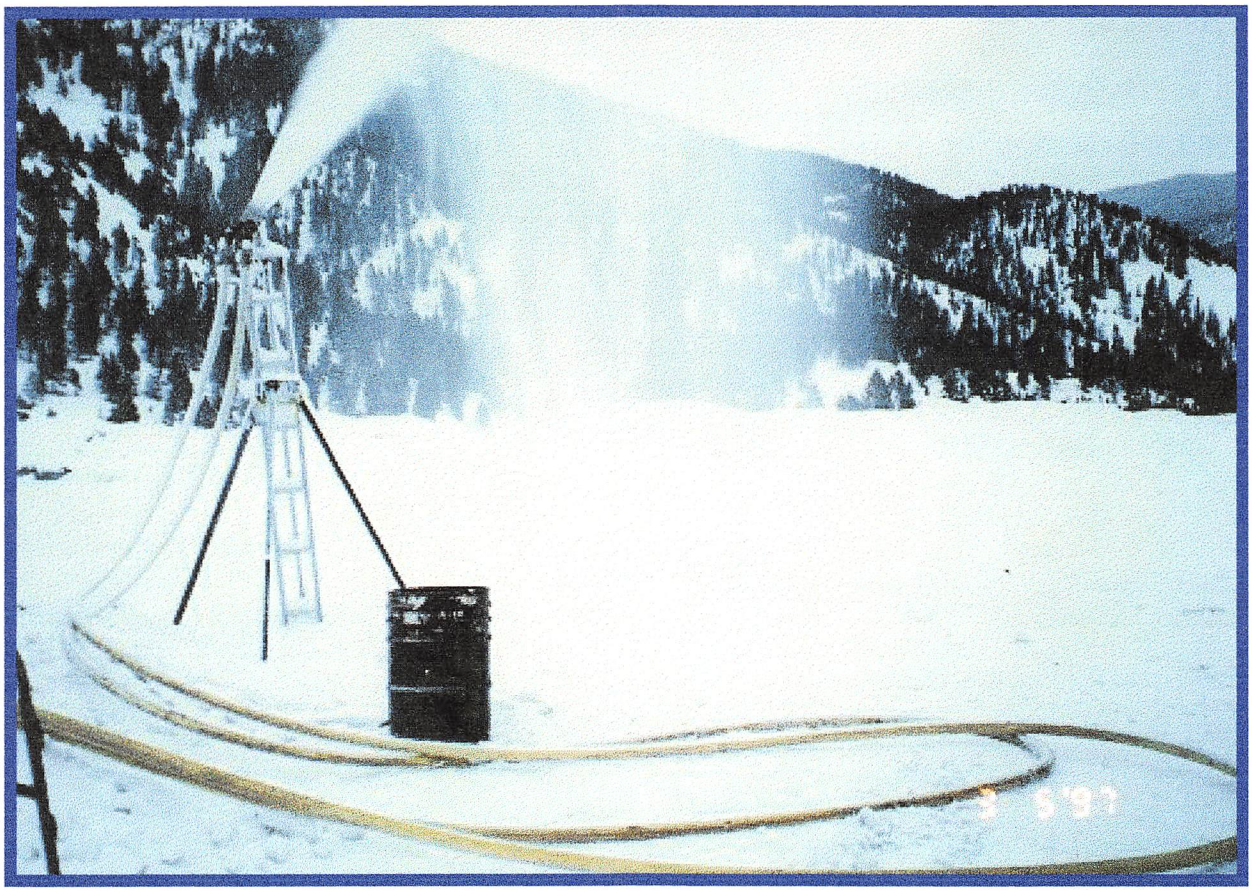
WATER QUALITY MONITORING PLAN FOR SNOWMAKING AT THE BIG SKY MOUNTAIN SITES



Prepared for:
MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
and
BIG SKY COUNTY WATER & SEWER DISTRICT #363
GALLATIN COUNTY, MONTANA

Prepared by:

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March 1999

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March 8, 1999
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Mr. Todd Teegarden, P.E.
P.O. Box 200901
1520 East Sixth Avenue
Helena, MT 59620-0901

RE: Big Sky Mountain Sites: Snowmaking Water Quality Monitoring Plan

Dear Todd:

Enclosed is a Draft copy of the Water Quality Monitoring Plan for the newly proposed Big Sky snowmaking sites for your review and comment. Please feel free to contact me if you have any questions or comments.

Sincerely,

MSE-HKM, INC.

