The State of New Hampshire
Department of Environmental Services

Robert R. Scott, Commissioner

March 14, 2023

Transmitted via Email to peter@tuckermancapital.com

Peter Milliken
Friends of Oak Hill
PO Box 441
Hanover, NH 03755

Subject: Water Conservation Plan Approval
Hanover – Oak Hill Cross Country Ski Center

Dear Peter Milliken:

On March 9, 2023, the New Hampshire Department of Environmental Services ("NHDES") Drinking Water and Groundwater Bureau received a Water Conservation Plan (the "WCP"), signed on March 9, 2023, for Oak Hill Cross Country Ski Center, located in Hanover, New Hampshire. Pursuant to RSA 485:61 and Env-Wq 2101, an applicant for a withdrawal from a surface water source associated with a project that requires a water quality certification pursuant to Section 401 of the federal Clean Water Act shall submit a water conservation plan to NHDES. Based on review of the WCP, NHDES has determined that the WCP complies with Env-Wq 2101, *Water Conservation* rules.

Pursuant to Env-Wq 2101.25, the Town of Hanover and the Upper Valley Lake Sunapee Regional Planning Commission were provided a copy of the WCP.

NHDES approves the WCP based on the following conditions:

1. No later than initiating a withdrawal from the source, a meter shall be installed to measure the volumes of water withdrawn from the source.

2. All meters shall be installed and maintained in accordance with the manufacturer's specifications and the American Water Works Association's M6 manual and relevant standards.

3. No later than initiating a withdrawal from the source, the source meter shall be read monthly, no sooner than 27 days and no later than 33 days from the last meter reading.

4. No later than initiating a withdrawal from the source, monthly source production volumes shall be reported to the NHDES Water Use Registration and Reporting Program on a quarterly basis in accordance with Env-Wq 2102. NHDES will assign the facility a Water Use Identification Number and provide instructions for registering as a data provider and utilizing the NHDES OneStop reporting tool.

5. All water conservation best management practices described in the WCP shall be implemented within 5 years of the date of this approval.

6. Every 3 years from the date of this approval, an ongoing compliance report shall be submitted to NHDES documenting how the system has maintained compliance with the WCP and Env-Wq 2101.

Please contact me with any questions at (603) 271-0659 or via e-mail at waterconservation@des.nh.gov.

Sincerely,

Kelsey Vaughn
Water Conservation Program
Drinking Water and Groundwater Bureau

ec: Tyler Phillips; Headwaters Consulting, LLC *(tyler@headwatersconsults.com)*
Alex Torpey; Town of Hanover *(alex.torpey@hanovernh.org)*
Meghan Butts; Upper Valley Lake Sunapee Regional Planning Commission *(mbutts@uvlsrpc.org)*
James Tilley, Christina Rambo; NHDES

Friends of Oak Hill
Oak Hill Cross Country Ski Center- Hanover, NH

Water Conservation Plan

Revised 3/9/2023

Introduction and Purpose

As part of the Water Quality Certification requirements for snowmaking water withdrawals, a facility must develop a Water Conservation Plan (WCP). This WCP was prepared in accordance with Env-Wq 2101.19 and Env-Wq 2101.20 and is intended to satisfy those requirements. The purpose of this WCP is to ensure efficient utilization of water resources (both potable water and raw water withdrawn for snowmaking purposes). Although the present facility does not have potable water service, the usage of water for snowmaking provides some opportunities to get the most out of the water withdrawn from Storrs Pond.

Facility Contact Information

Friends of Oak Hill
c/o Mr. Peter Milliken
PO Box 441
Hanover, NH 03755-2053
(802) 384-8694

Project Description

This project involves the total withdrawal of approximately 5 million gallons of water throughout the winter (November to March) from Storrs Pond for making machine-made snow to distribute on approximately 8.4 acres of land located on the Storrs Pond Recreation Area and the Oak Hill Ski Area Lands for a 3.3-kilometer cross-country ski trail loop. Snowmaking will only be performed when there is insufficient snow on the ground for grooming of the trails.

