stream buffers. Between years 2000 and 2010 during the tenure of the previous owner, a considerable amount of additional tree clearing was conducted property-wide, but only a small amount of stream buffer was impacted with ~2 acres or 3% of the total buffer clearing taking place in those years. The period between 2010 and 2014 saw an additional ~17 acres of buffer cleared for projects under the current ownership which amounts to 27% of the total buffer clearing. The Master Plan proposes clearing an additional ~10 acres of buffer, or 16% of the total clearing. But the Master Plan also proposes to revegetate approximately 1 acre of the original available buffer to restore buffer function in specific locations. The culmination of Master Plan activities would see a total of 62.2 acres of buffer cleared, leaving 74% of the total buffer in the study area intact and functional.

	Total Cleared Buffer Acres	Newly Cleared Buffer Acres	Intact Buffer Acres	% Buffer Remaining	% Buffer Cleared	Additional % Cleared	%Total Buffer Clearing Cumulative	% of Total Buffer Clearing Newly Cleared
Baseline Buffer (no clearing)	0	0	241	100%	0%	0%	0%	0%
as of Year 2000	35	35	207	86%	14%	14%	55%	55%
as of Year 2010	37	2	205	85%	15%	1%	59%	3%
as of Year 2014	53	17	188	78%	22%	7%	86%	27%
as of Master Plan	63	10	178	74%	26%	4%	101%	16%
as of Master Plan w/ Plantings	62.2	-0.9	178.8	74%	26%	-0.4%	100%	-1.4%

Table 3. Summary of buffer changes over time

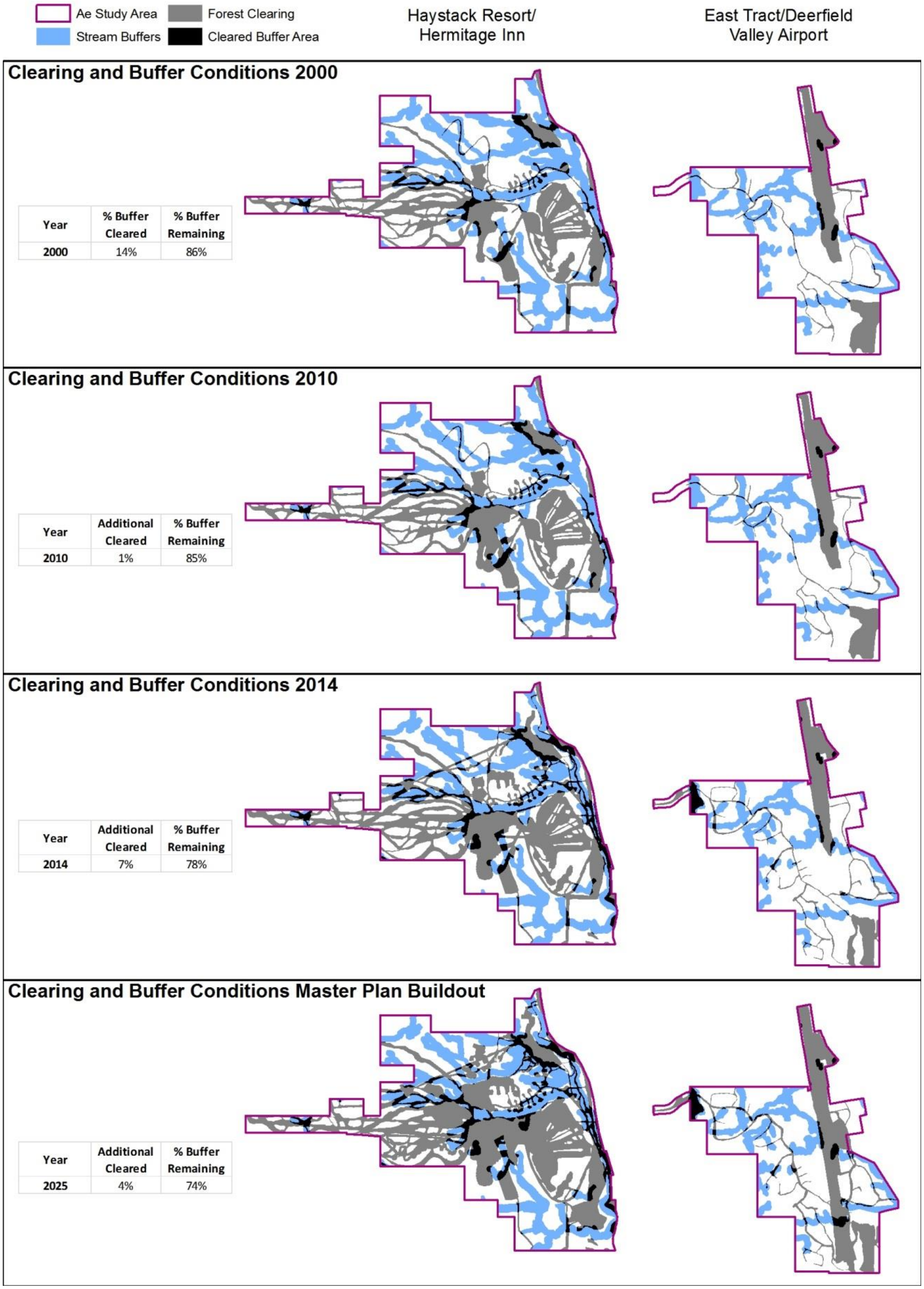

Figure 4. Buffer clearing changes over time

Rare, Threatened and Endangered Plant Species Report
The Hermitage Club at Haystack Mountain

June 9, 2015

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1. Introduction

Arrowwood Environmental (AE) was retained by Hermitage Club at Haystack Mountain to conduct a rare, threatened and endangered plant inventory as part of the environmental review of their Master Plan development. This inventory was conducted on lands around the Haystack Mountain ski resort and on the "East Tract" development west of the Deerfield Valley Airport. The following report outlines the methodology and results of this inventory. The final section discusses the proposed mitigation measures developed to minimize impacts on rare species.

2. Methodology

A methodology for conducting the rare plant survey was outlined in the document Proposed RTE Survey Protocol (Arrowwood Environmental, 2014) and is included in Appendix 1. A map of the transects conducted during this inventory is included in Appendix 2. This methodology was approved by Mr. Bob Popp, the Vermont Agency of Natural Resources state botanist. Email correspondence of this approval is included in Appendix 3.

Field work was conducted using this methodology by Michael Lew-Smith and Matthew Peters on the following dates in 2014: June 12-13, June 24-25, and September 16-18. In addition, a few rare species were discovered during the broader environmental assessment on October 2-3, 2013.

3. Results

The RTE inventory discovered 14 different plant species that are considered uncommon or rare in Vermont and one species that had not been documented previously in the state. The list of each of these occurrences is shown in Table 1 and the location of these populations is shown on the attached map (Appendix 4). The "id" column in the table corresponds to the populations identification number shown on this map. The S-rank column indicates the current rarity rank for each species. There were no species that are considered Threatened or Endangered in Vermont or federally.

Table 1. Summary of Plant Species Documented

ID	Species Name	S-Rank	Population Size	Habitat
1	*Hieracium umbellatum*	SU	4 plants	Open Ski Trail
2	*Polygala ambigua*	S1	1 plant	Disturbed Road Edge/Maintenance Area
3	*Platanthera orbiculata*	S2	1 plant	Forest
4	*Nabalus racemosus*	NR	17	Open Ski Trail
5	*Vaccinium caespitosum*	S2	2 patches 85% cover	Open Ski Trail
6	*Muhlenbergia uniflora*	S2S3	3	Open Ski Trail
7	*Polygala sanguinea*	S3	1 stem	Open Ski Trail
8	*Polygala sanguinea*	S3	1	Open Ski Trail
9	*Polygala sanguinea*	S3	appx 3000 stems	Open Ski Trail
10	*Juncus marginatus*	S3	200 ramets	Open Ski Trail
11	*Juncus marginatus*	S3	8 genets, 10 ramets	Open Ski Trail
12	*Juncus marginatus*	S3	75 genets,120 ramets	Open Ski Trail
13	*Paronychia fastigiata*	SU	59 stems	Disturbed Road Edge/Maintenance Area
14	*Platanthera orbiculata*	S2	1 stem	Forest
15	*Hypericum gentianoides*	S2	appx 300	Disturbed Road Edge/Maintenance Area
16	*Hypericum gentianoides*	S2	4 stems	Disturbed Road Edge/Maintenance Area
17	*Paronychia fastigiata*	SU	1 stem	Disturbed Road Edge/Maintenance Area
18	*Phegopterus hexagonoptera*	S2S3	150 fronds	Forest
19	*Eragrostis frankii*	S3	appx 100 stems	Disturbed Road Edge/Maintenance Area
20	*Paronychia fastigiata*	SU	1 stem	Disturbed Road Edge/Maintenance Area
21	*Polygala sanguinea*	S3	260 stems	Open Ski Trail
22	*Paronychia fastigiata*	SU	5 stems	Disturbed Road Edge/Maintenance Area
23	*Muhlenbergia uniflora*	S2S3	50	Open Ski Trail
24	*Juncus marginatus*	S3	52 genets	Open Ski Trail
25	*Polygala ambigua*	S1	7 stems	Disturbed Road Edge/Maintenance Area
26	*Polygala ambigua*	S1	appx 300	Disturbed Road Edge/Maintenance Area
27	*Hypericum gentianoides*	S2	3 stems	Disturbed Road Edge/Maintenance Area
28	*Polygala sanguinea*	S3	3 stems	Open Ski Trail
29	*Sisyrinchium angustifolium*	S2S3	60 stems	Open Ski Trail
30	*Paronychia fastigiata*	SU	16 stems	Disturbed Road Edge/Maintenance Area
31	*Muhlenbergia uniflora*	S2S3	thousands of stems	Open Ski Trail
32	*Muhlenbergia uniflora*	S2S3	appx 150	Open Ski Trail
33	*Muhlenbergia uniflora*	S2S3	appx 500	Open Ski Trail

34	*Muhlenbergia uniflora*	S2S3	50 stems	Open Ski Trail
35	*Muhlenbergia uniflora*	S2S3	50 stems	Open Ski Trail
36	*Muhlenbergia uniflora*	S2S3	1000s	Open Ski Trail
37	*Muhlenbergia uniflora*	S2S3	200	Open Ski Trail
38	*Muhlenbergia uniflora*	S2S3	1000s	Open Ski Trail
39	*Muhlenbergia uniflora*	S2S3	3 stems	Open Ski Trail
40	*Muhlenbergia uniflora*	S2S3	100s	Open Ski Trail
41	*Muhlenbergia uniflora*	S2S3	75	Open Ski Trail
42	*Muhlenbergia uniflora*	S2S3	10,000s	Open Ski Trail
43	*Muhlenbergia uniflora*	S2S3	appx 3000	Open Ski Trail
44	*Muhlenbergia uniflora*	S2S3	200	Open Ski Trail
45	*Muhlenbergia uniflora*	S2S3	1200	Open Ski Trail
46	*Polygala sanguinea*	S3	?	Open Ski Trail
47	*Juncus marginatus*	S3	2 stems	Open Ski Trail
48	*Polygala ambigua*	S1	26 stems	Disturbed Road Edge/Maintenance Area
49	*Paronychia fastigiata*	SU	appx 1000 stems	Disturbed Road Edge/Maintenance Area
50	*Platanthera macrophylla*	S1	1 plant	Forest
51	*Polygala sanguinea*	S3	15 stems	Open Ski Trail
52	*Juncus marginatus*	S3	1	Open Ski Trail

The Agency of Natural Resources typically requests mitigation for impacts greater than 20% of a population of a rare plant (ranks S1, S2 or S2S3). At this site, ANR was concerned mainly about the larger populations of the rarer species and provided a list of these species (Bob Popp, personal communication 2014; Appendix 3). This list is shown in Table 3.

Table 3. ANR's List of Hi-Priority Species with Proposed Impacts

ID	Species	Proposed Impacts
1	*Hieracium umbellatum*	None
4	*Nabalus racemosus*	None
5	*Vaccinium caespitosum*	None
6	*Platanthera orbiculata*	None
13	*Paronychia fastigiata*	None
15	*Polygala ambigua*	>20% Impacts from Hotel Development
18	*Polygala ambigua*	>20% Impacts from Hotel Development
19	*Paronychia fastigiata*	>20% Impacts from Hotel Development
20	*Hypericum gentianoides*	>20% Impacts from Hotel Development
22	*Paronychia fastigiata*	None
23	*Platanthera macrophylla*	None
29	*Sisyrinchium angustifolium*	None
50	*Phegopteris hexagonoptera*	None
52	*Platanthera orbiculata*	None

As can be seen in Table 3, impacts to most populations have been avoided. In the case of the *Phegopteris hexagonoptera* and *Platanthera orbiculata* the populations are found in forest habitats where there is no proposed development. It is likely that this habitat and these populations will therefore persist. In the case of *Hieracium umbellatum*, *Nabalus racemosus*, *Vaccinium caespitosum* and *Sisyrinchium angustifolium* these species are found primarily on the open ski trails. The continued management of these ski trails by Hermitage Club will likely maintain these habitats and these populations will likely persist.