Travis P. Teegarden

Travis P. Teegarden, P.E.
Agricultural Engineer

Enclosure

cc: Terry Webster, DEQ Permitting Division
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

WATER QUALITY MONITORING PLAN FOR SNOWMAKING AT THE BIG SKY MOUNTAIN SITES

BIG SKY COUNTY WATER & SEWER DISTRICT #363 GALLATIN COUNTY, MONTANA

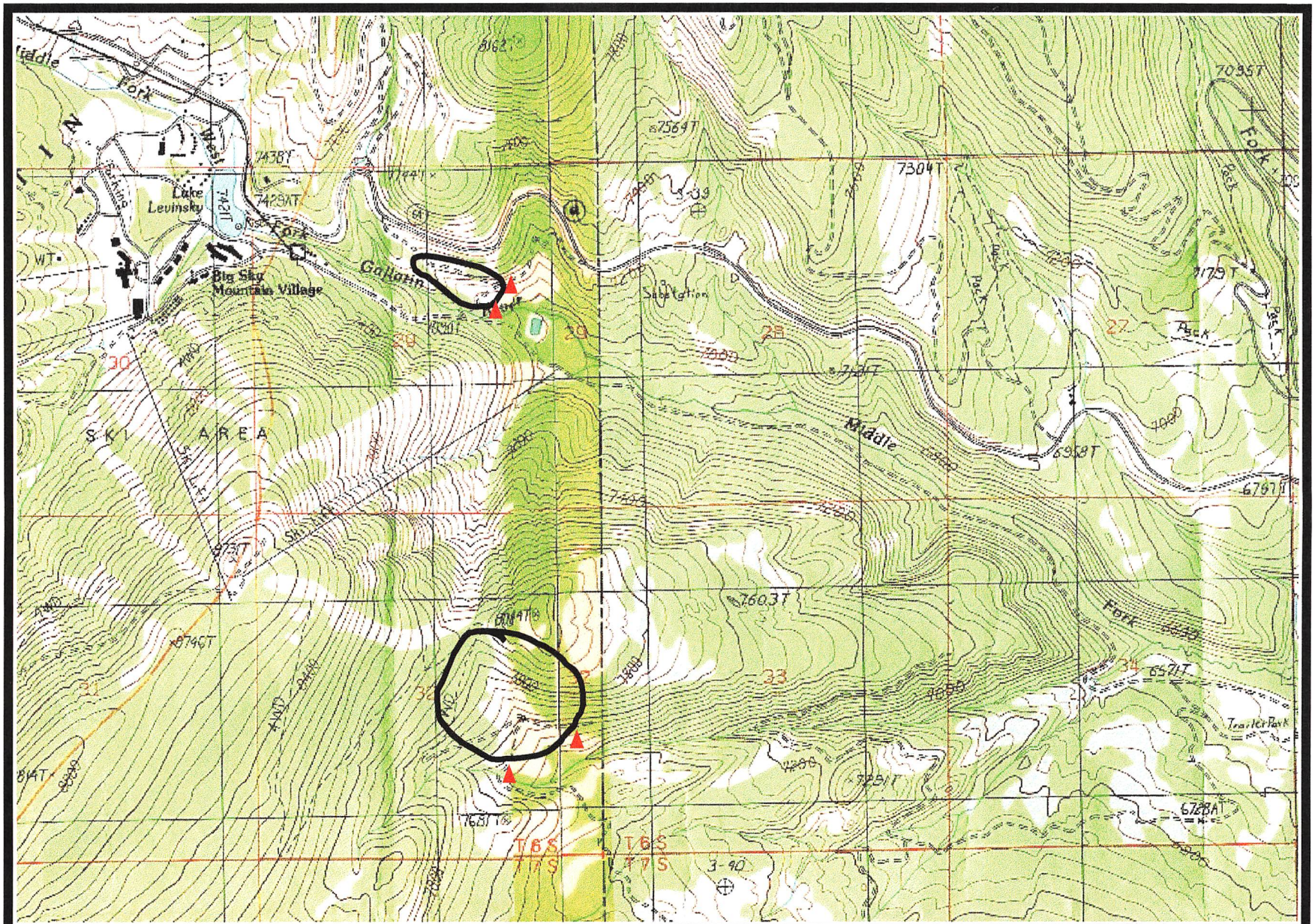
INTRODUCTION

Big Sky Water and Sewer District #363 is finalizing plans to land apply sanitary wastewater effluent using snowmaking from the Big Sky Mountain Ski and Summer Resort facilities. The plan is for wintertime land application using the freeze crystallization process. During the environmental review process, the Permitting Section of MDEQ determined that, per Section 17.30.1022 of the groundwater regulations ("Exclusions from Permit Requirements"), snowmaking at this site is considered exempt and that a groundwater discharge permit is not required for this project.

The proposed snowmaking sites cover approximately 22 acres located in Sections 29 and 32, Township 6 South, Range 3 East (see Figure 1). This document is the water quality monitoring plan for the snowmaking sites.