Pond water will be withdrawn through an intake screen that is connected via a subsurface pipe to a wet well that houses two (25-30 HP) submersible pumps. This structure is known as a submersible pump vault. These submersible pumps located in the single submersible pump vault will lift water approximately 60 vertical feet to the pumphouse located near the Oak Hill parking lot. The existing groomer shed is being repurposed to serve as a pumphouse that will house two (150 HP) horizontal centrifugal pumps and air compressor(s). This pumphouse will pressurize the water to that which is necessary for making quality snow at the snow guns. There will be two distinct distribution loops (North Loop and South Loop as seen on the attached *Draft Preliminary Snowmaking Pipeline Layout*), and pressurized water from the pumphouse will be routed through a new valve house, where valves will be used to direct snow to the desired loop. There will be approximately 10,000 feet of steel piping of various diameters to distribute water along the loops. The snow guns will be moved around the snowmaking distribution system and connected to the system at various fixed hydrant locations. The location of the hydrants will be field-determined during construction.

Water withdrawals will be measured by a flow meter at the pumphouse and will meet requirements of Env-Wq 2101.19(c) and (d). The meter will be either a Fuji Delta C ultrasonic meter (+/-1.5% of reading) or a Signet insertion mag meter (+/-1% of reading). Because there is no storage of the water withdrawn for snowmaking, a second meter at the point that water enters into the snowmaking system, which is required per RSA 488:4-a, will not be needed.

It is anticipated that the facility will operate a Davis Vantage Pro weather station for use in monitoring weather.

The South Loop has a dead-end section that could allow water to freeze in the pipes if such water does not move (please see attached *Draft Preliminary Snowmaking Pipeline Layout*). As such, several snow guns will be connected and always in operation at the end of this dead-end pipe when this South Loop is receiving water. To keep the North Loop from freezing when it is used to make snow, it will require the release of between 50-100 gpm of water back into Storrs Pond, where it will be co-mingled with water that is withdrawn through the intake screen and lifted to the pumphouse for pressurization and used for snowmaking on this North Loop.

Water remaining in either the North or South Loop at the end of a snowmaking session will be drained from piping at 5 low points and at the intake (another low point). A small, stone-filled sump will be constructed at each of the low points to capture and infiltrate the volume of drainback water (typically 350-800 gallons) into the ground. Drainback water that cannot be drained to one of these 5 low points at the end of a snowmaking session will be released back to Storrs Pond at the intake screen, and each drainback event is estimated to release 4,800 gallons for the South Loop and 2,500 gallons for the North Loop.

Appendix I -Oak Hill XC Facility Snowmaking Concept Design From Dartmouth's Oak Hill Master Plan-June, 2020 is attached to provide general information about potential equipment and operations. It is a general reference and not intended to reflect the final equipment or operations for this facility. Once the final equipment and operations are determined, this water conservation plan can be revised to document them, and that attachment can be removed.

Water Conservation Approach for Snowmaking

The following Best Management Practices will be followed to wisely use the water withdrawn from Storrs Pond for snowmaking:

- <u>Check weather forecasts</u> well in advance of a snowmaking session to ensure that a sufficient block of time with suitable wet bulb temperatures exists to make quality snow, rather than making slush at the tail end of a snowmaking session because personnel were not available to adjust snow guns during marginal snowmaking conditions. Longer snowmaking sessions also mean that a smaller proportion of the water withdrawn for the snowmaking session is lost to the ground from system drainback at low points.

- <u>Orient snow guns</u> to get the greatest throw (and therefore snow crystal nucleation), while taking care not to unnecessarily blow too much snow in the woods or outside of the desired area to be covered.

- <u>Make frequent checks on snow quality</u> and adjust orientation to account for changes in wind direction that may affect snow deposition areas (particularly in open areas, such as the stadium).

- Develop a system to address observed leakages at fittings and guns. This may include numbering the hydrants so that a noted problem area can be easily found by other staff during a non-snowmaking period to repair leaks or bringing a roll of flagging to flag problem locations when out on patrol of the system during snowmaking operations so that they can be easily found and repaired when the system is shut down.