In the case of *Polygala ambigua*, *Paronychia fastigiata* and *Hypericum gentianoides*, some of these populations are currently located in the gravel maintenance and equipment area. This area is characterized by densely packed gravel and is used as an equipment storage yard (Figure 1).

The four species found in this area prefer disturbed habitat and are located in the less-heavily travelled areas throughout the yard.

Figure 1. Equipment yard.

A brief synopsis of the biology of each of these three species is given below.

Polygala ambigua (alternate milkwort)

Polygala ambigua is a small annual with pink-white flowers and linear leaves (Figure 2). It is also known as *Polygala verticillata* variety *ambigua* and can be difficult to distinguish from *P. verticillata* variety *verticillata*. Both of these species, however, have the same rarity rank- S1S2. This species ranges throughout eastern North America but in New England it is uncommon to rare (Haines, 2011). It is found in meadows, fields, the edges of forests and many anthropogenic habitats. In our area, it flowers in late summer; the fruit is a small dry capsule which splits open when ripe. In Vermont, both varieties of this species are known from the towns of Burlington, Poultney, Brattleboro and Vernon (Gilman, in press).

Figure 2. *Polygala ambigua*

***Paronychia fastigiata* (hairy forked chickweed)**

Paronychia fastigiata is a small annual with greenish flowers and a forked stem. It is found throughout eastern North America and New England. It is generally known from disturbed habitats such as sandplains, barrens and disturbed areas. However, the only other occurrence known from Vermont was found in rich woods in Middlebury. This species is ranked as SU in Vermont, which indicates that its status is uncertain. There is some evidence that the species may be adventive (not native but spreading) from areas further south, but evidence is slight (Gilman, in press; Haines 2011).

Figure 3. *Paronychia fastigiata*

***Hypericum gentianoides* (orange grass)**

Hypericum gentianoides is a small annual with scale-like leaves, yellow flowers and a forked stem. These features make it quite distinctive from the 9 other members of this genus found in the state. This species is found throughout North America and New England in dry sandy and disturbed places. In Vermont, it is known only from southern Vermont in the towns of Townshend, Dummerston, Brattleboro and Vernon (Gilman, in press).

Figure 4. *Hypericum gentianoides*

4. Mitigation

AE has worked closely with ANR to develop a plan to mitigate impacts to the three species described above. As outlined above, all of these species are annuals which thrive in moderately disturbed sand/gravel habitats. Because they are annuals, transplanting individuals is not recommended. However, since they prefer disturbed habitats, there are other areas on the property which would provide suitable habitat for these species.

The mitigation plan consists of four steps which are outlined below.

1. **Harvest seed**. Harvesting the seed of these species would occur manually in the late summer of 2015, prior to construction. Seed from mature fruiting individuals will be harvested and stored temporarily in a cool, dry facility until Phase 3 can be implemented.

2. **Gather the seed bank.** The gravel substrate in which these populations exist presumably contains a seedbank which contains viable seed from each of these species. In select areas, the top 2”-3” layer of this gravel will be removed with a tractor or bucket-loader prior to construction. This seedbank will be temporarily stockpiled until Phase 3 can be implemented.

3. **Reseed in suitable habitat**. Suitable habitat for these species which is not going to be impacted by development will be identified. These areas will receive treatments of the seedbank and/or seed collected in Phases 1 and 2. Since a moderate amount of disturbance is necessary for the survival of these populations, these areas will not be flagged or protected from disturbance.

4. **Monitor newly seeded areas**. Plots will be established in the newly seeded areas. Success of the seedbank and seeded areas will be monitored once/year for a period of three years.

Appendix 1

Rare Plant Survey Protocol Report

ARROWWOOD ENVIRONMENTAL
950 BERT WHITE ROAD
HUNTINGTON, VT 05462
(802 434-7276 FAX: (802) 329-2259

Proposed RTE Survey Protocol
Hermitage Real Estate Holding Co.
Dover, Vermont
June 17, 2014

Arrowwood Environmental was retained by Hermitage Inn Real Estate Holding Co. to conduct a rare, threatened and endangered (RTE) plant species inventory as part of their Master Plan Development. These RTE inventories will occur during the 2014 field season as part of a wider environmental assessment. There are two main project areas: the Haystack ski area development and the East Tract development, east of the ski resort. Both of these areas are shown on the attached map.

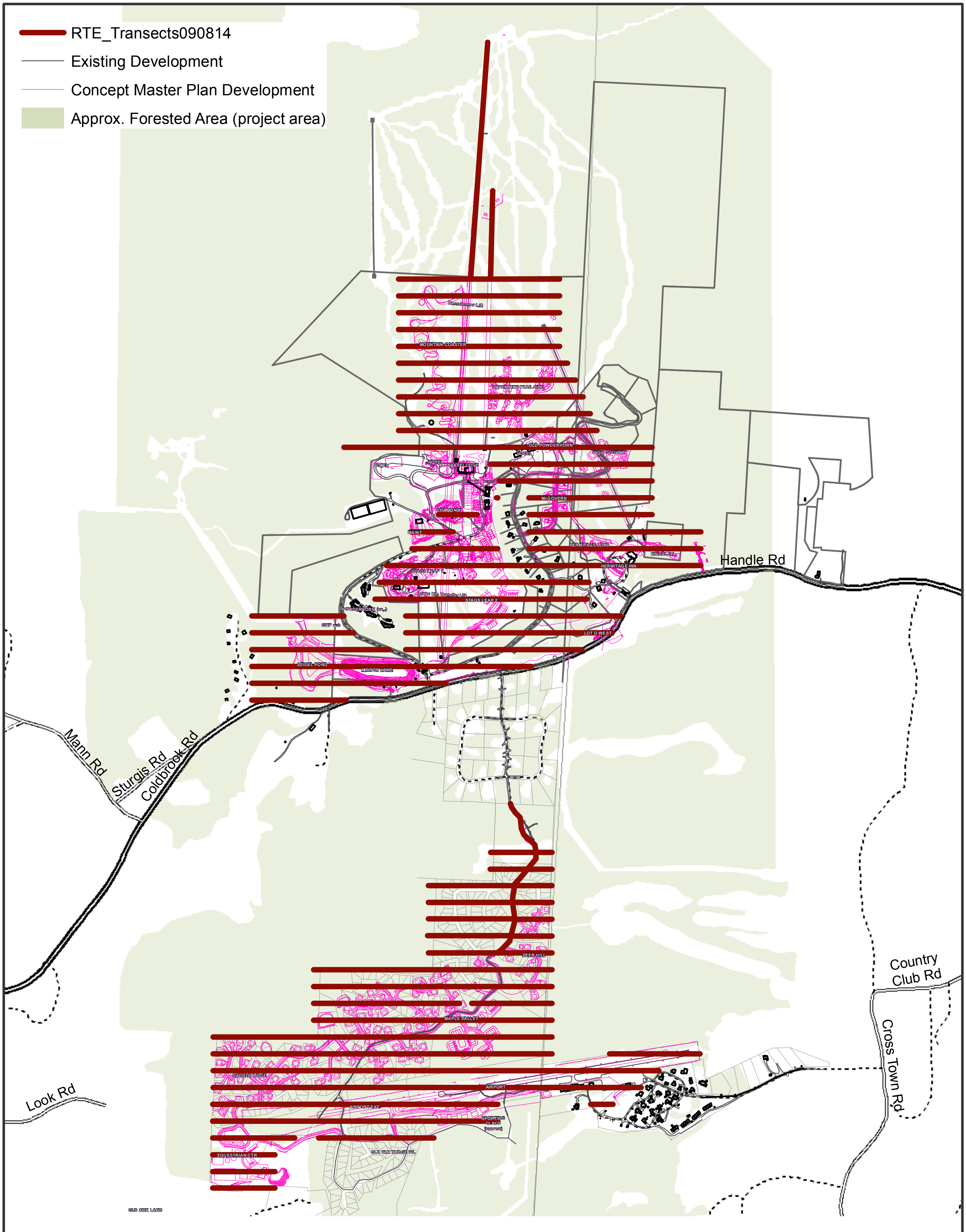
The only currently known ranked plant species from the area is an occurrence of *Platanthera macrophylla* on the north end of the Haystack ski area development. During the ongoing environmental assessment, two locations of this species were documented in the project area. Information on these occurrences, along with other occurrences documented during the survey will be reported to Non-game and Natural Heritage Project (NNHP). Populations will be mapped using GPS. NNHP Rare Plant Forms will be used to document the size and nature of the populations.

In order to inventory representative features and habitats within this project area, transects are placed approximately 200 feet apart. Each of these transects will be walked when conducting the RTE inventory. Instead of strict adherence to the transect line, a meander distance of approximately 75 feet will be permitted on each side of the line. This will enable the surveyor to target specific micro-habitats that may be unique but may not lie directly on the transect line. This "modified meander-transect" methodology allows for flexibility in targeting potential habitat while providing assurance that the entire project area receives representative coverage.

The attached map shows the approximate study area and transect locations. If development plans change, the final transect locations may be updated. Rare plant inventories will be conducted by Michael Lew-Smith and Matt Peters during the 2014 growing season between June 15th and September 15th.

Appendix 2

Rare Plant Transect Map



Hermitage Resort/Haystack Proposed RTE Study Transects

Monday, September 08, 2014 | 1 in = 1,638 ft

File: RTEtransects *Prepared By: A Worthley* *NAD 83, Vt State Plane*

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Appendix 3

Email correspondence with Mr. Bob Popp, Vermont State Botanist

From: Michael Lew-Smith [mailto:michael@arrowwoodvt.com]
Sent: Tuesday, June 17, 2014 10:54 AM
To: Popp, Bob
Cc: 'Dori Barton'
Subject: Haystack

Hi Bob,

I have attached a brief proposed methodology for the RTE work down at Haystack Mountain this summer. Matt Peters and I are hoping to get to work on it next week. Let me know if this looks ok.

Thanks.

-Michael

From: Popp, Bob [mailto:Bob.Popp@state.vt.us]
Sent: Friday, June 20, 2014 3:53 PM
To: 'Michael Lew-Smith'
Cc: 'Dori Barton'
Subject: RE: Haystack

Thanks Michael, this all looks fine, perhaps even a bit more than needed. We might mandate something this systematic for a novice, but you and Matt have an excellent sense of where you are likely to find R,T,E plants. So you should certainly focus on the more optimum areas such as seepy opening along the ski trails, etc. That said we all know that plants sometimes surprise us, but I'd still focus on the higher potential areas.

Good luck,
Bob

Bob Popp
Department Botanist
VT. Dept of Fish and Wildlife
Natural Heritage Inventory
(802) 476-0127

From: Michael Lew-Smith [mailto:michael@arrowwoodvt.com]
Sent: Thursday, April 02, 2015 11:11 AM
To: Popp, Bob; dori@arrowwoodvt.com
Subject: RE: Haystack RTE

Hi Bob,

I wanted to check in with you again about the Haystack Master Plan project and potential impacts to rare plants there. The list that you sent me previously about which populations you are concern about is included below. Most of these populations can be avoided. There are three, however, that will be significantly impacted: *Polygala verticillata var. ambigua, Hypericum gentianoides* and *Paronychia fastigiata.* These all occur in the same area, the current maintenance shed and mountain operations area. This area is currently a gravel parking area and equipment storage yard. This area is the proposed site for a hotel and condominium. I have attached a map showing the area as well as a picture of the site. The blue outline on the map is the proposed development, the plants are found in the clearing on the orthophotograph. The proposed parking area is not shown on this map, but would likely cover the remaining open area. Under these development plans, it is likely that most of the habitat for these species would be eliminated in this locale.

We are currently in the Master Plan permitting phase, so having a general understanding of a mitigation plan would be helpful for the permitting process. I have discussed with Haystack the possibility of flagging off some areas that may not be developed in the current maintenance area. It is my understanding that appropriate habitat in this area would not exist after development. The gravel parking areas and roads would be developed, converted to pavement, or landscaped. In terms of mitigation, these are my thoughts so far: All of these species are annuals and thrive in disturbed habitats. Since they are annuals, I don't think transplanting is the way to go. While the existing habitat would be destroyed, this type of habitat would exist elsewhere on the mountain. There are numerous gravel work roads all over the mountain, some of which have smaller populations of these species already growing along their margins. There is also going to be a new maintenance area nearby which would likely contain appropriate habitat. Prior to development, I would recommend removing some of the top layer of gravel from the existing maintenance area and "transplanting" the seed bank to appropriate habitat. Then monitoring the area for a few years to determine if it was successful.