BACKGROUND

In 1993, just prior to the vote to create Big Sky Water and Sewer District #363, the Montana Department of Health and Environmental Sciences (DHES) issued a Compliance Order that restricted the District from issuing further permits to connect to the sewage system without prior approval from the DHES. The moratorium was the result of deficiencies in the sewer and wastewater facilities and due to the fact that the effluent was being applied to the Big Sky Golf Course that did not meet DEQ standards.



PROPOSED SNOWMAKING AREAS

PROPOSED MONITOR WELLS

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USGS MAP OF ALTERNATIVE SNOWMAKING SITES

FIGURE 1

MSE-HKM prepared an Interim Action Work Plan (IAWP) that outlined short-term solutions necessary to comply with DEQ's requirements. The short-term improvements have been made and solutions to the Long Term Compliance Work Plan are currently being addressed. The long-term plans include further expansion and rehabilitation of the Big Sky wastewater facilities. Part of the future plan is to expand land application of wastewater to include snowmaking on the mountain sites shown in Figure 1.

OBJECTIVES

The purpose of this document is to outline the initial monitoring plan to ensure that snowmaking with treated effluent will not degrade the environment. Although the majority of the nutrients delivered through the snowmaking system will be treated in the freeze crystallization process, some will remain in the snowpack and also in the meltwater. Of the nutrients remaining after the snow melts, most will be utilized by the vegetation on the site. However, minor quantities may pass through the soil profile and leach to the groundwater. The monitoring components included in this plan will assure that Montana's non-degradation rules are being satisfied (i.e. the groundwater is not impacted by leaching nutrients). The monitoring plan proposed herein will provide data throughout the year to document water quality of the snowmaking area and any influence to the surrounding areas.

WASTEWATER TREATMENT SYSTEM

The wastewater consists of sanitary flows from the Big Sky Mountain Village area, associated facilities, condominium units and other residential housing. The proposed Mountain Village wastewater treatment and disposal system will utilize a small, aerated lagoon or mechanical treatment plant located in the eastern edge of Section 29 (T6S, R3E) for storage and primary treatment of the Mountain Village wastewater. The pond or plant site is located just east of the base of the Mad Wolf ski lift. A new 6 to 10 MG pond will provide storage during periods when conditions are not suitable for snowmaking. A pumping system will draw wastewater from the storage pond and deliver it via a ductile iron pipeline to the snowmaking site.

Based on data from the existing wastewater facilities at Big Sky, it is assumed that influent ammonia concentrations will contain Total Kjelkahl Nitrogen (TKN) concentrations ranging from 70 to 90 mg/l nitrogen in the lagoon. Reduction in the treatment plant will reduce the TKN by approximately 70 percent, from 80 mg/l to 56 mg/l.

Additional treatment of the wastewater effluent will be achieved through the freeze-crystallization process. Wastewater is sprayed through atomizing nozzles under high pressure and compressed air is added for atomization, projection and nucleation of the wastewater. As the droplets freeze, the contaminants are physically separated from the water but remain trapped within the center of the frozen droplet. Nutrients, such as phosphorous, are precipitated in insoluble form and will not re-dissolve into the melting snow. Nutrients and remaining organics agglomerate to the precipitating salts and are retained in the soil matrix for uptake by plants in the spring and summer.

Detailed discussion of the Snowfluent treatment process is available in literature from Delta Engineering and results of a pilot study at Big Sky, conducted in the spring of 1997, are summarized in a separate report. In general, it is expected that high levels of treatment will be achieved at the mountain site. Based on results of the pilot study, it is assumed that the Snowfluent melt water will have a total nitrogen concentration of approximately 2.4 milligrams per liter (mg/l).

SITE CONDITIONS

Site A1

This site lies at an elevation of approximately 7100 feet on a south-facing slope. Two intermittent streams that are tributaries to the Middle Fork drain the area and the river borders the site to the south. The general slopes are 6-15%, but the most desirable portion of the site (BP-3 and BP-4) is a small draw with 3-5% slopes. The soils are deep glacial tills with varying degrees of stoniness. The vegetation is small Lodgepole pine regrowth. The soil is mapped as

MacFarlane stony sandy loam. The profile studied (BP A1 1-4) are somewhat heavier textures than the typical profile description.

Four backhoe pits were dug and three ring permeameter tests were completed in the general area. Figure 2 shows the approximate locations of the backhoe pits and permeameter tests. Of the area studied, the most suitable portion is the 7.2 acres in the western portion of the study area (highlighted in Figure 2).