- Address wet trail areas. Making snow on areas that pond water or have a groundwater table close to the trail surface can require more snow than areas without such wetness. Note such areas during the season and identify the source of the problem once the snow is melting or has melted. Perhaps ponding can be addressed by re-establishing a crown or cross slope on the trail tread to direct water off of such areas. Maybe a culvert or ditch is blocked or has accumulations of material that can be removed to restore free-draining conditions.

Water Conservation Approach for Potable Water

The present facility is not serviced by municipal or private potable water supplies; however, if future improvements are made to the facility which might add fixtures (sinks, toilets, showers, etc.), such fixtures should carry the Water Sense labelling (see https://www.epa.gov/watersense for details). EPA administers this program, which is similar to the Energy Star program, and there are a number of common-sense tips presented on their website to help save water and money.

Revisit this Water Conservation Plan

With any process, it is important to review what works and what doesn't, so that a process can evolve and improve. The following is a list of things to consider:

- Review this WCP at the end of the season to make notes or a to-do list when potential improvements are fresh in the mind.

- Review this WCP and notes prior to the beginning of the season, so that to-do items can be addressed before the demands of system operation limit one's availability to make improvements.

- Remember that water that is pumped and not used efficiently has costs not only in the electrical costs used to pump water, but in compressor operation costs and staff time. Make a difference for the environment and in your budget by looking for ways to maximize the value in the snow that is made.

I certify that I have read this water conservation plan, understand the responsibilities of the facility as referenced in the plan, and that all information provided is complete, accurate, and not misleading.

Owner Name (print): Peter H. Millken

Owner Signature: [signature] Date: 3/9/23

ATTACHMENTS

Draft Preliminary Snowmaking Pipeline Layout
&
Appendix I -Oak Hill XC Facility Snowmaking Concept Design
From Dartmouth's Oak Hill Master Plan- June, 2020


NOTES / LEGEND
Surface/Shallow Bury Pipe
Buried Pipe
Low Point Drain
Scale 1" = 100'
North Loop
South Loop
Low Point Drain Location 4 350 gallons
Low Point Drain Location 1 800 gallons
Low Point Drain Location 3 600 gallons
Low Point Drain Location 2 450 gallons
Pump and Compressor house
Main System Drain
South Loop Drain back 4,800 gallons
No recirculation during operation
North Loop Drain back 2,500 gallons, 50-100 gpm recirculation during operations
Feed line to Pump and Compressor House
Submersible Pump Vault
Snomatic Controls and Engineering Inc.
SNO.MATIC
Green Mountain Building
4 Britton Lane
Lyme, NH 03768
Phone: (603) 795-2900
Fax: (603) 795-2910
www.snomatic.com
Email: info@snomatic.com
PROJECT TITLE
Oak Hill
DRAWING TITLE
Preliminary Snowmaking Pipeline Layout
Project no. XXX.X
Drawn by J. Wilkinson
Date 1/25/2023
Scale 1" = 100', Arch D SIZE
Drawing no. Oak Hill 2022 Upper PH alternative
Sheet no.

Appendix I.
Oak Hill XC Facility
Snowmaking Concept Design

Background

Dartmouth College is developing a Concept Design and Master Plan on the proposed upgrade of the Nordic trails on the Oak Hill property. The objective of this upgrade is to provide a quality Nordic venue capable of hosting NCAA championships as well as providing a reliable winter recreation opportunity for students, faculty, and community members. To accomplish this objective, snowmaking operations will be required to ensure reliable snow cover on the Nordic trails. This analysis outlines the recommended concept design for a snowmaking system on the Oak Hill property that will cover approximately 3.0 km of trail as well as a stadium area at the entrance of the venue.

Water Requirements and Supply

The Nordic trails will range from 7-9 m wide, which results in an area of approximately 24,000 m^2 or 6 acres that need to be covered. The stadium adds approximately 1.9 acres for a net of 7.9 acres. With an initial coverage depth averaging 2', this will require 2.4 million gallons of water to be converted to snow. Subsequent refreshing of the snowpack will require approximately 1.6 million gallons for a seasonal expected total water consumption of 4 million gallons.

Two water sources were considered to supply this requirement:

1. Storrs Pond, an approximately 13.5 acre[1] reservoir at the base of the Nordic venue
2. Municipal water, drawn from a main pipeline that runs down Reservoir Road from the Hanover Reservoir.