Once the development is slated to occur, we could work out the specifics, but I wanted to get your input on the general approach at this stage.

Thanks.

-Michael

Michael Lew-Smith
Ecologist/Botanist
Arrowwood Environmental
1315 Hopkins Hill Road
Hardwick, VT 05843
802-434-7276 ext. 2
www.arrowwoodvt.com

From: Popp, Bob [mailto:Bob.Popp@state.vt.us]
Sent: Friday, April 10, 2015 1:13 PM
To: 'Michael Lew-Smith'; dori@arrowwoodvt.com
Subject: RE: Haystack RTE

Hi Michael, thank you for this detailed accounting of the project's impact to the three rare plants. I agree with your approach entirely with one caveat. In addition to attempting to capture the seedbank by removing the top layer of gravel, I would advocate that an attempt be made to actually harvest seeds from mature plants in situ. Then we can figure out appropriate places to sow them as well as to spread the gravel. The edges of gravel roads sound appropriate if they are not likely to be run over by vehicles & equipment. As you know they are all ruderal species and come and go as conditions allow.

Bob

Bob Popp
Department Botanist
VT. Dept of Fish and Wildlife
Natural Heritage Inventory
(802) 476-0127

From: Michael Lew-Smith [mailto:michael@arrowwoodvt.com]
Sent: Wednesday, December 03, 2014 11:18 AM
To: Popp, Bob; dori@arrowwoodvt.com; Robert Harrington
Subject: Haystack RTE

Hi Bob,

I wanted to touch base with you about the rare plant inventory that Matt and I conducted down at Haystack Mountain in Dover. I have attached a large-scale map showing the populations of the plants that we discovered during that inventory. Since we don't really have a report to go along with the map, I thought I would offer a few notes below:

- The mountain is currently developing a Master Plan and is working with Act 250 to get various aspects of the project approved.
- There were no species listed as Threatened or Endangered.
- Almost all of the populations occur on the mountain side of the proposed development, not in the East Tract Area.
- There were a number of species found in the open ski trails on the mountain. These include Rose Milkwort Marginate Rush (*Juncus marginatus*), and One-flowered Muhlenbergia (*Muhlenbergia uniflora*). The Muhly was particularly abundant, with many populations in the thousands and some estimated in the tens of thousands.
- There were a couple of woodland species: Broad Beech Fern (*Phegopteris hexagonoptera*) and Large Round-leaved Orchid (*Platanthera orbiculata*). The orchid is an old EO from the area.
- Matt found a new species to the state! *Nabalus racemosus*. This small population of 17 plants (most in flower) is growing in an open ski trail. Matt knows it from the prairie. In New England, Haines reports it only from Maine in high-pH rocky river ledges and

shores. Seems a bit like a waif here, given where it is growing and its native habitat in this region. But who knows? I have attached a couple of pictures.

- The other interesting one in the ski trail was *Hieracium umbellatum*. A small population, only 4 plants. Ranked SU. I don't know much about the status of this one.
- The other suite of species was a bunch of annuals found in the disturbed gravelly equipment yard and parking area. This included *Paronychia fastigata*, Pineweed (*Hypericum gentianoides*), *Polygala ambigua*, and Frank's Lovegrass (*Eragrostis frankii*). It is a fairly large area (see map) and populations are generally good-sized and scattered throughout the area in less travelled zones. Two pictures of this area are also attached.

If you look at the map, our RTE survey transects are in green, polygons of plant populations are in orange and the proposed development is in purple. Existing development/clearings are the white background. Plant species, ranks and population numbers are given in the table.

There are no proposed changes to the ski trails, for the most part. I think that existing management has provided habitat for these species and that will likely continue. The current equipment area is the site of a proposed hotel. The detailed plans for the hotel have not been worked out yet, but I believe it will encompass most of the equipment area and parking lot where the plant populations are shown. It is likely that, post construction, there will be gravel road edges and parking areas in the vicinity, but not likely as large as what currently exists.

Once you have had a chance to look through this, let me know what you think. Perhaps we can discuss.

Thanks.

-Michael

Michael Lew-Smith
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Arrowwood Environmental
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Hardwick, VT 05843
802-434-7276 ext. 2
www.arrowwoodvt.com

From: Popp, Bob [mailto:Bob.Popp@state.vt.us]
Sent: Friday, December 12, 2014 10:03 AM
To: 'Michael Lew-Smith'; dori@arrowwoodvt.com; Robert Harrington
Subject: RE: Haystack RTE

Michael, thank you for providing this. I am hoping that at least some of the rare plant populations can be considered during the master plan development. I am most concerned about the larger populations of the rarer species as listed below. It would be helpful to know what populations are likely to be impacted although perhaps you don't know that for certain at this point. The Agency generally requests mitigation for impacts to greater than 20% of a rare plant (i.e. S1, S2, S2S3) population. For purposes of this project every occurrence for a species would be considered as the same population.

Hi Priority Plant Populations:

1 Narrow-Leaved Hawkweed (*Hieracium umbellatum*)
4 Glaucous rattlesnake-root (*Nabalus racemosus*)
5 Dwarf Blueberry (*Vaccinium caespitosum*)
6 Round-Leaved Bog-Orchid (*Platanthera orbiculata*)
13 Hairy Forked Whitlow-Wort (*Paronychia fastigiata*)
15 Whorled Milkwort (*Polygala verticillata var. ambigua)*
18 Whorled Milkwort (*Polygala verticillata var. ambigua)*
19 Hairy Forked Whitlow-Wort (*Paronychia fastigiata*)
20 Orange-Grass St. John'S-Wort (*Hypericum gentianoides*)
22 Hairy Forked Whitlow-Wort (*Paronychia fastigiata*)
23 Large-Leaved Bog-Orchid (*Platanthera macrophylla*)
29 Narrow-Leaved Blue-Eyed-Grass (*Sisyrinchium angustifolium*)
50 Broad Beech Fern (*Phegopteris hexagonoptera*)
52 Round-Leaved Bog-Orchid (*Platanthera orbiculata*)

Thanks,
Bob

Bob Popp
Department Botanist
VT. Dept of Fish and Wildlife
Natural Heritage Inventory
(802) 476-0127

Appendix 4

Map of Rare Plant Locations

RTE Species List

ID	Species Name	S-Rank	Population Size	Habitat
1	Hieracium unbellatum	SU	4 plants	Open ski trail
2	Polygala ambigua	S1	1 plant	Edge of gravel access road
3	Juncus marginatus	S3	1	Margin of gravel access drive
4	Nabalus racemosus	NR	17	Open ski trail
5	Vaccinium caespitosum	S2	2 patches 85% cover	Open ski trail
6	Platanthera orbiculata	S2	1 stem	Northern Hardwood Forest
7	Polygala sanguinea	S3	1 stem	Open ski trail
8	Polygala sanguinea	S3	1	Open ski trail
9	Polygala sanguinea	S3	appx 3000 stems	Open ski trail
10	Juncus marginatus	S3	200 ramets	Open ski trail
11	Juncus marginatus	S3	8 genets, 10 ramets	Seep and ditch along road
12	Juncus marginatus	S3	75 genets, 120 ramets	Seep and ditch along gravel road
13	Paronychia fastigiata	SU	59 stems	Disturbed gravel edge
14	Hypericum gentianoides	S2	3 stems	Gravel roadside
15	Polygala ambigua	S1	26 stems	Edge of gravel road and work area
16	Paronychia fastigiata	SU	1 stem	Gravel patch next to building
17	Paronychia fastigiata	SU	1 stem	Edge of gravel road
18	Polygala ambigua	S1	appx 300	Gravel road, parking and equipment area
19	Paronychia fastigiata	SU	appx 1000 stems	Gravel parking lot and equipment area
20	Hypericum gentianoides	S2	appx 300	Gravel parking lot and equipment area
21	Polgala sanguinea	S3	260 stems	Open ski trail
22	Paronychia fastigiata	SU	16 stems	Gravel road edge
23	Platanthera macrophylla	S1	1 plant	Northern Hardwood Forest
24	Juncus marginatus	S3	52 genets	Wet ski trail
25	Polygala ambigua	S1	7 stems	Edge of gravel road
26	Hypericum gentianoides	S2	4 stems	Gravel road edge, newly disturbed
27	Paronychia fastigiata	SU	5 stems	Gravel road edge, newly disturbed
28	Polygala sanguinea	S3	3 stems	Open ski trail
29	Sisyrinchium angustifolium	S2S3	60 stems	Open ski trail
30	Eragrostis frankii	S3	appx 100 stems	Gravel parking lot and equipment area
31	Muhlenbergia uniflora	S2S3	thousands of stems	Open ski trail
32	Muhlenbergia uniflora	S2S3	appx 150	Open ski trail
33	Muhlenbergia uniflora	S2S3	appx 500	Open ski trail
34	Muhlenbergia uniflora	S2S3	50 stems	Open ski trail
35	Muhlenbergia uniflora	S2S3	50 stems	Open ski trail
36	Muhlenbergia uniflora	S2S3	1000s	Open ski trail
37	Muhlenbergia uniflora	S2S3	200	Open ski trail
38	Muhlenbergia uniflora	S2S3	1000s	Open ski trail
39	Muhlenbergia uniflora	S2S3	3 stems	Open ski trail
40	Muhlenbergia uniflora	S2S3	100s	Open ski trail
41	Muhlenbergia uniflora	S2S3	75	Open ski trail
42	Muhlenbergia uniflora	S2S3	10,000s	Open ski trail
43	Muhlenbergia uniflora	S2S3	appx 3000	Open ski trail
44	Muhlenbergia uniflora	S2S3	200	Open ski trail
45	Muhlenbergia uniflora	S2S3	1200	Open ski trail
46	Polygala sanguinea	S3	?	Open ski trail
47	Juncus marginatus	S3	2 stems	Open ski trail
48	Muhlenbergia uniflora	S2S3	3	Edge of gravel road
49	Muhlenbergia uniflora	S2S3	50	Edge of gravel road
50	Phegopterus hexagonoptera	S2S3	150 fronds	Hemlock-Northern Hardwood Forest
51	Polygala sanguinea	S3	15 stems	Open ski trail
52	Platanthera orbiculata	S2	1 plant	Northern Hardwood Forest

Notes & Disclaimers:
Wetlands by Arrowwood Environmental, 2012-2014. Wetland mapping has ONLY been conducted within the defined study area. Although some wetlands that extend beyond this border were mapped, their inclusion does NOT suggest comprehensive assessment of those areas outside the designated study area. Wetland classification is ongoing- this is not a final classification map. Wetland mapping accuracy varies and is indicated on this map by color- see legend. Submeter accuracy refers to boundary survey by sub-meter grade GPS equipment. Map grade refers to collection with professional GPS without specific accuracy claims. Other wetland boundaries were derived from orthophoto review and professional judgement. Vernal pool function has been confirmed by Arrowwood Environmental ecologists.

Stream mapping accuracy varies by location. Within proposed development areas, stream top of bank/top of slope has been identified per the ANR guidelines and surveyed by Arrowwood Environmental. Other streams within the Study Area were mapped through a combination of mapping-grade gps equipment during field investigation and remote review of site topography and aerial imagery. Streams outside the Study Area were provided by outside sources, or assumed for connectivity. Stream perenniality is preliminary based on observed channel and flow conditions at the time of assessment.

Forest cover depicted here is approximate and derived from various sources including remote aerial photography and is provided for general cartographic visualization only.

Site data by Arrowwood Environmental, Harrington Engineering, Joyce Land Surveying and the Hermitage Club.

The Hermitage Club at Haystack Mountain Rare, Threatened and Endangered Species Locations

PROGRESS PRINT: Subject to Change

Friday, January 09, 2015 | File: AE002_RTE | Prepared By: A Worthley, Arrowwood Environmental | Coordinate System: NAD 83, Vt State Plane | 1 inch = 250 feet

Sheet: **AE-002**

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HARRINGTON ENGINEERING, INC.
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P.O. Box 248, North Pomfret, VT 05053
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Stormwater Treatment & Detention - Mountain & Hermitage Inn

Area	Design Concept
Chamonix Village	Stormwater collection to Mirror Lake
Stag’s Leap	Stormwater collection to Mirror Lake
Lower Mountain Townhouses	Stormwater collection to Mirror Lake
North Base Lodge, Roads, Parking	Stormwater collection to Mirror Lake
South Base Lodge, Road, Parking, Hotels	Underground storm chambers and pipes and/or utilize existing ponds
Maintenance Area (New)	Underground storm chambers and pipes
Maintenance Area (Existing), Northern Hotel, Parking	Underground storm chambers and pipes
Upper Mountain, Trailside	Disconnects, filter depressions, dry swales and underground storm pipes
Hermitage Inn Four Homes	Disconnects, underground storm chambers, dry swales
Hermitage Inn Area	Underground storm chambers
Mountain Coaster	Disconnects

Robert S. Harrington

From:	Jonathan Harrington <jon.harrington@myfairpoint.net>
Sent:	Friday, August 14, 2015 1:55 PM
To:	'Robert S. Harrington'
Subject:	FW: RE: Haystack - stormwater meeting follow up
Follow Up Flag:	Follow up
Flag Status:	Flagged

From: McIntyre, Megan [mailto:Megan.McIntyre@state.vt.us]
Sent: Friday, July 17, 2015 2:06 PM
To: jon.harrington@myfairpoint.net
Subject: RE: RE: Haystack - stormwater meeting follow up

Thank you Jon – I'll discuss this during our division meeting regarding the 401, and will let you know if any additional information will be needed. - Megan

---

From: jon.harrington@myfairpoint.net [mailto:jon.harrington@myfairpoint.net]
Sent: Friday, July 17, 2015 1:58 PM
To: McIntyre, Megan
Cc: heinet@aol.com
Subject: Fwd: RE: Haystack - stormwater meeting follow up

Megan, I received the email below from Chris Gianfagna who is the Stormwater Analyst with the Vermont Stormwater Section. This was a follow up to a meeting that I had with Chris regarding our planned stormwater measures for compliance at the East Tract Development. Is this email going to be sufficient to include with the 401 permit application? Thank you. Jon H.