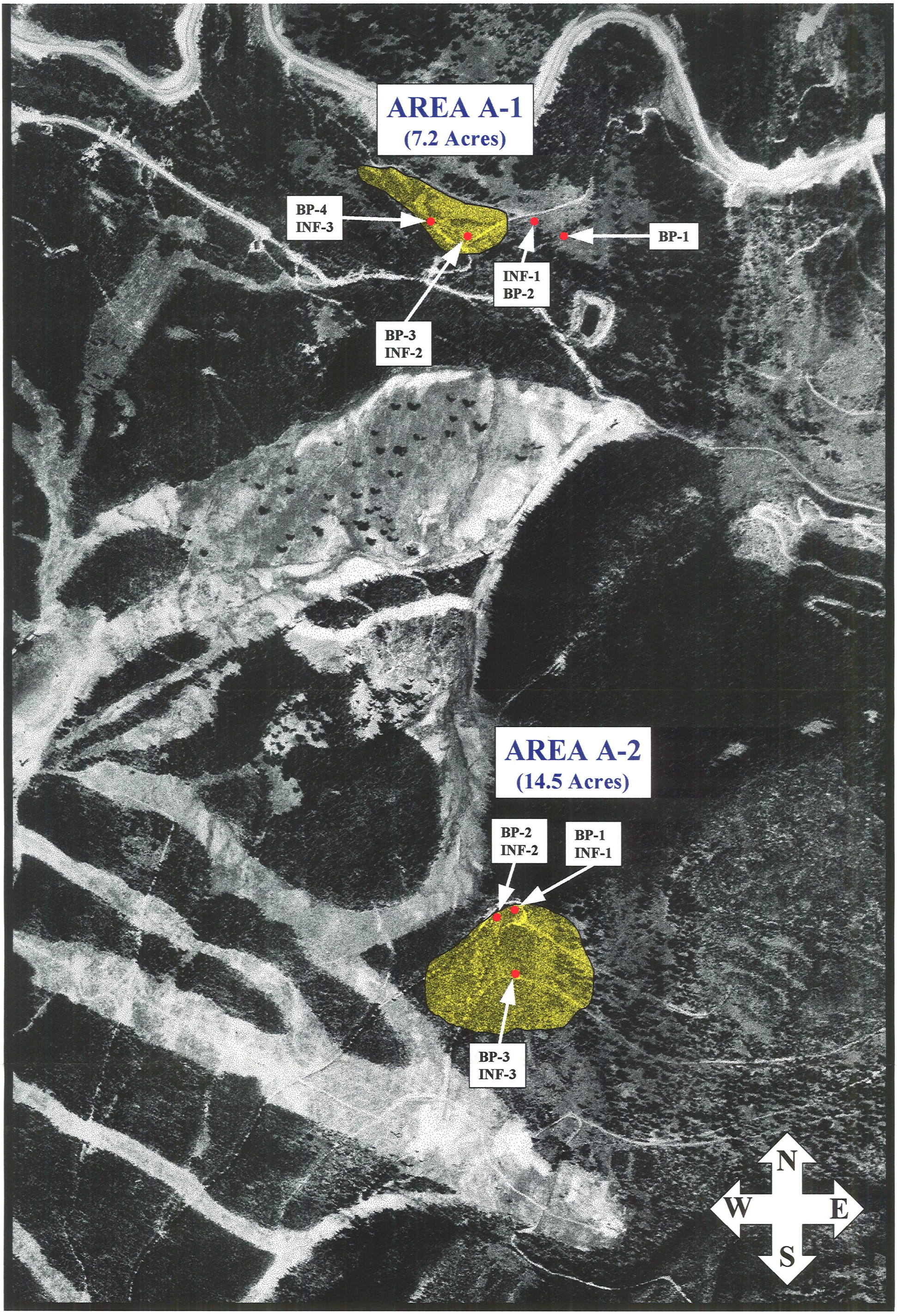
A water seep lies immediately east of BP-1. The soil profile showed many large mottles below a 24-inch depth indicating a long-term fluncuating water table. The soil was saturated and unstable throughout the profile with water f lowing into the hole at about 3 feet. Figure 3 shows a log of the backhoe pit BP-1. The eastern portion of the area is not suitable due to slopes and high water table.

The other three backhoe pits have medium textured soils, reasonable slopes and no water table (see soil logs in Figure 4-6). No bedrock or other restrictive layers that would inhibit hydraulic conductivity were encountered.

Three ring permeameter tests were completed. They are located near backhoe pits BP-2, 3 and 4 and are referred to as INF-1, INF-2 and INF-3 in Figure 2, respectively. The soils were moist due to recent snow melt, but the test sites were pre-soaked to approximate saturated flow conditions. The results are shown in Table 1.