Of these two options, Storrs Pond has been selected based on the following considerations:

1. There is ample water to satisfy snowmaking needs. There is 4.4 million gallons of water in the top 12" of the pond. The pond is fed by springs, a few tributaries, and the outflow from the Hanover Reservoir. During late November and December when the snowmaking system will be primarily operated, the College is not in session and the demand for municipal water is low. The town of Hanover has indicated that if natural inflow to Storrs pond is not sufficient to maintain acceptable water level, additional water can be released from the Reservoir to compensate for snowmaking withdrawals. Because of the short duration of snowmaking operations (expected 2-3 weeks), any minor drop in the reservoir level would soon be restored.

2. Water from the pond is not chlorinated. Chlorination has a negative impact to the snowmaking process (inhibition of nucleating particles), and is an unnecessary expense for snowmaking operations.

[1] Estimated based on mapping and aerial photography

3. Water from the main pipeline would need to be purchased from the municipality, creating an annual operating cost that could be significant.

Snowmaking Technology

There are 2 types of snowguns that have been used in other Nordic venue snowmaking systems:

1. Low Air consumption "stick" guns that mix compressed air and water to create snow. These guns have a series of water nozzles that create a bulk water spray, and one or several nucleating nozzles that used compressed air to create seed ice particles. When this nucleation spray impinges on the bulk water spray, the water droplets in the spray start the freezing process. Stick guns are available with very concentrated plumes which are ideal on the relatively narrow trails of a Nordic center. In most installations, a compressed air pipeline and water pipeline are constructed on the side of the trail to supply the snowguns.

2. Fan guns which are much larger than stick guns and generally have a less concentrated plume. Fan guns use a large ducted fan which blows high velocity air into a water spray to distribute the droplets over a wide area. Fan guns generally have on-board compressors to generate a nucleating spray which, as in the stick guns, impinges on the bulk water spray to enhance freezing. Fan guns require power (typically 15-25 HP per fan), with most installations running power instead of a compressed air line.

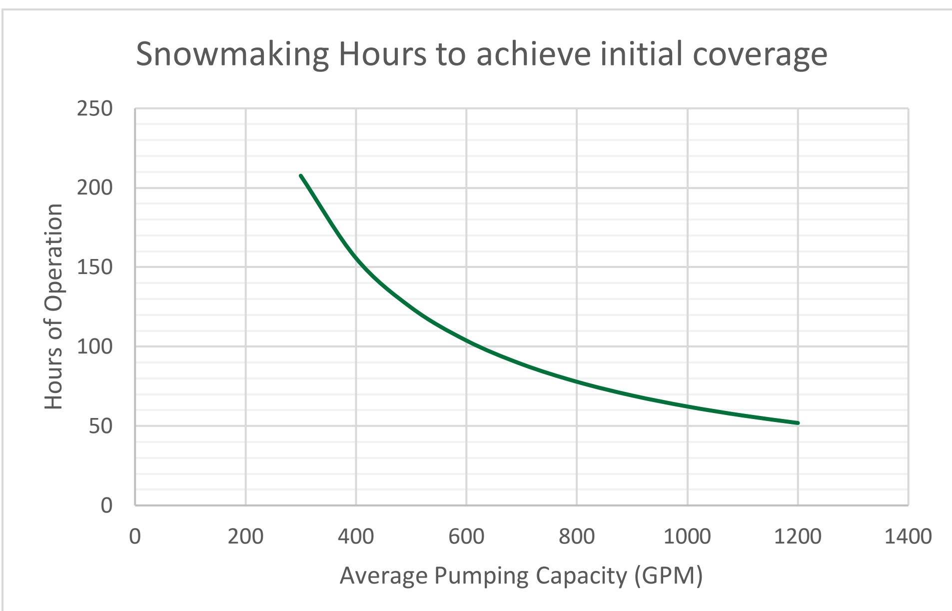
Fan guns are best suited for wider, open areas and are often used in Nordic stadium areas or to make large piles of snow that are subsequently trucked out to the trails and spread with a manure spreader. Stick guns are best suited for narrow trails, and have been used at most “make in place” Nordic snowmaking systems (Rikert, Quarry Road/Waterville). Both types of guns have generally similar energy efficiency characteristics.