Jonathan C. Harrington, P.E.
Harrington Engineering, Inc.
P.O. Box 248
North Pomfret VT 05053

phone: 802.457.3151

Date: Wed, 10 Jun 2015 17:50:35 +0000
From: "Gianfagna, Chris" <Chris.Gianfagna@state.vt.us>
Reply-To: "Gianfagna, Chris" <Chris.Gianfagna@state.vt.us>
Subject: RE: Haystack - stormwater meeting follow up
To: "jon.harrington@myfairpoint.net" <jon.harrington@myfairpoint.net>

Hi Jon,

I spoke with Neil this morning. His primary concern was that enough thought was given on a large scale to the types of treatment and the space needed for it. I think we covered that in our meeting, as well as making sure you were aware of the upcoming manual revisions and the implications for projects currently in the design phase.

He also wanted to ensure that there was no confusion between the ability to discharge treated stormwater into a wetland versus actually using an existing wetland for treatment.

Let me know if you have any questions.

Thanks,

Chris

From: jon.harrington@myfairpoint.net [mailto:jon.harrington@myfairpoint.net]
Sent: Wednesday, June 10, 2015 10:49 AM
To: Gianfagna, Chris
Subject: Fwd: Haystack - stormwater meeting follow up

Hi Chris - I just wanted to follow up opn the email below and see if you've had a chance to check with Neil Kanman regarding his needs on our current stormwater plan for Haystack and the East Tract area. Thanks in advance. Jon Harrington

----- Forwarded message from Jonathan Harrington <jon.harrington@myfairpoint.net> -----

Date: Mon, 1 Jun 2015 05:29:53 -0400
From: Jonathan Harrington <jon.harrington@myfairpoint.net>
Reply-To: Jonathan Harrington <jon.harrington@myfairpoint.net>
Subject: Haystack - stormwater meeting follow up
To: chris.gianfagna@state.vt.us
Cc: "'Robert S. Harrington'" <heinet@aol.com>

Chris,

It was good meeting with you last week to review the stormwater on the Haystack development. As I mentioned, I am finishing up the stormwater application package for 2015 construction and plan to have that submitted in the near future.

As discussed at our meeting, I am attaching an overall map of the Haystack Development which shows a general location of active and future projects, for your reference moving forward. I am also attaching the preliminary stormwater plan for the East Tract Development.

As part of the wetland permitting, we have been asked by Neil Kanman to provide us with a statement regarding stormwater feasibility for the proposed development. Could you coordinate with Neil as discussed to satisfy his requirement?

We discussed the anticipated stormwater compliance for the future projects, summarized as follows:

Haystack Development

- Chamonix Village and Stag’s Leap, and North of Base Lodge – stormwater collection to Mirror Lake

- South of Base Lodge – Underground storm chambers and pipes and/or utilize existing ponds

- Lower Mountain Townhouses – stormwater collection to Mirror Lake

- Maintenance Facility – Underground storm chambers and pipes

- Upper Mountain – Trailside (High Country) – disconnects, filter depressions, dry swales and underground storm pipes

- Hermitage Inn (four homes) – Disconnects, underground storm chambers, dry swales

- Hermitage Inn Area – lower pasture area – Underground storm chambers

- Mountain Coaster - disconnects

East Tract Development & Airport

- Grass treatment swales and disconnects along the road

- Site balancing along road

- Underground Stormwater Detention and treatment and disconnects at the airport

Please let me know if you need any more information. Thank you.

Jon

Jonathan C. Harrington, P.E.
Harrington Engineering, Inc.
P.O. Box 248
North Pomfret VT 05053

phone: 802.457.3151

----- End forwarded message -----

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Transportation
Land Development
Environmental
Energy
Services

7056 US Route 7
Post Office Box 120
North Ferrisburgh, Vermont 05473
802.497.6100
Fax 802.425.7799

Memorandum

To: Craig Heindel | Date: December 5, 2014

Project No.: 57680.00

From: Meddie J. Perry | Re: Hermitage Snowmaking NAA Modeling

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VHB has prepared this memorandum to summarize the modeling of snowmaking water Needs and Alternatives for the Hermitage Club's snowmaking system in the Town of Wilmington, Vermont. Pioneer Environmental Associates, LLC. (now VHB) had previously developed a Snowmaking Water Supply Needs and Alternatives Analysis ("NAA") for Haystack Ski Area in December of 2005 (PEA, 2005). Pioneer's Haystack Ski Area NAA model was used as a basis for this most recent modeling. The 2014 modeling has been completed in response to the request of the Vermont Agency of Natural Resources ("VT ANR") and in accordance with our contract with the Hermitage Inn Real Estate Holding Co., LLC dated March 3, 2014. This modeling has been developed to follow the requirements of Chapter 16 of the Vermont Environmental Protection Rules, *Water Withdrawals for Snowmaking*, dated February 15, 1996 (hereinafter referred to as the 1996 Snowmaking Rules).

1. Introduction

The Hermitage Club operates a ski and summer resort in the Town of Wilmington in southern Vermont. Currently, the Hermitage Club has a trail network of 147.4 acres of skiable terrain, of which 127.4 acres (86 percent of the trail area) are served by the existing snowmaking system which presently is supplied with water from an intake that is shared with Mount Snow. The Club's goal is to expand skiing terrain to a total of 193.3 acres with 100 percent snowmaking coverage and to operate its own intakes independently of Mount Snow. Thus, at full buildout, the proposed increase in snowmaking coverage at Hermitage would be approximately 66 new acres in addition to current coverage.

This modeling evaluates the proposed expansion to 193.3 acres of snowmaking at Hermitage in phases, including present conditions (127.4 acres of coverage) as a baseline, a Phase 1 initial expansion to 100% snowmaking coverage of existing terrain (147.4 acres of coverage), a Phase 2 near-term expansion with new trails and snowmaking on 154.4 acres, and a Phase 3 potential full build-out to 193.3 acres of coverage. This modeling evaluates existing system components at the Hermitage Club, as well as proposed changes to the snowmaking system.

2.0 Existing and Proposed Snowmaking System Components

The current Hermitage Club snowmaking system consists of the Cold Brook intake and Mirror Lake storage pond, both of which are shared with Mount Snow, and 127.4 acres of trail coverage. Details of the components are discussed below.

2.1 Water Sources

Cold Brook – The watershed of Cold Brook at the intake is 3.35 square miles. The maximum withdrawal rate at the intake is 3,500 gallons per minute (gpm), although a potential increase to 5,000 gpm is being considered. Currently, the withdrawn water is shared equally between Mount Snow and the Hermitage Club, although Mount Snow plans to discontinue its use of this intake once it has developed a new storage reservoir and a new intake further downstream, which are anticipated to be in use for the 2017-2018 season. The current wintertime conservation flow is 0.58 csm, based on past studies, but expansion of the snowmaking system would trigger an increase in conservation flows to the current requirement of 0.80 csm pursuant to sections 16-03(3)(b) and 16-07(3)(a) of the Snowmaking Rules.

Haystack Brook – A new intake is proposed on Haystack Brook, where the watershed is 1.18 square miles. A withdrawal capacity of 2,000 or 3,500 gpm is being considered.

2.2 Water Storage

A total of 14.6 Mgal of usable storage is provided in Mirror Lake. Currently, the volume is shared equally between Mount Snow and the Hermitage Club, effectively providing 7.3 Mgal of storage volume for each resort. An expansion of the total useable volume to 28.4 Mgal is being contemplated.

Additionally, Hermitage is planning to construct a new storage reservoir called Siegel Pond, with a useable volume of 22 Mgal. Siegel Pond would be constructed for Phase 3, only after the enlargement of Mirror Lake to 28.4 Mgal.

2.3 Trail Coverage and Proposed Phased Expansion

As noted above, the present extent of snowmaking at the Hermitage Club covers 127.4 acres of ski trails. A summary of the phases of snowmaking coverage, including prior conditions evaluated in the former NAA, current conditions, and three phases of expansion, is presented in Table 1.

Phase 1 is a proposed initial phase of expansion to snowmaking coverage on 100% of the current 147 acres of ski terrain that is planned to occur in the 2015 or 2016 construction season. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, and the Haystack Brook intake would be constructed with a 2,000 gpm capacity. These upgrades would require imposition of a 0.8 csm conservation flow at both intakes. The Cold Brook intake and the Mirror Lake storage reservoir would continue to be shared with Mount Snow.

Phase 2 involves a proposed near-term expansion of snowmaking coverage to 154.4 acres of ski terrain. This phase of expansion is planned to occur in the 2017 to 2020 time-frame, once Mount Snow is using a new intake further downstream on Cold Brook and a new 120-Mgal storage reservoir ("West Lake") which have been permitted and are expected to have been constructed by 2017.

Phase 3 consists of a potential full build-out of snowmaking coverage to 193.3 acres of ski terrain, which would occur somewhere in the 2021 to 2025 time-frame, pending agreements from landowners and approvals of technical permits from regulatory agencies. As in the prior phases of expansion, the Hermitage Club would exclusively utilize the Cold Brook intake. Construction of Siegel Pond may occur during Phase 3 if planned archaeological digs confirm that the site is not archaeologically sensitive, in order to follow-up on an initial desktop-based assessment that identified a potential for archaeological issues. Phase 3 may be divided into a Phase 3A without Siegel Pond, and a Phase 3B with construction of the Pond if feasible.

Table 1: Ski Trail Coverage Summary

Scenario		Novice	Intermediate	Expert	Terrain Park	Total
A) 2005 NAA – Current (2005) Snowmaking Trail Coverage	**Acres with Snowmaking**	**47.8**	**45.8**	**26.8**	**0.0**	**120.4**
	% of Total Snowmaking Acreage	40%	38%	22%	0%	100%
H1) Current (2014) Snowmaking Trail Coverage	**Acres with Snowmaking**	**54.8**	**45.8**	**26.8**	**0.0**	**127.4**
	% of Total Snowmaking Acreage	43%	36%	21%	0%	100%
H2) Phase 1: Proposed Initial Expansion to 100% Snowmaking on all Current Trails	**Acres with Snowmaking**	**51.3**	**58.4**	**37.7**	**0.0**	**147.4**
	% of Total Snowmaking Acreage	35%	40%	26%	0%	100%
H3) Phase 2: Proposed Near-Term Expansion with New Trails	**Acres with Snowmaking**	**58.3**	**58.4**	**37.7**	**0.0**	**154.4**
	% of Total Snowmaking Acreage	38%	38%	24%	0%	100%
H4) Phase 3: Potential Full Build-Out	**Acres with Snowmaking**	**65.3**	**79.0**	**49.0**	**0.0**	**193.3**
	% of Total Snowmaking Acreage	34%	41%	25%	0%	100%

3.0 Water Needs for Snowmaking

Water demands for the various stages of buildout to 193.3 acres of snowmaking coverage were calculated based on standard rates of water application in the ski industry, consistent with the approach of the prior NAA (PEA, 2005). Historic usage rates from the mountain were not used as a basis for the demand analysis, because insufficient data are available and more significantly, because the resort's supply of water is insufficient to meet demand, therefore historic consumption under-estimates actual water needs.

Standard water application rates that were used for the demand analysis are as follows:

- 175,000 gallons of water per acre-foot of manmade snow
- Manmade snow depths based on trail ability level, because steeper trails require deeper snow to withstand skier traffic:
  - 1.5 feet for novice trails
  - 2.0 feet for intermediate trails
  - 3.0 feet for expert trails
- 2.75 coverage events per season

VHB used a daily resolution to model the distribution of demand throughout the season, following a typical demand curve that achieves one full coverage by mid-December in order to meet ski resort goals for the Christmas-to-New Year's peak visitor season, consistent with the 2005 NAA.