TABLE 1
INFILTRATION RATES AT SITE A1

TEST #	LOCATION	FINAL INFILTRATION RATE
A1-1	BP-2, INF-1	10 INCHES PER HOUR
A1-2	BP-3, INF-2	12 INCHES PER HOUR
A1-3	BP-4, INF-3	10 INCHES PER HOUR



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BIG SKY MOUNTAIN SITE:
SNOWMAKING WATER QUALITY PLAN
Location of Backhoe Pits and Infiltration Tests

FIGURE 2

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LOG OF EXPLORATION HOLE
A1-1

FIGURE 3

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. : 7100.0
Drill Hole Location : AREA A-1
Total Depth : 7.0
Water Level (Date) : 3.0 (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		CLAY LOAM, (CL); dark gray-brown, crumb structure, friable, slightly sticky and plastic, moderately slow permeability, glacial till, outwash, wet, moderate stones - boulders
				1.0		SILT LOAM to LOAM, (SIL - L); dark gray-brown, sub-angular blocky structure, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, wet, moderate stones - boulders, large mottles
				3.33		GRAVELLY LOAM, (GL); dark gray brown, structurally massive, friable, sliughtly sticky, slightly plastic, moderate permeability, glacial till, outwash, more than 50% stones - boulders
				5		Hole unstable due to water seeping into hole. Water seep to east of pit
				7.0		TOTAL PIT DEPTH OF 7.0 FEET
				10		Slope 6 - 8% Clear cut Re-growth of lodgepole pine Sample #1 taken from 0.0 to .83 feet Sample #2 taken from 3.33 to 5.0 feet
				15		

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LOG OF EXPLORATION HOLE
A1-2

FIGURE 4

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. :
Drill Hole Location :
Total Depth : 9.33
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.50		LOAM to CLAY LOAM; (L - CL); gray brown, weak sub-angular blocky, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, slight stones, cobbles on surface roots to 3.0 feet
				1.67		GRAVELLY SILTY CLAY LOAM, (GrSCL); brown, weak sub-angular blocky structure, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, moist
						GRAVELLY SILTY CLAY LOAM, (GrSICL); structurally massive, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, moist fragments upto 12" in diameter increasing with depth 30 - 50% fragments
				5.0 5		GRAVELLY CLAY LOAM to CLAY, (GrCL - C); structurally massive, firm, plastic and sticky, slow permeability, glacial till, outwash, stones, fragments, cobbles, boulders increase with depth
				9.33		TOTAL PIT DEPTH OF 9.33 FEET
				10		No bedrock or water table, soil moist due to snow melt Slope 6 - 8% Clear cut Re-growth of lodgepole pine Sample #3 taken from 0.0 to .50 feet Sample #4 taken from .50 to 1.67 feet
				15		

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LOG OF EXPLORATION HOLE
A1-3

FIGURE 5

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. :
Drill Hole Location :
Total Depth : 7.17
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.50		LOAM to SILT LOAM; (L-SIL); gray brown, granular, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, moist roots to 3.33 feet
						GRAVELLY LOAM to SILTY CLAY LOAM, (GrL-SICL); brown, weak sub-angular blocky structure, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, moist, 20% stones
				2.5		GRAVELLY SILTY CLAY LOAM, (GrSICL); structurally massive, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, 10 - 20% stones, fragments
				5		
				7.17		TOTAL PIT DEPTH OF 7.17 FEET
						No bedrock or water table Slope 3 - 6% Clear cut Re-growth of lodgepole pine Pit is located on the side slope of draw
						Sample #5 taken from 0.0 to .50 feet Sample #6 taken from .50 to 2.50 feet
				10		
				15		

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LOG OF EXPLORATION HOLE
A1-4

FIGURE 6

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. :
Drill Hole Location :
Total Depth : 10.0
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.50		CHANNERY LOAM; gray brown, granular structure, friable, non-plastic, slightly sticky, moderate permeability, glacial till, outwash less soil development with increasing elevation, roots to 4.0 feet 30% fragments, moist
				1.67		CLAY LOAM to LOAM, (CL-L); red brown, weak sub-angular blocky structure, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash 10% stones, fragments, soils very consistent below 20" depth, moist
				3.33		CLAY LOAM, (CL); red brown, structurally massive, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, 10% stones, fragments, moist
						CLAY LOAM, (CL); red brown, structurally massive, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, 10% stones, fragments, moist
				5		
				7.50		CLAY LOAM, (CL); red brown, structurally massive, friable, slightly sticky, slightly plastic, moderate permeability, glacial till, outwash, 10% stones, fragments, moist
				10.0	10	TOTAL PIT DEPTH OF 10.0 FEET
						Slope 3 - 5% Clear cut Re-growth of lodgepole pine Pit is in the upper reach of a small draw
						Sample #7 taken from 0.0 to .50 feet Sample #8 taken from .50 to 1.67 feet
					15	

Site A2

This site lies at an elevation of approximately 7800 feet (800 feet above the Middle Fork) and is one mile south of the river. The selected site lies along a ridge with south facing slopes. A shallow draw runs to the northeast, which would allow the runoff to be concentrated and diked. The slopes are 3-5% along the ridge and up to 15% or more on the slopes. The vegetation is a stand of thinned Lodgepole pine.

