5 SNOWMAKING PLAN

5.1 INTRODUCTION

Heavenly Mountain Resort presently covers approximately 309.6 acres of terrain with machine made snow using a predominantly internal mix air/water system. The system is in good condition, but in the past has been very labor intensive to operate with four separate pump stations, two reservoirs and three compressor locations. The most recent analysis calls for expanding the snowmaking to cover a total of 528.3 acres. The following analysis was completed by Sno.matic Controls and Engineering to provide guidance in expanding and upgrading the snowmaking system in view of recent technological changes in snowmaking. This includes developing strategies to:

1. Improve the safety and efficiency of the existing system
2. Reduce the operating complexities of the existing system
3. Develop a long range strategy to provide coverage for the expansion acreage as outlined under the master plan

The Heavenly Master Plan also calls for the reduction of noise levels associated with snowmaking. Mitigation measure 7.5-12 (Master Plan Chapter 7) provides the CNEL reduction targets and strategies for the three Heavenly base areas. As shown below in Table 5-1, significant noise reductions associated with fan gun operations occurred at the California Base Lodge during the 2003/2004 season.

Table 5-1

Summary of Measured Noise Levels at the Tahoe Seasons Resort
(Average Measured CNEL Values - Year 2003/2004)

Year	CNEL on days with Snowmaking	CNEL on Days without Snowmaking	CNEL During Measurement Period	Total # of Monitoring Days	Total # of Snowmaking Days
1996/1997	74.1 dBA	61.7 dBA	71.6 dBA		
1997/1998	73.5 dBA	61.8 dBA	70.2 dBA		
1998/1999	73.0 dBA	62.0 dBA	69.5 dBA		
1999/2000	74.3 dBA	62.0 dBA	73.0 dBA	141	101
2000/2001	74.1 dBA	60.0 dBA	72.2 dBA	140	89
2001/2002	73.9 dBA	60.3 dBA	72.1 dBA	145	93
2002/2003	72.0 dBA	63.1 dBA	68.3 dBA	150	61
2003/2004	67.4 dBA	62.3 dBA	65.7 dBA	104	56

* The 2000/2001 – 2003/2004 measurement site is different than in previous years

5.2 ASSESMENT OF THE EXISTING SYSTEM

The existing snowmaking capacity is summarized below:

Compressor Capacity:	California	16,800 cubic feet/minute (cfm) of permanent air[1]
	Nevada	38,200 cfm of permanent air
	Total	55,000 cfm
Water Capacity:	California	5 million gallon reservoir
(pumping up)		800 gallons per minute (gpm) withdrawal from STPUD[2]
		2,000 gpm gravity out of California Dam (flowing down)
		1,500 gpm above California Dam (pumping up)
	California Subtotal	4,300 gpm (2800 lower/1500 upper)
	Nevada	50 million gallon reservoir
		600 gpm pumping up from KGID (Stagecoach)[3]
		2,800 gpm snowmaking capacity[4]
	Nevada Subtotal	3,600 gpm
	Total Existing Pump Capacity	**7,900 gpm**

Low Energy Fan Guns 25 fixed, 12 mobile (as of November 2004)

Table 5-2

2007 Master Plan Amended Facilities - Existing & Proposed Snowmaking Summary

	Existing (2004)			MPA (07) proposed		
	Acres	***Acre feet***		***Acres***	***Acre feet***	
		(snow)	*(water)*		*(snow)*	*(water)*
California	188	659	366	230	805	447
Nevada	121	424	235	298	1,043	579
Total	**309**	**1,083**	**602**	**528**	**1,848**	**1,027**

[1] In previous years, 9,100 cfm of portable diesel compressor capacity has been rented. As of the 2003 operating season, these machines were eliminated and new fan guns installed with an equivalent production capacity
[2] Pump capacity. Estimated availability 800 gpm/24 hours per day under normal conditions
[3] Pump Capacity. Availability restricted to 600 gpm for 16 hours a day
[4] This does not account for 600 gpm capacity when Stagecoach pumps operated at higher capacity. Operating pumps at this low of a capacity is inefficient and needs to be reviewed.