The different phases of expansion involve varying proportions of novice, intermediate, and expert terrain and different acreages of coverage, therefore VHB determined the water demand independently for each phase based on the planned acreages of each ability level. Pages 1 through 3 of the Attachment present the water demand analysis in tabular and graphical form. Table 2 below summarizes the demands for the proposed expansion phases.

Table 2: Snowmaking Water Demand Summary

Scenario	Acres of Snowmaking Coverage	Mgal per Season	Mgal/acre
A) 2005 NAA – Current (2005) Snowmaking Trail Coverage	120.4	117.3	0.97
H1) Current (2014) Snowmaking Trail Coverage	127.4	122.3	0.96

Table 2: Snowmaking Water Demand Summary			
Scenario	**Acres of Snowmaking Coverage**	**Mgal per Season**	**Mgal/acre**
H2) Phase 1: Proposed Initial Expansion to 100% Snowmaking on all Current Trails	147.4	147.7	1.0
H3) Phase 2: Proposed Near-Term Expansion with New Trails	154.4	152.7	0.99
H4) Phase 3: Potential Full Build-Out	193.3	193.9	1.0

4.0 Evaluation of Water Availability

Consistent with the 2005 Haystack NAA and the 2007 Mount Snow NAA (and subsequent supplements), the availability of water for snowmaking for each day during the ski season was evaluated using a mass-balance hydrograph model. Following the Vermont Department of Environmental Conservation (DEC) Guidance Document for Alternatives Analysis, snowmaking needs are considered met if the model predicts that 80 percent of demand will be satisfied in 80 percent of the years that are analyzed.

4.1 Model Methodology

The mass-balance hydrograph model was used to determine the availability of water for snowmaking by determining water demand, forecasting the range of likely amounts of streamflow, accounting for the conservation flow limits, and modeling inputs to and outputs from storage, for each day of the year. In order to capture the range of variation from dry to wet years and to account for different climate cycles, the model independently evaluated 65 different years, using available USGS streamflow data.

In order to evaluate the mutual effects of Mount Snow's and the Hermitage Club's snowmaking systems on one another, due to their shared use of watersheds and withdrawal and storage facilities, the model accounts for water demand and consumption by both resorts. Withdrawals at upstream locations, such as the Hermitage Club's Cold Brook intake and proposed Haystack Brook intake, are factored-in to the availability of water at downstream locations such as Mount Snow's proposed new Cold Brook intake. The modeling is consistent with the mass-balance hydrograph model that VHB used for the Mount Snow NAA (PEA, 2007), and the results were evaluated for compatibility with the prior modeling and preferred alternatives that were approved for Mt Snow (VT ANR, 2010).

VHB modeled nineteen different scenarios in order to evaluate water needs and availability for the four different phases of expansion. Within the individual phases of expansion, the modeling assessed various potential intake options, conservation flow limits, storage volumes, and pump capacities to identify a preferred alternative. The model incorporated the planned upgrades of Mount Snow's system (e.g. increases in demand, new Cold Brook intake, West Lake storage reservoir, and discontinuance of Snow Lake intake) in sync with the anticipated schedule for the Hermitage Club's proposed upgrades.

For each day, the model performs the following computations:

- Determination of natural streamflow at the Cold Brook intake site
- Determination of conservation flow at the Cold Brook intake site
- Determination of resulting downstream flow at Cold Brook based on withdrawal rate limitations (i.e., conservation flow limits, and alternative potential maximum water withdrawal rates)
- Determination of natural streamflow at the Haystack Brook intake site
- Determination of conservation flow at the Haystack Brook intake site

- Determination of resulting downstream flow at Haystack Brook based on withdrawal rate limitations (i.e., conservation flow limits, and alternative potential maximum water withdrawal rates)
- Determination of resulting flow downstream of the Hermitage Club's intakes, at Mount Snow's proposed Cold Brook intake
- Evaluation of water availability for Mount Snow from its various sources (North Branch of the Deerfield/Snow Lake, Carinthia Pond, and proposed Cold Brook intake)
- Determination of snowmaking demands of Mount Snow and Hermitage Club
- Determination of the volume of water that may be pumped into storage, depending on volume already in storage, pump limits, available streamflow, and snowmaking demand of Mount Snow and Hermitage Club
- Determination of volume of water in storage available to meet demand for each resort

The model generates output tables summarizing the results at each resort for each year in each scenario, tabulating amounts of available streamflow, withdrawal and usage volumes, and percent completion of annual demand. The model determines statistical exceedence values to select the 80th percentile exceedence year, which should meet 80 percent of demand to be considered adequate for snowmaking needs, in accordance with Vermont DEC policy.

4.1.1 Streamflow Analysis for Modeling

To provide a long-term period of record, so that the modeling reflects fluctuations in streamflow from year to year, 65 years of daily streamflow data were used to represent flows at the intake sites in Cold and Haystack Brooks. Because a long-term flow record does not exist for either brook, the daily flows were derived from a previously-conducted record extension based on the nearby USGS Beaver Brook gauge (#01167800). With a 6.38 mi^2 watershed area, and similar elevation and terrain to the Cold and Haystack Brook Watersheds, the Beaver Brook gauge provides a suitable representation of flows at the project. The Beaver Brook gauge operated from 1963 until it was discontinued in 1977, providing a 15-year period of record. In order to provide sufficiently long period of record to capture the range of variation from dry to wet years and to account for different climate cycles, a record extension was developed, based on a statistical comparison to the USGS Ayers Brook gauge (#01142500) because it provided the best correlation with the flow data measured at the Beaver Brook gauge.

This extended-record streamflow data set was previously used in the NAA's for Haystack (PEA, 2005) and Mount Snow (PEA, 2007). It is necessary to compare the results of the current modeling to the prior NAA's in order to evaluate the impacts of the scenarios for Mount Snow and Haystack on each other's water availability, therefore the prior streamflow data set was used to provide a consistent basis for comparison to prior conditions and to previously approved alternatives.

4.1.2 Streamflow Analysis for Conservation Flows

Presently, a site-specific conservation flow of 0.58 csm applies at the Cold Brook intake. This flow limit would be superseded once the Hermitage Club expands its snowmaking system to trigger the requirements of the 1996 Snowmaking Rules, at which point the default statewide February Median Flow ("FMF") of 0.8 csm would be applicable at the Cold Brook and Haystack Brook intakes. Insufficient site-specific streamflow data exist for a determination of a new site-specific conservation flow, in accordance with section 16-06(3) of the 1996 Snowmaking Rules which specifies at least 10 years of daily flow data to determine a site specific conservation flow. At the Cold Brook intake, accurate streamflows have been measured since the 2008-2009 winter season, for only 6 years of record. No flow data have been measured at the Haystack Brook intake site.

4.2 Mass Hydrograph Results

A summary of simulation results is provided in Table 3. Page 4 of the Attachment provides a more detailed summary table which includes input and output details for Mount Snow and for the Hermitage Club. Pages 5 through 7 of the Attachment present Comparison Tables that contrast various pairs of scenarios to evaluate the effects of changing individual variables (such as the volume of Mirror Lake, construction of Siegel Pond, intake pump capacities, the 50% limit on withdrawals above the conservation flow, etc.), to facilitate decision-making about specific options. Tables and graphs of simulation data for each scenario that show water availability and snowmaking completion for each of the 65 years evaluated are provided in the Attachment, pages 8 through 41.

In table 3, the following formatting is used:

- Scenario H1 = Existing Conditions
- Scenario ID's beginning with "H2" – Phase 1 Initial Expansion to 100% coverage of existing trails
- Scenario ID's beginning with "H3" – Phase 2 Near-Term Expansion
- Scenario ID's beginning with "H4" – Phase 3 Potential Full Build-Out
- High-lighted scenarios are the preferred alternatives for each of the 3 Phases

Table 3: Mass Hydrograph Analysis – Summary of Results				
Scenario ID	**Description**	**Annual Hermitage Club Demand (Mgal)**	**Percent Completion (80-percentile year)**	**Comment**
H1	Existing conditions: 127.4 Acres of snowmaking terrain coverage. Cold Brook Intake w/ 0.58-csm cons. flow shared with Mt Snow, Mirror Lake shared with Mt Snow (14.6 Mgal total useable volume).	122	45.9%	current conditions - unable to meet 80/80 standard
H2A-1	Initial Expansion: 147 Acres of snowmaking terrain. Upgrade the Cold Brook Intake (3,500 gpm capacity) and share with Mt Snow, new 0.8 csm cons. flow; install proposed Haystack Brook Intake (2,000 gpm pump w/ 50% limit), Mirror Lake shared with Mt Snow (14.6 Mgal total useable volume).	148	38.4%	addition of Haystack Bk (2,000 gpm pump) w/ 50% limit, but imposition of 0.8 csm at both intakes, results in net gain of 12 Mgal in avg year, but only 0.6 Mgal gain in 80 pctile year
H2A-2	Same as H2A-1 but with 5,000 gpm maximum Cold Brook withdrawal capacity	148	38.4%	bigger (5,000 gpm) pump at Cold Bk - no significant benefit
H2A-3	Same as H2A-1 but with 3,500 gpm maximum Haystack Brook withdrawal capacity	148	38.4%	bigger (3,500 gpm) pump at Haystack Bk - no benefit
H2A-4	Same as H2A-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	148	38.4%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - no significant benefit
H2B-1	Upgrade the Cold Brook Intake (3,500 gpm capacity) and share with Mt Snow, new 0.8 csm conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump w/ 50% limit), enlarged Mirror Lake shared with Mt Snow (28.4 Mgal total useable volume), 147 Acres of snowmaking	148	44.5%	enlarged Mirror Lake adds 7.2 Mgal in avg year and 9.0 Mgal in 8- pctile year, compared to only adding Haystack Bk w/ 50% limit
H2B-2	Same as H2B-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	148	44.9%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario

Table 3: Mass Hydrograph Analysis – Summary of Results

Scenario ID	Description	Annual Hermitage Club Demand (Mgal)	Percent Completion (80-percentile year)	Comment
H2C-1	same as H2A-1, but without the 50% limitation on Haystack Brook withdrawals	148	39.6%	with current Mirror Lake configuration, removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. Compared to scenario H2A-1, removing the 50% limit provides modest benefit: 2.3 Mgal in an average year, and 1.7 Mgal in the 80 pctile year.
H2C-2	same as H2B-1, but without the 50% limitation on Haystack Brook withdrawals	148	47.9%	Recommended scenario for 147 Ac coverage phase: with enlarged Mirror Lake, removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. Compared to scenario H2B-1, removing the 50% limit provides modest benefit: 2.0 Mgal in an average year, and 5.0 Mgal in the 80 pctile year.
H3A-1	Near-Term Expansion: 154.4 Acres of snowmaking terrain. Upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new 0.8 csm conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump, 0.8 csm cons. flow w/o 50% limit), Mirror Lake 14.6 Mgal useable volume.	153	55.9%	Water availability for Hermitage Club increases due to no more sharing with Mt Snow (expected to be utilizing West Lake and new Cold Brook intake by this time) - but still not meeting 80/80 target.
H3A-2	Same as H3A-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	153	56.4%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario
H3B-1	Same as H3A-1 but enlarge Mirror Lake to 28.4 Mgal useable volume,	153	65.0%	Recommended scenario for 154 Ac coverage phase: enlarged Mirror Lake adds 9.3 Mgal in avg year and 13.8 Mgal in 80- pctile year, compared to H3A-1. Still falls short of 80/80 target. Removing the 50% limitation on Haystack Bk is justified because more water is needed than is available.

Table 3: Mass Hydrograph Analysis – Summary of Results				
Scenario ID	**Description**	**Annual Hermitage Club Demand (Mgal)**	**Percent Completion (80-percentile year)**	**Comment**
H3B-2	Same as H3B-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	153	66.3%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario
H4A-1	Full Build-Out: 193.3 Acres of snowmaking terrain. Upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new 0.8 csm conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump, 0.8 csm cons. flow w/o 50% limit), Mirror Lake 14.6 Mgal useable volume.	194	48.5%	full build-out - falls short of 80/80 target with current volume Mirror Lake
H4A-2	Same as H4A-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	194	48.5%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario
H4B-1	Same as H4A-1 but enlarge Mirror Lake to 28.4 Mgal useable volume	194	55.6%	Recommended scenario for Full Build-Out: enlarged Mirror Lake adds 11.2 Mgal in avg year and 13.8 Mgal in 80- pctile year, compared to H3A-1. Still falls short of 80/80 target. Removing the 50% limitation on Haystack Bk is justified because more water is needed than is available.
H4B-2	Same as H4B-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	194	55.6%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario
H4C-1	Same as H4B-1 but add Siegel Pond with 22 Mgal useable storage	194	66.5%	Recommended scenario for Full Build-Out: Siegel Pond adds 11.9 Mgal in avg year and 21.2 Mgal in 80- pctile year, compared to H3B-1. Still falls short of 80/80 target. Removing the 50% limitation on Haystack Bk is justified because more water is needed than is available.