The soils are deep glacial till soils mapped by NRCS as Shaddow very flaggy loam. As in area A-1 the soils tend to be of medium texture. No bedrock or other restrictive layers, or water table was encountered in the soils investigation except as noted in BP2A-2 (see Figure 8). Three backhoe pits were dug in the 14.5-acre site (see Figure 2). The logs are shown in Figures 7, 8 and 9.

The till derived soil profiles in this area are very heterogeneous till soils. Soil textures vary from sand to clay loams and rock fragments compose from 0 to more than 80% of the soil volume. However, contiguous bedrock was not encountered. Hole depths varied from 88 to 100 inches depending on the degree of rockiness and the stability of the pit walls. All soils were moist to wet due to snow melt and recent rain and snow, but no water tables were encountered.

All of the pits indicate that the soils are suitable as snow making sites. The glacial tills typically have extremely variable permeability rates depending on the soil texture. Backhoe pit A1-1 (Figure 7) displayed a layer of dense gray clay at about 88 inches, but this layer was not found in either of the other two backhoe pits. Since this layer seems to occur within the top ten feet only at the top of the study area it is of minor concern for water percolation.

Three ring permeameter tests were run, one at each backhoe pit location (see Figure 2). The infiltration rates are shown in Table 2.

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LOG OF EXPLORATION HOLE
A2-1

FIGURE 7

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. : 7800.0
Drill Hole Location : Area A2
Total Depth : 7.50
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.83		LOAM to SILT LOAM; (L-SIL); gray brown, weak sub-angular blocky structure, friable, slightly plastic, moderate permeability, glacial till, very irregular boundary, very heterogeneous profile, 20% fragments
						CLAY LOAM, (CL); olive, structurally massive, friable, slightly sticky, moderately slow permeability, glacial till, very heterogeneous
				3.0		CHANNERY CLAY LOAM to CLAY; olive and pink, structurally massive, plastic, slightly sticky, slow permeability, glacial till, blocky shale fragments increasing with depth - not contiguous, 0 - 30% fragments
				4.5		CHANNERY CLAY LOAM to CLAY; pink, structurally massive, plastic, slightly sticky, slow permeability, glacial till, increasing blocky sandstone, shale fragments (20 - 50%)
				5		
				7.5		TOTAL PIT DEPTH OF 7.50 FEET
						No bedrock or water table encountered Pit is in the top of a saddle in re-growth of lodgepole pine
						Sample #2A-1 taken from 0.0 to .83 feet Sample #2A-2 taken from .83 to 3.0 feet
				10		
				15		

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LOG OF EXPLORATION HOLE
A2-2

FIGURE 8

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. : 7800.0
Drill Hole Location : Area A2
Total Depth : 7.33
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	M (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.25		CLAY LOAM; (CL); olive, weak sub-angular blocky structure, hard, slightly plastic, slightly sticky, moderately slow permeability, glacial till, fill due to logging road construction
				1.0		LOAM, (L); brown, weak granular structure, friable, slightly plastic, slightly sticky, moderately slow permeability, glacial till, original A horizon, very wet due to snow melt
				2.0		VERY CHANNERY LOAM; olive, friable, slightly plastic, slightly sticky, moderate permeability, very heteogeneous in texture, blocky black shale fragments, glacial till
				3.0		SILTY CLAY LOAM to CLAY LOAM, (SICL - CL); olive, structurally massive, slightly plastic, slightly sticky, moderately slow permeability, glacial till
				5		SILTY CLAY LOAM to CLAY LOAM, (SICL - CL); olive, structurally massive, friable, slightly plastic, slightly sticky, modertely slow permeability, glacial till, extremely heteogeneous
				7.33		At 7.33 feet, gray clay, very hard, slowly permeable
						TOTAL PIT DEPTH OF 7.33 FEET
				10		Pit is located on a side slope (3 - 8%) Re-growth lodgepole pine
						Sample #2A-3 taken from .25 to 1.0 feet Sample #2A-4 taken from 1.0 to 2.5 feet
				15		

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LOG OF EXPLORATION HOLE A2-3