General Design Parameters

a. Ideally, snowmaking systems should use water with temperatures near 35°F. This assists in the cooling process at the snowgun and point of application.

b. Some of the existing snowmaking terrain is very rough and rocky. Heavenly presently grooms this terrain in the winter, and relies on snowmaking operations to produce up to five feet of snow before opening trails. By not grading the trails or not burying the pipe, additional snow depth is required to cover these obstacles. At several locations the air and water pipelines switch position, leading to some confusion during nighttime snowmaking.

c. Since Heavenly is split into two large, distinctive terrain pods, remote control of the snowmaking operations is difficult. There are presently four distinctive pump or compressor stations located at various points throughout the resort. This can make the start-up of facilities inefficient. Heavenly has recently installed upgraded control software to improve system monitoring data collection and coordinate operation of the snowmaking facilities. It is expected that this software will improve the situation in the coming years.

d. Operations are affected by climatic conditions (e.g., wet bulb air temperature and electric utility rate structure).

e. Modify the existing construction practice of installing new air and water pipelines above ground. To solve the identified problems of freezing lines, in-ground valve vaults (for connecting above ground to below ground sections) and skier safety hazards. Determine additional situations on a project-by-project basis where below ground installation will improve system operations and avoid adverse environmental impacts.

5.3 ADDITIONAL SNOWMAKING ACREAGE

As stated above, Heavenly currently maintains and operates snowmaking on approximately 309 acres of skiing terrain. The Master Plan proposes expanding that terrain to include snowmaking on both proposed and existing terrain. The ultimate system buildout will cover 229.9 acres on the California side and 298.4 acres on the Nevada side. Thus the ultimate snowmaking system would cover 528.3 acres of terrain. This represents a net increase of 24.4 acres over the MP (96). Tables 5-3 and 5-4 of the Master Plan summarize the existing and proposed snowmaking acreage. These tables are shown below.

Table 5-3

Existing Snowmaking Facilities - September 2004

Master Plan '96 Trail #	Existing '07 Trail #	Trail Name	*Length (feet)*	*Width (feet)*	*Acreage (acres)*	*Ability (skill class)*	*Acre ft. / Acre (1)*	*Acre ft. (2)*	*Change from Master Plan '96 Approved Acres (3)*	*Change from Master Plan '96 Approved Acre ft. (4)*
California										
In Basin										
1	B1	EAST BOWL -THE FACE	3,220	220	16.3	EXP	5	81.3	0	0
2	B2	GUNBARREL	2,030	175	8.2	EXP	5	40.8	0	0
5	D1	WORLD CUP	1,000	260	6.0	LOW	2.7	16.1	0	0
6	1	ROUND-A-BOUT	17,000	40	15.6	NOV	2.7	42.1	0	0
7	E1	PATSY'S	1,730	200	7.9	NOV	2.7	21.4	0	0
9	G1	MAGGIES	5,210	80	8.4	NOV	2.7	22.7	0	0
10	G2	CAT TRACK	1,070	40	1.0	LOW	2.7	2.7	0	0
13	G5	MOMBO MEADOWS	1,190	170	4.1	LOW	2.7	11.1	0	0
14	G6	MOMBO	1,700	25	1.0	LOW	2.7	2.6	0	0
14	G7	LOWER MOMBO	1,200	90	2.5	LOW	2.7	6.7	0	0
16	2	RIDGE RUN	1,200	60	1.7	LOW	2.7	4.5	0	0
16	3	LOWER RIDGE RUN	4,610	155	15.9	NOV	2.7	42.9	0	0
23	H9	CANYON - SKY CANYON	2,400	128	6.1	LOW	2.7	16.5	0	0
24	H10	JACKPOT (RUSUTSU)	1,860	125	4.3	LOW	2.7	11.6	0	0
25	I1	LIZ'S	4,630	100	9.6	INT	2.7	25.9	0	0
26	H11	STEAMBOAT	1,430	130	3.3	INT	2.7	8.9	0	0
27	I3	UPPER ELLIE'S / ELLIE'S	4,490	130	12.4	ADV	4	49.6	0	0
*29	GG1	UPPER CALIFORNIA TRAIL	2,900	145	7.4	LOW	2.7	20.0	-1.3	-3.4
29	5	CALIFORNIA TRAIL	6,010	50	5.5	LOW	2.7	14.9	0	0
**29A	GG2	SAM'S DREAM	1,500	125	4.3	LOW	4	17.2	0	0
*29B	GG3	TAMARACK RETURN	650	50	0.8	LOW	2.7	2.2	0.8	2.0
*30	K1	PERFECT RIDE (WEST BOWL)	1,260	300	8.7	NOV	2.7	23.4	0	0
31	L1	ENCHANTED FOREST	500	200	2.3	BEG	2.7	6.2	-1.4	-3.8
32	M1	ENCHANTED FOREST II	390	100	0.9	BEG	2.7	2.4	0	0
33	N1	PIONEER PLATTER PULL	700	150	2.4	BEG	2.7	6.5	0	0
34	O1	LEARN TO SKI CENTER	400	150	1.4	BEG	2.7	3.7	0	0
*81	HH1	EASY STREET (1/2)	750	200	3.4	NOV	2.7	9.3	-4.5	-12.2
*82	GG6	CASCADE	2,800	125	8.0	LOW	4	32.1	1.2	4.8
**83	HH2	VON SCHMIDT'S TEACHING AREA	600	300	4.1	NOV	2.7	11.2	0	0
In Basin Total					**173.4**			**556.5**	**-5.2**	**-12.6**
					30.4					
Out of Basin										
54	V4	BIG DIPPER (1/5)	1,080	150	3.7	INT	2.7	10.0	0	0
58	V8	ORION'S (1/2)	1,820	200	8.4	LOW	2.7	22.6	0	0
**72	V10	METEOR (1/2)	970	130	2.9	INT	2.7	7.8	0.6	-1.5
Out of Basin Total					**15.0**			**40.4**	**0.0**	**-1.5**
California Total					**188.4**			**596.9**	**-5.2**	**-14.1**