Table 3: Mass Hydrograph Analysis – Summary of Results				
Scenario ID	**Description**	**Annual Hermitage Club Demand (Mgal)**	**Percent Completion (80-percentile year)**	**Comment**
H4C-2	Same as H4C-1 but with both 5,000 gpm maximum Cold Brook and 3,500 gpm maximum Haystack Brook withdrawal capacities	194	66.5%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario

4.2.1 Results for Current Conditions

Scenario H1 evaluates the ability of the existing system that is shared with Mount Snow to meet the Hermitage Club's demand of 122 Mgal annually. The conservation flow at Cold Brook (0.58 csm) remains as currently permitted. The existing system fails to meet the 80/80 snowmaking performance target for the current 127.4 acres of coverage. This scenario indicates that the existing intake and storage are inadequate for the current amount of snowmaking coverage. The model output and graphs for Scenario H1 are located on pages 8 and 9 of the Attachment.

4.2.2 Results for Phase 1: Proposed Initial Phase of Expansion

Scenario H2A-1 evaluates the proposed initial phase of expansion to snowmaking coverage on 100% of the current 147 acres of ski terrain. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, and the Haystack Brook intake would be constructed with a 2,000 gpm capacity. These upgrades would require imposition of a 0.8 csm conservation flow at both intakes. This scenario also evaluates a 50% limitation on withdrawal above the FMF at Haystack Brook, which may be required pursuant to section 16-06(4) of the 1996 Snowmaking Rules. The Cold Brook intake and the Mirror Lake storage reservoir would continue to be shared with Mount Snow. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage. The model output and graphs for Scenario H2A-1 are located on pages 10 and 11 of the Attachment.

Scenario H2A-2 is the same as H2A-1 except that it contemplates a higher-capacity withdrawal of 5,000 gpm at Cold Brook. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and the larger withdrawal capacity does not provide any significant benefit because the system is storage-limited. The model output and graphs for Scenario H2A-2 are located on pages 12 and 13 of the Attachment. The Comparison Tables on page 5 of the Attachment contrast the results of scenarios H2A-1 and H2A-2.

Scenario H2A-3 is the same as H2A-1 except that it contemplates a higher-capacity withdrawal of 3,500 gpm at Haystack Brook. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and the larger withdrawal capacity does not provide any significant benefit because the system is storage-limited. The model output and graphs for Scenario H2A-3 are located on pages 14 and 15 of the Attachment. The Comparison Tables on page 5 of the Attachment contrast the results of scenarios H2A-1 and H2A-3.

Scenario H2A-4 is the same as H2A-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and again the larger withdrawal capacity does not provide any significant benefit because the system is storage-limited. The model output and graphs for Scenario H2A-3 are located on pages 16 and 17 of the Attachment. The Comparison Tables on page 5 of the Attachment contrast the results of scenarios H2A-1 and H2A-4.

Scenario H2B-1 evaluates the ability of a possible enlargement of Mirror Lake to 28.4 Mgal useable volume to support the proposed initial phase of expansion to snowmaking coverage on 100% of the current 147 acres of ski terrain. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, and the Haystack Brook intake would be constructed with a 2,000 gpm capacity. These upgrades would require imposition of a 0.8 csm conservation flow at both intakes. This scenario evaluates a 50% limitation on withdrawal above the FMF at Haystack Brook. The Cold Brook intake and the Mirror Lake storage reservoir would continue to be shared with Mount Snow. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, however the expansion of Mirror Lake would provide a benefit compared to leaving it in its current configuration. The model output and graphs for Scenario H2B-1 are located on pages 18 and 19 of the Attachment. The Comparison Tables on page 5 of the Attachment contrast the results of scenarios H2A-1 and H2B-1 to quantify the benefit of enlarging Mirror Lake.

Scenario H2B-2 is the same as H2B-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and again the larger withdrawal capacity does not provide any significant benefit because the system is storage-limited even with the larger Mirror Lake. The model output and graphs for Scenario H2B-2 are located on pages 20 and 21 of the Attachment.

Scenario H2C-1 is the same as H2A-1 (upgrade the Cold Brook Intake with a 3,500 gpm capacity and new 0.8 csm conservation flow, and share with Mt Snow; install proposed Haystack Brook Intake with a 2,000 gpm capacity, current-size Mirror Lake shared with Mt Snow), except that it contemplates the removal of the 50% limit on withdrawal at Haystack Brook. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. The model output and graphs for Scenario H2C-1 are located on pages 22 and 23 of the Attachment. The Comparison Tables on page 6 of the Attachment contrast the results of scenarios H2A-1 and H2C-1.

Scenario H2C-2 is the same as H2B-1 (upgrade the Cold Brook Intake with a 3,500 gpm capacity and new 0.8 csm conservation flow, and share with Mt Snow; install proposed Haystack Brook Intake with a 2,000 gpm capacity, enlarged 28.4 Mgal Mirror Lake shared with Mt Snow), except that it contemplates the removal of the 50% limit on withdrawal at Haystack Brook. Despite the larger storage volume, this system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. The model output and graphs for Scenario H2C-2 are located on pages 24 and 25 of the Attachment. The Comparison Tables on page 6 of the Attachment contrast the results of scenarios H2B-1 and H2C-2. Scenario H2C-2 is the recommended alternative for the initial phase of expansion because it comes closest to meeting the 80/80 target (47.9 percent of demand met in the 80th percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, pursuant to the Flow Determination Letter (VT ANR, 2010).

4.2.3 Results for Phase 2: Proposed Near-Term Phase of Expansion

Scenario H3A-1 evaluates the proposed near-term expansion of snowmaking coverage to 154.4 acres of ski terrain. This phase of expansion is planned to occur in the 2017 to 2020 time-frame, once Mount Snow is using the permitted but not currently constructed West Lake and new intake further downstream on Cold Brook, so the Hermitage would have exclusive use of Mirror Lake and its Cold Brook intake. As in the initial phase of expansion, Hermitage would utilize the Cold Brook intake with a 3,500 gpm withdrawal capacity and the Haystack Brook intake with a 2,000 gpm capacity. A 0.8-csm conservation flow at both intakes would apply. A 50% limitation on withdrawal above the FMF at

Haystack Brook was not analyzed, because the prior scenarios showed that more water is needed than is available without the limitation, pursuant to section 16-06(4)(a) of the 1996 Snowmaking Rules. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 154.5 acres of coverage. The model output and graphs for Scenario H3A-1 are located on pages 26 and 27 of the Attachment.

Scenario H3A-2 is the same as H3A-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage because the system is storage-limited. The model output and graphs for Scenario H3A-2 are located on pages 28 and 29 of the Attachment. The Comparison Tables on page 6 of the Attachment contrast the results of scenarios H3A-1 and H3A-2.

Scenario H3B-1 evaluates the ability of a possible enlargement of Mirror Lake to 28.4 Mgal useable volume to support the proposed near-term phase of expansion to snowmaking coverage on 154.4 acres of ski terrain. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, the Haystack Brook intake would be constructed with a 2,000 gpm capacity, and a 0.8 csm conservation flow at both intakes would apply without a 50% limitation on withdrawal above the FMF. These sources and storage would be used exclusively by the Hermitage Club. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 154.4 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. However, the expansion of Mirror Lake would provide a benefit compared to leaving it in its current configuration. The model output and graphs for Scenario H3B-1 are located on pages 30 and 31 of the Attachment. The Comparison Tables on page 6 of the Attachment contrast the results of scenarios H3A-1 and H3B-1 to quantify the benefit of enlarging Mirror Lake at this phase of expansion. Scenario H3B-1 is the recommended alternative for the near-term phase of expansion because it comes close to meeting the 80/80 target (65 percent of demand met in the 80th percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, pursuant to the Flow Determination Letter (VT ANR, 2010).

Scenario H3B-2 is the same as H3B-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 154.4 acres of coverage (66.3 percent of demand met in the 80th percentile exceedance year), and again the larger withdrawal capacity does not provide a significant benefit because the system is storage-limited even with the larger Mirror Lake. The model output and graphs for Scenario H3B-2 are located on pages 32 and 33 of the Attachment. The Comparison Tables on page 6 of the Attachment contrast the results of scenarios H3B-1 and H3B-2.

4.2.4 Results for Phase 3: Potential Full Build-Out

Scenario H4A-1 evaluates the potential full build-out of snowmaking coverage to 193.3 acres of ski terrain. As in the prior phases of expansion, the Hermitage Club would exclusively utilize Mirror Lake, the Cold Brook intake with a 3,500 gpm withdrawal capacity, and the Haystack Brook intake with a 2,000 gpm capacity. A 0.8 csm conservation flow at both intakes would apply. A 50% limitation on withdrawal above the FMF at Haystack Brook was not analyzed, because the prior scenarios showed that more water is needed than is available without the limitation, pursuant to section 16-06(4)(a) of the 1996 Snowmaking Rules. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage. The model output and graphs for Scenario H4A-1 are located on pages 34 and 35 of the Attachment.

Scenario H4A-2 is the same as H4A-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage because the system is storage-limited. The model output and graphs for Scenario H4A-2 are located on pages 36 and 37 of the Attachment. The Comparison Tables on page 7 of the Attachment contrast the results of scenarios H4A-1 and H4A-2.

Scenario H4B-1 evaluates the ability of a possible enlargement of Mirror Lake to 28.4 Mgal useable volume to support the proposed full build-out expansion to snowmaking coverage on 193.3 acres of ski terrain. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, the Haystack Brook intake would be constructed with a 2,000 gpm capacity, and a 0.8 csm conservation flow at both intakes would apply without a 50% limitation on withdrawal above the FMF. These sources and storage would be used exclusively by the Hermitage Club. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. However, the expansion of Mirror Lake would provide a benefit compared to leaving it in its current configuration. The model output and graphs for Scenario H4B-1 are located on pages 38 and 39 of the Attachment. The Comparison Tables on page 7 of the Attachment contrast the results of scenarios H4A-1 and H4B-1 to quantify the benefit of enlarging Mirror Lake at this phase of expansion.

Scenario H4B-2 is the same as H4B-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage (55.6 percent of demand met in the 80th percentile exceedance year, as with scenario H4B-1), and again the larger withdrawal capacity does not provide a significant benefit because the system is storage-limited even with the larger Mirror Lake. The model output and graphs for Scenario H4B-2 are located on pages 40 and

41 of the Attachment. The Comparison Tables on page 7 of the Attachment contrast the results of scenarios H4B-1 and H4B-2.

Scenario H4C-1 evaluates the ability of possible construction of Siegel Pond with 22 Mgal useable volume, in addition to the expansion of Mirror Lake to 28.4 Mgal, to support the proposed full build-out expansion to snowmaking coverage on 193.3 acres of ski terrain. Along with the expansion in snowmaking terrain, the Cold Brook intake would be upgraded with a 3,500 gpm withdrawal capacity, the Haystack Brook intake would be constructed with a 2,000 gpm capacity, and a 0.8 csm conservation flow at both intakes would apply without a 50% limitation on withdrawal above the FMF. These sources and storage would be used exclusively by the Hermitage Club. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. However, the storage volume provided by the expansion of Mirror Lake and construction of Siegel Pond would help Hermitage to come as close to meeting the 80/80 target as is feasible. The model output and graphs for Scenario H4C-1 are located on pages 42 and 43 of the Attachment. The Comparison Tables on page 7 of the Attachment contrast the results of scenarios H4B-1 and H4C-1 to quantify the benefit of adding Siegel Pond at this phase of expansion. Scenario H4C-1 is the recommended alternative for the full build-out phase of expansion because it comes closest to meeting the 80/80 target (66.5 percent of demand met in the 80th percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, pursuant to the Flow Determination Letter (VT ANR, 2010).

Scenario H4C-2 is the same as H4C-1 except that it contemplates higher-capacity withdrawals of both 5,000 gpm at Cold Brook, and 3,500 gpm at Haystack Brook. This system configuration also would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage (66.5 percent of demand met in the 80th percentile exceedance year, as with scenario H4C-1), and again the larger withdrawal capacity does not provide a significant benefit because the system is storage-limited even with Siegel Pond. The model output and graphs for Scenario H4C-2 are located on pages 44 and 44 of the Attachment.

4.2.5 Recommended Alternatives

The recommended alternative for the proposed initial phase of expansion to snowmaking coverage on 100% of the current 147 acres of ski terrain, is Scenario H2C-2. This scenario involves an upgraded Cold Brook Intake that is shared with Mt Snow, with a 3,500 gpm capacity and new 0.8 csm conservation flow; a new Haystack Brook Intake with a 2,000 gpm capacity, 0.8 csm conservation flow, and no 50% limit on withdrawal above the FMF; and an enlarged 28.4 Mgal Mirror Lake that is shared with Mt Snow. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 147 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. This scenario is the recommended alternative for Phase 1 because it comes closest to meeting the 80/80 target (47.9 percent of demand met in the 80th percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, while maximizing instream flows.