FIGURE 9

Project No. : 4M357.102
Project : BIG SKY SNOW MAKING
Location : BIG SKY, MT
Drill Date : 6/8/98
Drill Method : BACKHOE PIT

Surface Elev. :
Drill Hole Location :
Total Depth : 9.17
Water Level (Date) : DRY (6/8/98)
Field Logged by : R. WAPLES

SAMPLES	RECOVERY	N (%)	N	DEPTH (feet)	LITHOLOGY	GEOLOGIC DESCRIPTION
				0		
				.67		LOAM to SILT LOAM; (L-SIL); brown, weak granular structure, friable, slightly plastic, slightly sticky, moderate permeability, glacial till, moist to wet fromsnow melt
						LOAM to SILT LOAM; (L-SIL); olive, structurally massive, friable, slightly plastic, slightly sticky, moderate permeability, glacial till, moist to wet
				2.08		CHANNERY CLAY LOAM to CLAY; olive, structurally massive, firm, plastic, slightly sticky, moderately slow to slow permeability, glacial till
				5		
				5.83		STONEY, CHANNERY CLAY LOAM to CLAY; olive, structurally massive, plastic, slightly sticky, moderately slow to slow permeability, glacial till, up to 80% stones and fragments
				6.67		SANDY CLAY LOAM, (SCL); olive, structurally massive, friable, slightly plastic, slightly sticky, moderate permeability, glacial till, stones throughout
				9.17		TOTAL PIT DEPTH OF 9.17 FEET
				10		Pit is located is on side slope in lodgepole pine re-growth adjacent to logging road
						Sample #2A-5 taken from 0.0 to .67 feet
						Sample #2A-6 taken from .67 to 2.08 feet
				15		

TABLE 2 INFILTRATION RATES AT SITE A2		
TEST #	**LOCATION**	**FINAL INFILTRATION RATE**
A2-1	BP-1, INF-1	8 INCHES PER HOUR
A2-2	BP-2, INF-2	7 INCHES PER HOUR
A2-3	BP-3, INF-3	9 INCHES PER HOUR

Summary

Both sites, A1 and A2, have been determined as acceptable for stockpiling snow. Ideally, the manufactured snow should be kept within the natural small drainages that are found on each site. The sites will have small constructed berms spaced at intervals across the landscape to restrict snow melt runoff from leaving the site. The till soils typically have enough clay content for dike construction. Soil compaction would be required because some of the soils tend to become unstable under saturated conditions.

During the winter, the snow-covered forest floor serves to insulate the soil so that soil freezing, if it does occur, occurs slowly and does not penetrate deeply. Consequently, during the spring thaws, runoff within the site will be eliminated by the permeability of the subsurface forest soil horizons and the constructed berms.

PROPOSED SNOWMAKING SCHEDULE

The proposed plan is to dispose of 50.5 million gallons of wastewater during winter months via the Snowfluent process. Snowmaking will begin as soon as climatic conditions are suitable (climatic conditions will be defined by Delta Engineering in the final design report). As with any natural system, climatic conditions vary annually. Therefore, operation of the proposed snowmaking systems will need to be modified annually to adjust for climatic conditions.

MONITORING COMPONENTS

Meteorological Data

The climatic conditions allowable for snowmaking will be defined in the final design stage by Delta Engineering. As deemed necessary by Delta Engineering, climatic conditions will be monitored to help determine adequate snowmaking conditions.

Effluent Stream

Grab samples of the effluent stream (water being delivered to the snowmaking site) should be collected twice monthly. The effluent stream characteristics should be analyzed:

- Fecal Coliform Bacteria
- Nitrate Nitrogen
- Phosphorous
- Alkalinity
- Electric Conductivity

The influent flows, lagoon level, effluent discharge volumes and remaining storage should be recorded on a daily basis.

Snow Pack

Cores from various locations in the snow pack should be collected an analyzed monthly for both nutrients and bacteria. The same constituents listed above for effluent monitoring should be analyzed in the snow pack samples. At DEQ's discretion, this sampling frequency can be reduced or eliminated after two years of sampling, based on results.

Melt Water

Grab samples of melt water inside the constructed berms (if present) should be sampled and tested for the same parameters as listed for effluent monitoring. Grab samples and testing should occur weekly during the entire snow melt period for the first two years of snowmaking. This

sampling frequency can be reduced or eliminated at the discretion of DEQ, based on the first two years sampling results.