Stick guns were selected as the basis for the snowmaking design at Oak Hill for the following reasons:

1. They are best adapted to the narrow trails occurring in the vast majority of the trail network.
2. They are relatively low cost so that a number of guns can be purchased and spread out over the trail network to minimize (or eliminate) the need to move guns from one position to another.
3. While fan guns have the edge in marginal snowmaking temperatures (above 25 deg), there should be ample time for snowmaking operations below this temperature to provide snow coverage by early to mid-December.

Required Snowmaking Capacity

The selection of snowmaking capacity (pumping capacity, compressed air capacity, snowgun number) is a process of balancing capital cost against the required time to achieve coverage. The following graph compares the hours snowmaking must operate to achieve coverage against the average pumping capacity of the system.



To assess expected snowmaking conditions at the site, a temperature study was completed using daily max/min temperature data from a NCDC coop recording station located in Hanover. Hourly temperature values were interpolated from this data to estimate the number of hours below or between various temperature values. The results indicate that from 11/15 to 12/15, there are 146 hours with temperatures below 26 deg on an average year. In 8 out of 10 years there are at least 88 hours (statistical percentile calculation). From Figure 1, it is apparent that with 88 hours available, the average pumping rate of the system needs to be slightly more than 600 gpm to complete coverage.

Wet Bulb Temperature bin Distribution (Hours below Temperature)

	Between 11/15 and 12/15						Between 12/16 and 12/25				
	<28	<26	<24	<22	<20		<28	<26	<24	<22	<20
2010	286	226	175	138	97		182	166	138	109	85
2011	83	51	29	18	8		140	129	112	92	77
2012	172	112	51	14	5		63	48	34	18	8
2013	242	192	146	122	103	Note 1	126	113	101	87	72
2014	239	168	121	86	49		50	28	20	12	7
2015	78	51	31	19	9		17	8	2	0	0
2016	149	113	90	71	44		142	122	112	103	84
2017	195	138	103	81	68		173	155	137	107	91
2018	313	279	237	179	137		108	90	69	49	33
2019	279	207	147	98	66		166	146	122	101	88
Average	**194**	**146**	**106**	**76**	**54**		**109**	**93**	**79**	**63**	**51**
8 in 10 Yr	**123**	**88**	**43**	**19**	**9**		**58**	**40**	**28**	**16**	**8**

Note 1…data missing 11/26 to 12/4 in 2013

Wet Bulb Temperature bin Distribution (Hours between Temperature Bins)

Year of	Between 11/15 and 12/15						Between 12/16 and 12/25					
Record	**28 to 26**	**26 to 24**	**24 to 22**	**22 to 20**	**<20**	**Total<26**	**28 to 26**	**26 to 24**	**24 to 22**	**22 to 20**	**<20**	**Total<26**
2010	60	51	37	41	97	226	16	28	29	24	85	166
2011	32	22	11	10	8	51	11	17	20	15	77	129
2012	60	61	37	9	5	112	15	14	16	10	8	48
2013	50	46	24	19	103	192	13	12	14	15	72	113
2014	71	47	35	37	49	168	22	8	8	5	7	28
2015	27	20	12	10	9	51	9	6	2	0	0	8
2016	36	23	19	27	44	113	20	10	9	19	84	122
2017	57	35	22	13	68	138	18	18	30	16	91	155
2018	34	42	58	42	137	279	18	21	20	16	33	90
2019	72	60	49	32	66	207	20	24	21	13	88	146
Average	**49**	**40**	**30**	**22**	**54**	**146**	**16**	**14**	**16**	**12**	**51**	**93**
8 in 10 Yr	**33**	**23**	**16**	**10**	**9**	**88**	**12**	**9**	**9**	**8**	**8**	**40**

The design maximum pumping capacity for the system has been increased to 1,000 gpm for the following reason:

1. In order to achieve an average rate of 600 gpm, a higher maximum rate is required due to start-up/shut down times, and the fact that the flow through the snowguns will be lower during marginal snowmaking temperatures and higher during temporary periods of colder temperature.