The recommended alternative for the proposed near-term phase of expansion to snowmaking coverage on 154.4 acres of ski terrain, is Scenario H3B-1. This scenario involves the Hermitage Club exclusively using an upgraded Cold Brook Intake with a 3,500 gpm capacity and new 0.8 csm conservation flow; a new Haystack Brook Intake with a 2,000 gpm capacity, 0.8 csm conservation flow, and no 50% limit on withdrawal above the FMF; and an enlarged 28.4 Mgal Mirror Lake. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 154.4 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. This scenario is the recommended alternative for Phase 2 because it comes closest to meeting the 80/80 target (65 percent of demand met in the 80th percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, while maximizing instream flows.

The recommended alternative for the proposed Phase 3 expansion to a potential full build-out of snowmaking coverage on 193.3 acres of ski terrain, is Scenario H4C-1. This scenario involves the Hermitage Club exclusively using an upgraded Cold Brook Intake with a 3,500 gpm capacity and new 0.8 csm conservation flow; a new Haystack Brook Intake with a 2,000 gpm capacity, 0.8 csm conservation flow, and no 50% limit on withdrawal above the FMF; an enlarged 28.4 Mgal Mirror Lake, and construction of Siegel Pond with an additional 22 Mgal of storage. This system configuration would fail to meet the 80/80 snowmaking performance target for the expanded 193.3 acres of coverage, and therefore removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. This scenario is the recommended alternative for Phase 3 because it comes closest to meeting the 80/80 target (66.5 percent of demand met in the 80^{th} percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, while maximizing instream flows.

An alternative preferred scenario for Phase 3 expansion would be Scenario H3C-1. This scenario is the same as H4C-1 except without the construction of Siegel Pond. In the event that construction of Siegel Pond is not permittable or feasible, due to potential archaeological concerns or other issues, then scenario H3C-1 would become the preferred alternative because it comes the next-closest to meeting the 80/80 target (55.6 percent of demand met in the 80^{th} percentile exceedance year), and does not conflict with Mount Snow's previously approved preferred alternative, while maximizing instream flows.

5.0 Conclusions

This memorandum presents updated Needs and Alternatives Analysis modeling for the Hermitage Club snowmaking system, based on the present plans for expansion.

The current configuration of water sources, storage, and trail coverage cannot meet the 80/80 target. Although proposed improvements including an upgraded Cold Brook intake, new Haystack Brook intake, enlarged Mirror Lake, Siegel Pond, and eventual exclusive use rather than sharing Cold Brook intake and Mirror Lake with Mount Snow, would make more water available, the increases in conservation flow that would be required would offset some of the gains in capacity.

The modeling predicts that the Hermitage Club's 80/80 target would not be met in any scenario for any phase of build-out, which would limit the resort's ability to provide adequate skiing coverage in years with poor natural snowfall. Thus, this result supports the need for the proposed improvements in withdrawals and storage, and justifies deleting a 50% withdrawal limit for Haystack Brook in all buildout scenarios, because more water is needed than would be available with the limitation.

Based on the model results, withdrawal capacities at Cold Brook or Haystack Brook in excess of 3,500 and 2,000 gpm respectively are not recommended because the benefit would be minimal, which is the case because the limiting factors for water availability are streamflow and storage volume, rather than withdrawal capacity, which is adequate at these proposed rates.

Enlarging Mirror Lake is recommended for all phases of expansion, in order to come as close to meeting the 80/80 target as feasible. Likewise, construction of Siegel Pond is recommended for Phase 3 expansion.

Regarding Mt Snow and the potential for competing water uses, the recommended alternatives for the Hermitage Club are consistent with the prior modeling and preferred alternatives selected for Mt Snow. The alternatives recommended in this memorandum are compatible with Mt Snow's previously approved water availability.

References

PEA, 2005. Haystack Ski Area, Wilmington, Vermont: Snowmaking Water Supply Needs and Alternatives Analysis. Pioneer Environmental Associates, Vergennes, VT. December 21, 2005.

PEA, 2007. Mount Snow Resort, West Dover, Vermont: Snowmaking Needs and Alternatives Analysis. Pioneer Environmental Associates, Vergennes, VT. February 12, 2007.

PEA, 2007. Mount Snow Resort, West Dover, Vermont: Supplement to Snowmaking Needs and Alternatives Analysis. Pioneer Environmental Associates, Vergennes, VT. November 8, 2007.

VT ANR, 1996. Environmental Protection Rules, Chapter 16, Water Withdrawals for Snowmaking. Vermont Agency of Natural Resources: Department of Environmental Conservation. February 15, 1996.

VT ANR, 2010. "Mount Snow Resort – Proposed Snowmaking Expansion: Agency Review Under Environmental Protection Rules". Vermont Agency of Natural Resources: Department of Environmental Conservation. Letter from Brian T. Fitzgerald to Kelly Pawlak of Mt Snow Ltd, September 1, 2010.

ATTACHMENT

Hermitage Club: Snowmaking Needs and Alternative Analysis

Snowmaking Water Demand Summary

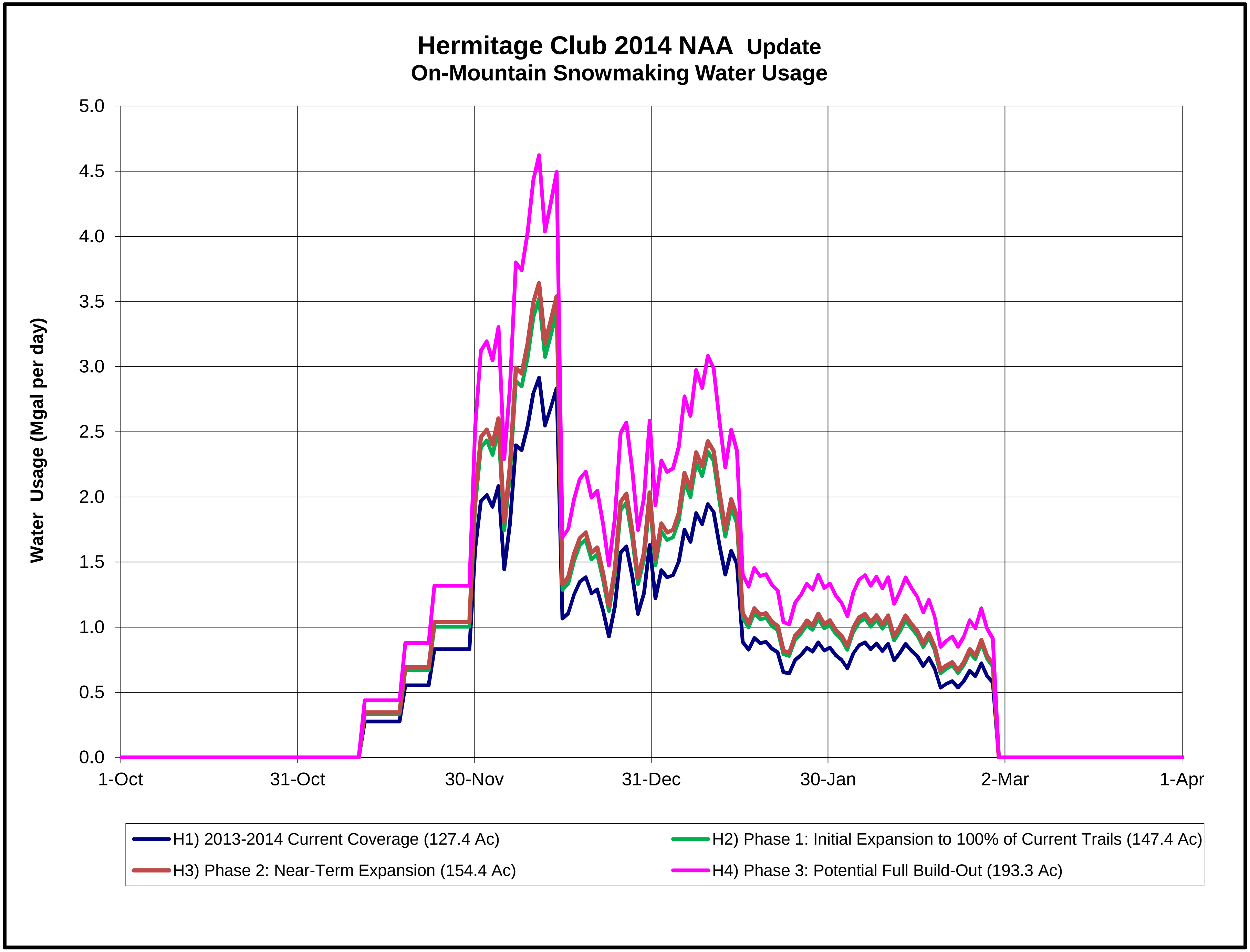
Prepared by VHB: December 5, 2014

	Snowmaking Water Demand					
	Novice	**Intermediate**	**Expert**	**Terrain Park**	**Total**	**Units**
A) 2005 NAA - Current (2005) Snowmaking Trail Coverage						
Total with Snowmaking	**47.8**	**45.8**	**26.8**	**0.0**	**120.4**	Acres
Percent of Total	40%	38%	22%	0%	100%	
Snow Depth per Coverage	1.5	2.0	3.0	3.0	--	Feet
Water Equivalent	175,000	175,000	175,000	175,000	175,000	Gallons per acre foot
Water Volume per Coverage, for all acreage of trail	12,547,500	16,030,000	14,070,000	0	42,647,500	Gallons
Number of Coverages per Season	2.75	2.75	2.75	2.75	2.75	Times per season
Total Water Volume per Season	**34,505,625**	**44,082,500**	**38,692,500**	**0**	**117,280,625**	**Gallons**
Water Application Rate	**721,875**	**962,500**	**1,443,750**	**NA**	**974,092**	**Gallons per acre**
Water Application Rate	**0.72**	**0.96**	**1.44**	**NA**	**0.97**	**Mgal/acre**
H1) Current (2014) Snowmaking Trail Coverage						
Total with Snowmaking	**54.8**	**45.8**	**26.8**	**0.0**	**127.4**	Acres
Percent of Total	43%	36%	21%	0%	100%	
Snow Depth per Coverage	1.5	2.0	3.0	3.0	--	Feet
Water Equivalent	175,000	175,000	175,000	175,000	175,000	Gallons per acre foot
Water Volume per Coverage, for all acreage of trail	14,385,000	16,030,000	14,070,000	0	44,485,000	Gallons
Number of Coverages per Season	2.75	2.75	2.75	2.75	2.75	Times per season
Total Water Volume per Season	**39,558,750**	**44,082,500**	**38,692,500**	**0**	**122,333,750**	**Gallons**
Water Application Rate	**721,875**	**962,500**	**1,443,750**	**NA**	**960,234**	**Gallons per acre**
Water Application Rate	**0.72**	**0.96**	**1.44**	**NA**	**0.96**	**Mgal/acre**
H2) Phase 1 Initial Expansion: Build-Out to 100% Snowmaking on all Current Trails						
Total with Snowmaking	**51.3**	**58.4**	**37.7**	**0.0**	**147.4**	Acres
Percent of Total	35%	40%	26%	0%	100%	
Snow Depth per Coverage	1.5	2.0	3.0	3.0	--	Feet
Water Equivalent	175,000	175,000	175,000	175,000	175,000	Gallons per acre foot
Water Volume per Coverage, for all acreage of trail	13,466,250	20,440,000	19,792,500	0	53,698,750	Gallons
Number of Coverages per Season	2.75	2.75	2.75	2.75	2.75	Times per season
Total Water Volume per Season	**37,032,188**	**56,210,000**	**54,429,375**	**0**	**147,671,563**	**Gallons**
Water Application Rate	**721,875**	**962,500**	**1,443,750**	**NA**	**1,001,842**	**Gallons per acre**
Water Application Rate	**0.72**	**0.96**	**1.44**	**NA**	**1.00**	**Mgal/acre**

Hermitage Club: Snowmaking Needs and Alternative Analysis
Snowmaking Water Demand Summary
Prepared by VHB: December 5, 2014