Monitor Wells

Monitor wells should be constructed down-gradient of the land application area to assess the affect, if any, of land application of wastewater on groundwater. Based on the topography and visual inspection of the land application site during MSE-HKM's field investigations, it appears that the depth to groundwater is significant, possibly 100 feet or more. Monitor wells located at the land application site will not provide useful information if samples cannot be collected from the wells. Based on this information, a useful and economical placement of the monitor wells is along the Middle Fork of the Gallatin River to the north and a tributary to the south of the proposed land application area (see Figure 1). Final location of the placement of wells will be coordinated with DEQ and will depend upon the ability to obtain access and permission for monitoring equipment on private land.

The monitor wells should be installed and samples collected monthly prior to land application to establish baseline conditions. After land application begins, the monitor wells should be tested monthly for the first two years, testing for the following parameters:

- Fecal Coliform Bacteria
- Nitrate Nitrogen
- Phosphorous
- Alkalinity
- Electrical Conductivity

At DEQ's discretion, the monitor well sampling frequency may be reduced to quarterly to semi-annually in future years, based on results from the first two years of monitoring.

Soil Sampling

Soil fertility monitoring should be conducted prior to snowmaking and land application of effluent to determine baseline soils information. After land application begins, samples should be collected in the spring and fall (before and after spray irrigation) to assess the affect of land

applying effluent onto the site. Two samples, at three depths, should be collected from each bermed area inside the land application area. Soil samples should be collected at three depths: 6 to 12 inches, 12 to 24 inches and 24 to 36 inches. Soil samples from the land application area should be collected and analyzed for the following nutrients and heavy metals and other relevant parameters:

- PH
- Cation Exchange Capacity
- Total Kjeldahl Nitrogen
- Organic Nitrogen
- Ammonia Nitrogen
- Nitrate Nitrogen
- Total Phosphorous
- Total Potassium
- Cadmium
- Copper
- Chromium
- Mercury
- Nickel
- Lead
- Zinc
- Calcium
- Magnesium
- Iron
- Chloride
- Sodium

Additionally, an assessment of forage conditions, including photo documentation of species population, density and maturity, should be made prior to land application and annually in the fall after land application begins. The information documented during the site assessments should be submitted with required reports to DEQ.

MONITORING SCHEDULE

Table 3 summarizes the proposed monitoring activities for the Big Sky mountain snowmaking sites.

TABLE 3 MONITORING SCHEDULE SUMMARY						
MONTH	CLIMATE	WASTEWATER EFFLUENT STREAM	SNOW PACK	SNOW MELT WATER	MONITOR WELLS	SOILS
January	❄	❄	❄		❄	
February	❄	❄	❄		❄	
March	❄	❄	❄		❄	
April	❄	❄	❄	❄	❄	
May	❄	❄	❄	❄	❄	
June			❄	❄	❄	❄
July					❄	
August					❄	
September					❄	
October					❄	❄
November	❄	❄			❄	
December	❄	❄	❄		❄	

SPECIAL CONDITIONS

Land application via snowmaking is a best management practice for the disposal and utilization of wastewater. The goal of any land application project is to minimize or eliminate the negative impacts to the environment and to maximize as many positive impacts to the surroundings as possible. The following paragraphs briefly address some site-specific, special conditions that apply to the proposed Big Sky mountain land application project.

Nitrogen

Due to the chemical nature of municipal wastewater, a major concern for environmental impact as a result of land application projects is groundwater contamination. At the Big Sky mountain sites, groundwater depths are unknown, but are believed to be greater than 100 feet. Analysis using EPA's guidelines for land application indicates that this project will minimize negative impacts on the groundwater from nitrates. Nutrient uptake of nitrogen should utilize the majority of the nitrogen applied to the system if applied at approximately 2.4 mg/l.

Phosphorous

Based on initial MSE-HKM, Inc. field investigations, the forest soils at the mountain land application site are phosphorous deficient and should have the ability to tightly bind large quantities of phosphorous as iron and aluminum compounds. This is very typical in most acidic forest soils. Total phosphorous retention increases with increasing soil depth. The soils at the proposed site are highly variable in depth, but should be able to "tie up" or utilize the phosphorous added to the system with no impacts to the surrounding environment. Even under cumulative phosphorous applications, the annual retention capability of the soil matrix should not greatly decrease.

Harvest of Timber

The vegetation and timbered forest utilizes nutrients and water annually. However, nutrient removal does not occur to any great extent without harvest. Rather, nutrient accumulation occurs at the site. Eventually, the removal of both nitrogen and phosphorous is dependant upon removal of the forage and timber. Therefore, it is recommended that the trees and vegetation be harvested from the site every 15 years, to assure uptake rates are optimized.

Fencing

Fencing will be installed at both snowmaking sites (A1 and A2) to eliminate the potential of human access and direct contact with the snow pack. At Site A1, it is proposed to install fencing around the entire site. At Site A2, it is proposed that fencing be installed only on the edge of the south boundary of the property, adjacent to the ski area.