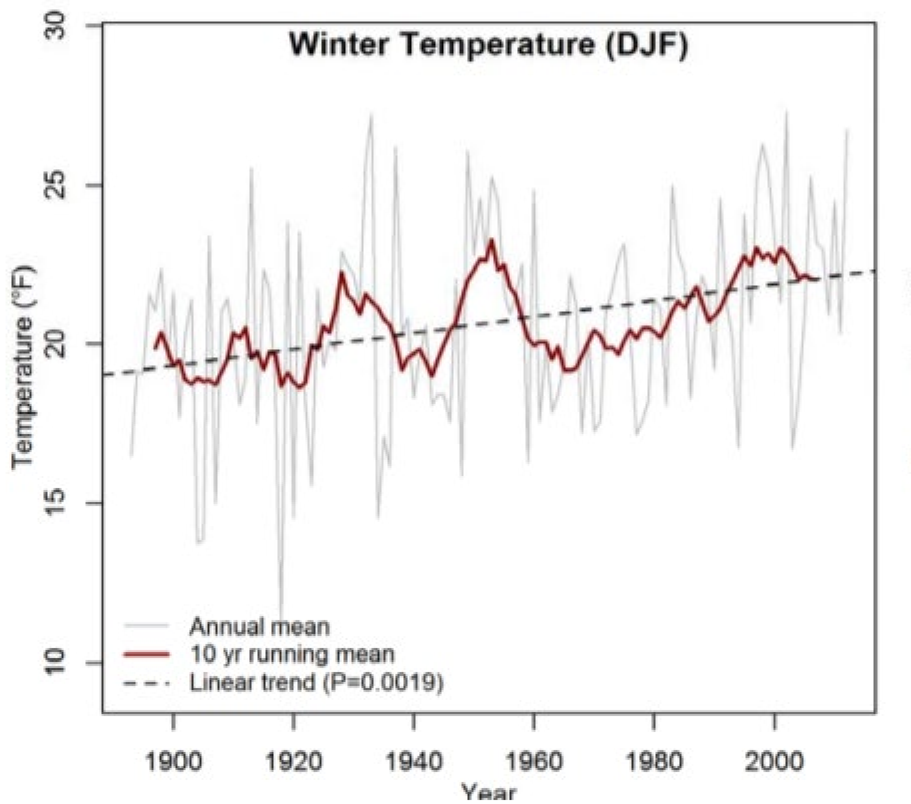
2. The temperature analysis includes hours where the temperature only dips down during short periods. These short periods are not likely to be captured due to the operating constraints of getting the system on-line.

3. The incremental cost of higher pumping capacity is very low compared to the overall cost of the snowmaking system.

Impact of Climate Change

It is difficult to accurately project the impact of future climate change on snowmaking operations at Oak Hill because climate projections generally focus on average temperature values which do not necessarily translate to the number of hours below a threshold temperature.

However, to gain a rough estimate of potential impacts, projections were used from a 2014 analysis by Nicholas Fisichelli using data from the Hanover NH weather station. (NPS Climate Change Response Program https://irma.nps.gov/Datastore/DownloadFile/512640). This analysis includes the following graph of historical winter mean temperatures (DJF).



By visually extending the linear trend line provided in this graph, it appears that mean winter temps will remain below 26 deg for 50+ years. When the running mean (or an annual mean) reaches the 26 deg threshold, by definition the temperature will be lower than 26 deg 50% of the time which should allow snowmaking to continue. It should be noted that 26 deg is used as the threshold for making snow in this analysis. That threshold is more of an economic than physical threshold; it is possible to make snow at

28 or even 30 degrees (or higher during low humidity periods) but the low production rates make it not worth the effort and expense. As temperatures rise, it may become worth the effort which will result in higher energy and labor costs, but not eliminating the ability to make snow all together.

The referenced analysis projects that average temperatures will rise 3-5 degrees by 2050 and 5-8 degrees by the end of the century. If that average rise corresponds with winter temperatures, the hours occurring below 20 deg presently will reflect the conditions when averages have increased by 6 degrees. Under this condition, there will be enough hours to produce the desired snow by Christmas during an average year, but not enough hours in 2 out of 10 years. During those years, coverage would be delayed into January, still affording a reasonable amount of time for racing and recreation at the facility.