	Snowmaking Water Demand					
	Novice	**Intermediate**	**Expert**	**Terrain Park**	**Total**	**Units**
H3) Phase 2: Near-Term Expansion						
Total with Snowmaking	**58.3**	**58.4**	**37.7**	**0.0**	**154.4**	Acres
Percent of Total	38%	38%	24%	0%	100%	
Snow Depth per Coverage	1.5	2.0	3.0	3.0	--	Feet
Water Equivalent	175,000	175,000	175,000	175,000	175,000	Gallons per acre foot
Water Volume per Coverage, for all acreage of trail	15,303,750	20,440,000	19,792,500	0	55,536,250	Gallons
Number of Coverages per Season	2.75	2.75	2.75	2.75	2.75	Times per season
Total Water Volume per Season	**42,085,313**	**56,210,000**	**54,429,375**	**0**	**152,724,688**	**Gallons**
Water Application Rate	**721,875**	**962,500**	**1,443,750**	**NA**	**989,150**	**Gallons per acre**
Water Application Rate	**0.72**	**0.96**	**1.44**	**NA**	**0.99**	**Mgal/acre**
H4) Phase 3: Potential Full Build-Out						
Total with Snowmaking	**65.3**	**79.0**	**49.0**	**0.0**	**193.3**	Acres
Percent of Total	34%	41%	25%	0%	100%	
Snow Depth per Coverage	1.5	2.0	3.0	3.0	--	Feet
Water Equivalent	175,000	175,000	175,000	175,000	175,000	Gallons per acre foot
Water Volume per Coverage, for all acreage of trail	17,141,250	27,650,000	25,725,000	0	70,516,250	Gallons
Number of Coverages per Season	2.75	2.75	2.75	2.75	2.75	Times per season
Total Water Volume per Season	**47,138,438**	**76,037,500**	**70,743,750**	**0**	**193,919,688**	**Gallons**
Water Application Rate	**721,875**	**962,500**	**1,443,750**	**NA**	**1,003,206**	**Gallons per acre**
Water Application Rate	**0.72**	**0.96**	**1.44**	**NA**	**1.00**	**Mgal/acre**

NA - data not available


Hermitage Club 2014 NAA Update
On-Mountain Snowmaking Water Usage
Water Usage (Mgal per day)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1-Oct
31-Oct
30-Nov
31-Dec
30-Jan
2-Mar
1-Apr
H1) 2013-2014 Current Coverage (127.4 Ac)
H2) Phase 1: Initial Expansion to 100% of Current Trails (147.4 Ac)
H3) Phase 2: Near-Term Expansion (154.4 Ac)
H4) Phase 3: Potential Full Build-Out (193.3 Ac)

Hermitage Club: Snowmaking Needs and Alternative Analysis
Summary of Snowmaking Mass Balance Hydrograph Analyses
Prepared by VHB: December 5, 2014

Scenario	Comment	Model Input: Total Mt. Snow Snowmaking Demand (Mgal)	Total Haystack Snowmaking Demand (Mgal)	Existing Cold Brook Withdrawal: Cold Brook Conservation Flow (csm)	Existing Cold Brook Withdrawal: % to Haystack Ski Area (%)	Existing Cold Brook Withdrawal: Mirror Lake Storage Volume[1] (Mgal)	Existing Cold Brook Withdrawal: Mirror Lake Pumping Rate[2] (gpm)	New Haystack Brook Withdrawal: Conservation Flow (csm)	New Haystack Brook Withdrawal: Pumping Rate (gpm)	New MS Cold Brook Withdrawal: Conservation Flow (csm)	New MS Cold Brook Withdrawal: Pumping Rate (gpm)	MS - No. Br. @ Snow Lake Withdrawal: Conservation Flow (csm)	MS - No. Br. @ Snow Lake Withdrawal: Storage Volume (Mgal)	MS - No. Br. @ Snow Lake Withdrawal: Pumping Rate (gpm)	Model Output (Projected Snowmaking Usage): Mount Snow 80th Percentile Year* (Mgal)	Mount Snow 80th Percentile Year* % of Target	Mount Snow Average Year (Mgal)	Mount Snow Average Year % of Target	Haystack 80th Percentile Year* (Mgal)	Haystack 80th Percentile Year* % of Target	Haystack Average Year (Mgal)	Haystack Average Year % of Target	notes
H1	Existing conditions: Cold Brook Intake shared with Mt Snow, Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 127.4 Acres of snowmaking terrain coverage (current coverage amount)	360	122	0.58	50%	14.6	3,500	0.00	0	0.00	0	0.15	11.0	2,000	246	68.5%	303	84.3%	56.2	45.9%	86.5	70.7%	current conditions - unable to meet 80/80 standard
H2A-1	Phase 1 Expansion: Upgrade the Cold Brook Intake (3,500 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump w/ 50% limit), Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	14.6	3,500	0.8 + 50%	2,000	0.00	0	0.15	11.0	2,000	266	73.8%	299	83.1%	56.8	38.4%	98.3	66.5%	addition of Haystack Bk (2,000 gpm pump) w/ 50% limit, but imposition of 0.8 csm at both intakes, results in net gain of 12 Mgal in avg year, but only 0.6 Mgal gain in 80 pctile year
H2A-2	Phase 1 Expansion: Upgrade the Cold Brook Intake (5,000 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump w/ 50% limit), Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	14.6	5,000	0.8 + 50%	2,000	0.00	0	0.15	11.0	2,000	266	73.8%	299	83.1%	56.8	38.4%	98.4	66.6%	bigger (5,000 gpm) pump at Cold Bk - no significant benefit
H2A-3	Phase 1 Expansion: Upgrade the Cold Brook Intake (3,500 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump w/ 50% limit), Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	14.6	3,500	0.8 + 50%	3,500	0.00	0	0.15	11.0	2,000	266	73.8%	299	83.1%	56.8	38.4%	98.3	66.6%	bigger (3,500 gpm) pump at Haystack Bk - no benefit
H2A-4	Phase 1 Expansion: Upgrade the Cold Brook Intake (5,000 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump w/ 50% limit), Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	14.6	5,000	0.8 + 50%	3,500	0.00	0	0.15	11.0	2,000	266	73.8%	299	83.1%	56.8	38.4%	98.4	66.6%	bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - no significant benefit
H2B-1	Phase 1 Expansion: Upgrade the Cold Brook Intake (3,500 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump w/ 50% limit), enlarged Mirror Lake shared with Mt Snow (28.4 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	28.4	3,500	0.8 + 50%	2,000	0.00	0	0.15	11.0	2,000	279	77.6%	305	84.7%	65.8	44.5%	105.5	71.4%	enlarged Mirror Lake adds 7.2 Mgal in avg year and 9.0 Mgal in 8-pctile year, compared to only adding Haystack Bk w/ 50% limit
H2B-2	Phase 1 Expansion: Upgrade the Cold Brook Intake (5,000 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump w/ 50% limit), enlarged Mirror Lake shared with Mt Snow (28.4 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	28.4	5,000	0.8 + 50%	3,500	0.00	0	0.15	11.0	2,000	279	77.6%	305	84.8%	66.4	44.9%	105.8	71.6%	enlarging Mirror Lake along with bigger pumps at both Cold Bk (5,000 gpm) and Haystack Bk (3,500 gpm) - insignificant benefit compared to above scenario
H2C-1	same as scenario H2A-1, but without the 50% limitation on Haystack Brook withdrawals: Upgrade the Cold Brook Intake (3,500 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), Mirror Lake shared with Mt Snow (14.6 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	14.6	3,500	0.80	2,000	0.00	0	0.15	11.0	2,000	266	73.8%	299	83.1%	58.4	39.6%	100.5	68.1%	with current Mirror Lake configuration, removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. Compared to scenario H2A-1, removing the 50% limit provides modest benefit: 2.3 Mgal in an average year, and 1.7 Mgal in the 80 pctile year.
H2C-2	same as scenario H2B-1, but without the 50% limitation on Haystack Brook withdrawals: Upgrade the Cold Brook Intake (3,500 gpm pump) and share with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), enlarged Mirror Lake shared with Mt Snow (28.4 Mgal total volume), 147 Acres of snowmaking terrain coverage	360	148	0.80	50%	28.4	3,500	0.80	2,000	0.00	0	0.15	11.0	2,000	279	77.6%	305	84.7%	70.8	47.9%	107.5	72.8%	**with enlarged Mirror Lake, removing the 50% limitation on Haystack Bk is justified because more water is needed than is available. Compared to scenario H2B-1, removing the 50% limit provides modest benefit: 2.0 Mgal in an average year, and 5.0 Mgal in the 80 pctile year.** **preferred scenario - 147 Ac coverage**
H3A-1	Phase 2 Expansion: upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), Mirror Lake 14.6 Mgal total volume, 154.4 Acres of snowmaking terrain coverage	476	153	0.80	100%	14.6	3,500	0.80	2,000	0.80	10,000	NA	0.0	0	237	49.8%	383	80.5%	85.4	55.9%	118.7	77.7%	water availability for Haystack increases due to no more sharing with Mt Snow (expected to be utilizing West Lake and new Cold Brook intake by this time) - but still not meeting 80/80 target
H3A-2	Phase 2 Expansion: upgrade the Cold Brook Intake (5,000 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump), Mirror Lake 14.6 Mgal total volume, 154.4 Acres of snowmaking terrain coverage	476	153	0.80	100%	14.6	5,000	0.80	3,500	0.80	10,000	NA	0.0	0	297	62.5%	383	80.5%	86.1	56.4%	118.8	77.8%	above scenario but with larger pumps - no significant benefit
H3B-1	Phase 2 Expansion: upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), enlarge Mirror Lake to 28.4 Mgal total volume, 154.4 Acres of snowmaking terrain coverage	476	153	0.80	100%	28.4	3,500	0.80	2,000	0.80	10,000	NA	0.0	0	237	49.8%	381	80.1%	99.2	65.0%	128.0	83.8%	**enlarged Mirror Lake adds 9.3 Mgal in avg year and 13.8 Mgal in 80- pctile year, compared to H3A-1. Still falls short of 80/80 target.** **preferred scenario - 154 Ac coverage**
H3B-2	Phase 2 Expansion: upgrade the Cold Brook Intake (5,000 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump), enlarge Mirror Lake to 28.4 Mgal total volume, 154.4 Acres of snowmaking terrain coverage	476	153	0.80	100%	28.4	5,000	0.80	3,500	0.80	10,000	NA	0.0	0	305	64.1%	382	80.2%	101.2	66.3%	128.2	83.9%	above scenario but with larger pumps - no significant benefit
H4A-1	Potential Full Build-Out: upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), Mirror Lake 14.6 Mgal total volume, 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	14.6	3,500	0.80	2,000	0.80	10,000	NA	0.0	0	278	58.4%	379	79.7%	94.1	48.5%	142.0	73.2%	full build-out - falls short of 80/80 target with current volume Mirror Lake
H4A-2	Potential Full Build-Out: upgrade the Cold Brook Intake (5,000 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump), Mirror Lake 14.6 Mgal total volume, 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	14.6	5,000	0.80	3,500	0.80	10,000	NA	0.0	0	278	58.4%	379	79.7%	94.1	48.5%	142.2	73.3%	above scenario but with larger pumps - no significant benefit
H4B-1	Potential Full Build-Out: upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), enlarge Mirror Lake to 28.4 Mgal total, 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	28.4	3,500	0.80	2,000	0.80	10,000	NA	0.0	0	278	58.4%	378	79.4%	107.9	55.6%	153.3	79.0%	enlarged Mirror Lake adds 11.2 Mgal in avg year and 13.8 Mgal in 80- pctile year, compared to H3A-1. Still falls short of 80/80 target.
H4B-2	Potential Full Build-Out: upgrade the Cold Brook Intake (5,000 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump), enlarge Mirror Lake to 28.4 Mgal total, 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	28.4	5,000	0.80	3,500	0.80	10,000	NA	0.0	0	278	58.4%	378	79.4%	107.9	55.6%	153.7	79.3%	above scenario but with larger pumps - no significant benefit
H4C-1	Potential Full Build-Out: upgrade the Cold Brook Intake (3,500 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (2,000 gpm pump), enlarge Mirror Lake to 28.4 Mgal total, add Siegel Pond (22 Mgal), 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	28.4	3,500	0.80	2,000	0.80	10,000	NA	0.0	0	279	58.6%	377	79.3%	129.0	66.5%	165.2	85.2%	**Addition of Siegel Pond provides a substantial increase in availability of water to meet demand, but does not attain the 80/80 target.** **preferred scenario - 193 Ac coverage**
H4C-2	Potential Full Build-Out: upgrade the Cold Brook Intake (5,000 gpm pump), no longer shared with Mt Snow, new conservation flow; install proposed Haystack Brook Intake (3,500 gpm pump), enlarge Mirror Lake to 28.4 Mgal total, add Siegel Pond (22 Mgal), 193.3 Acres of snowmaking terrain coverage	476	194	0.80	100%	28.4	5,000	0.80	3,500	0.80	10,000	NA	0.0	0	279	58.6%	377	79.3%	129.0	66.5%	165.8	85.5%	above scenario but with larger pumps - no significant benefit

1 Total Mirror Lake Volume (Including combined Haystack & Mt. Snow portions for scenarios where it is shared)
2 Total Withdrawal Rate (Including combined Haystack & Mt. Snow portions for scenarios where it is shared)