It should be noted that climate science is a complicated subject; if necessary, more refined calculations regarding potential snowmaking impacts would need to be performed by a qualified climate scientist.

Design Configuration

The various facets of the proposed snowmaking design are described below:

1. Pumping/Compressors
    a. An underground vault will be constructed at the edge of Post Pond slightly to the north of the existing Byrne Pavilion.   This vault will be roughly 4' x 6' with the top of the vault about 12" above ordinary high-water level of the pond. This vault will be fed by a PVC water line that runs out into the pond far enough to mount an intake that is in approximately 6' of water. Two 15 HP submersible pumps will be installed inside the vault to direct water to the main pumphouse located further on-shore.

    b. A main pump/compressor building is proposed that is located about 350' from the intake vault. This location is central to the piping loops, and will house 2 horizontal, centrifugal pumps, each with the capacity to deliver 500 gpm of water at 515 psi. The main pump/compressor building will be approximately 22' x 32', which provides limited space for gun and hose storage.

    c. Compressed air will be supplied by rented electric compressors that will be located outside the main pump building. These compressors are supplied on wheels, and will be rolled up to a piping manifold installed on the exterior wall of the pump building. The pumphouse will be located so that if Dartmouth opts in the future to purchase compressors, they building could be extended by 10' and house compressors inside. Electric compressor rental costs at present range between $4-$4.50/cfm-month with a minimum 2 month rental. Two 900 cfm compressors are recommended.

2. Piping
    a. Two main loops of piping have been designed to service the northern and southern trail sections. Each loop runs up to a high point of the trail network, then back downhill to return to the pumphouse. This eliminates the need for drainage points at low points along the piping loop. Several spur lines have been designed to extend snowmaking coverage to trail areas outside of the main loop.

b. For the most part, piping has been designed to ensure that hydrants are located on each segment of trail. There is one exception where the close proximity of trail section allows coverage from a common pipe.

c. Giving the undulating characteristics of the trails, there will inevitably be areas where it is not possible to maintain a continuous grade for drainage. If grade cannot be maintained by trenching or elevating the pipe, a special hydrant attachment will be installed at the low points that will draw water out of the bottom of the pipe when the water pipelines are blown out with compressed air at the end of an operating cycle.

d. Piping will be located on the edge of the trail corridor; shallow buried where possible (1-3' coverage) and surface laid or "scratch buried" on the upper portions of the trail where rock precludes deeper burying. Vertical hydrant risers will be installed every 125' on the top of the pipe. The pipe will be routed to minimize hydrant locations in "fall zones" (outside corners of downhills); if necessary, provisions can be added to remove the hydrants after snowmaking operations have been completed.

e. Each piping loop returns to the pumphouse so that water can be continuously circulated through the piping and run back to the pumphouse. During marginal snowmaking temperatures (above 20 deg), both loops can be operated at the same time; during colder periods only one loop will be operated.

f. Several valving stations are proposed to allow operations on only part of the trail if desired. This will also allow snowmaking operations to continue if a groomer mistakenly damages a hydrant on the second half of the piping loop.

3. <u>Snowguns</u>
   a. Snowguns can be mounted on mobile sleds or fixed on small posts located at the side of the trail. To minimize labor requirements, fixed mount guns are proposed for the majority of hydrant locations. The guns will be supplied with swing out brackets that allow the gun to be rotated about 5' into the trail. For the initial installation it is proposed that guns be purchased for roughly half of the fixed mount locations. Once snowmaking operations have been completed on one piping loop, the gun will be relocated to the mounts on the second piping loop.

   b. Mobile guns will be provided for areas where fixed posts are not appropriate and to fill in gaps that require multiple hose runs from the main hydrant locations

   c. In the stadium area, higher volume fixed tower guns (30') will be mounted. These guns are more effective for wider areas.

4. Operations
    a. It is anticipated that snowmaking operations will stage out of the main pumphouse area, and hose storage/thawing will be located at that facility. Snowmaking crews will need access to a warming facility in the base during the limited hours when snowmaking is in progress.

Electrical Rates/Operating Costs

The tariff charged by the electric utility, Liberty, includes the following charges:

1. An energy fee for kWH of electricity consumed each month (currently $.011/kWH)
2. A monthly "demand" fee for the highest load connected during that month (highest average 15 minute load) (currently $8.14/kW)
3. A minimum demand fee for months with little or no power use which is set at 80% of the highest demand set in the last 12 months.

There is a clause that allows a customer after the first year of usage to "elect" for an optional demand calculation it loads are considerably lower than the highest loads for a duration of at least 2 months. This requires contacting the utility on an annual basis, but would allow Dartmouth to eliminate the minimum demand fee for the 10 non-snowmaking months.

A calculation of energy costs is provided below assuming that the snowmaking system is operated during 2 months for a total of 200 hours.

Projected Electrical Operating Costs--Snowmaking

Assume	200	hrs
Pumps	400	HP
Compressors	500	HP
Total HP	900	HP
	671.4	KW
Energy Usage	134280	KW-hrs
Per kWH (Rate G1)	$ 0.1105	$/kWH
Base Energy Cost	$14,837.94	
Demand Rate	$ 8.14	$/kW
Demand Base rate	$ 5,465.20	
Credit for High Voltage Delivery	$ 0.44	$/kW
High Voltage Delivery Credit	$ 295.42	
Net Monthly Demand	$ 5,169.78	
Demand for 2 month period	$10,339.56	
Net Electric Cost--2 months	$25,177.50	
Minimum Demand Ratchet	0.8	
Minimum Demand KW	537.12	
Demand per month, non operating periods	$ 4,372.16	
Net over 10 months	$43,721.57	
Total First Year Electrical Costs	$68,899.07	
Subsequent Annual Electrical Costs (if annual election is made)	$25,177.50	
Compressor Rental 2 months, $4.50/cfm-month	$16,200.00	

Conclusion/Summary

1. A snowmaking system is proposed to cover 3.0 km of trail, with piping and coverage as outlined in Figure 1.

2. Storrs Pond has been selected as the water source due to proximity to the site. An alternative supply option using treated municipal water was abandoned due to the potential purchase cost of the water and the fact that the water would be chlorinated which impedes the freezing process.

3. The projected seasonal total water consumption for snowmaking is 4 million gallons. Storrs pond is fed by natural run off and water release from the Hanover Reservoir. The town typically has excess water during the period that snow would be made (mid-November to late December) and can supplement natural inlets to the reservoir to ensure that there is minimal change to the surface elevation of Storrs Pond.

4. The recommended snowmaking system capacity is 1,000 gpm of water pumping and 1,800 cfm of compressed air supply. This will require 2 x 200 HP water pumps and 2 x 250 HP oil free air compressors. With this capacity, the trails should be able to be covered in 75-100 hours of snowmaking operations.

5. Water for snowmaking will be pumped from a small vault located on the North side of the beach at the Byrne Pavilion/Area 1. An inlet pipe will be run from this vault to a point in the pond that is approximately 6' deep. The approximate size of the vault is 4' x 6'. Submersible pumps in this vault will direct water to the main pumphouse located adjacent to the entrance to the Byrne Pavilion area. This structure will be approximately 22' x 32' and will house two horizontal pumps that generate snowmaking pressures. This structure will provide limited space for hose and gun storage as well.

6. Compressed air will be supplied by 2 x 900 cfm rented electric, oil free compressors. These compressors are supplied on wheels and will be connected to a piping manifold mounted on the side of the pump building. These compressors will be rented for 2 months and subsequently removed. This will require temporary wheeled access to the pumphouse location at the end of the snowmaking season

7. The piping system runs in predominantly 2 large loops with water running back to the pumphouse for circulation. Pipe will be shallow or "scratch" buried wherever possible.

8. Snowguns will consist primarily of low air consumption "stick" guns mounted on posts drilled on the side of the trails. Mobile sled mounted guns will be used in areas where posts could present a danger to skiers. An optional fan gun has been included for the stadium area.

9. The estimated capital cost of the snowmaking installation is $2.0 million. At present electric rates, the cost of electricity to operate the system each year will be approximately $31,000, though first year costs will be significantly higher ($84,000)