Notes:

(1) Acre feet of water needed per acre of ski run to achieve complete snow coverage. 2.7 indicates a ski run will require 2.7 acre feet of water per ski run acre per year to achieve snow coverage of ground cover. This number is assumed to be worst case for a ski season.

(2) Total acre feet of water required for complete snow coverage of the ski run for a ski season. This number is calculated by multiplying the Snowmaking Acreage by the Acre ft/Acre column.

(3) Change from Master Plan (1996) Approved to Master Plan Amendment (2007) Proposed build out.

(4) Additional water requirements of Master Plan Amendment (2007) from Master Plan (1996).

* All or partially implemented since adoption of the Master Plan in 1996.

** Approved to be implemented but not yet constructed.

Table 5-3 (cont'd)

Existing Snowmaking Facilities - September 2004

Master Plan '96 Trail #	Existing '07 Trail #	Trail Name	*Length (feet)*	*Width (feet)*	*Acreage (acres)*	*Ability (skill class)*	*Acre ft. / Acre (1)*	*Acre ft. (2)*	*Change from Master Plan '96 Acres (3)*	*Change from Master Plan '96 Acre ft. (4)*
Nevada										
In Basin										
40	Q1	BOULDER (EDGEWOOD) BOWL	3,000	250	17.2	NOV	4	68.9	0	0
44	S1	OLYMPIC DOWNHILL (3/5)	5,190	130	15.5	LOW	2.7	41.8	0	0
65	9	STEVE'S	740	30	0.5	LOW	2.7	1.4	0	0
68	X1	BOULDER SKI SCHOOL	700	175	2.8	BEG	2.7	7.6	0	0
*81	HH1	EASY STREET (1/2)	760	200	3.5	NOV	2.7	9.4	-4.5	-12.2
In Basin Total					**39.5**			**129.1**	**-4.5**	**-12.2**
Out of Basin										
41	7	LOWER WAY HOME	1,900	120	5.2	BEG	2.7	14.1	0	0
44	S1	OLYMPIC DOWNHILL (2/5)	3,460	130	10.3	LOW	2.7	27.9	0	0
47	8	PEPI'S	3,500	50	4.0	LOW	2.7	10.8	0	0
48	S5	CROSSOVER	4,500	65	6.7	LOW	2.7	18.1	0	0
54	V4	BIG DIPPER (4/5)	4,300	150	14.8	INT	2.7	40.0	0	0
55	V6	ORION'S BELT	580	80	1.1	LOW	2.7	2.9	0	0
58	V8	ORION'S (1/2)	1,820	200	8.4	LOW	2.7	22.6	0	0
59	V9	LOWER ORION'S	1,590	108	2.9	LOW	2.7	7.8	0	0
62	W3	LITTLE DIPPER	2,600	175	10.4	INT	5	52.2	0	0
63	W4	COMET	3,250	190	14.2	LOW	2.7	38.3	0	0
**72	V10	METEOR (1/2)	985	130	2.9	INT	2.7	7.9	0.6	-1.5
*81A	HH3	SILVER SPUR	450	50	0.5	LOW	2.7	1.4	0.5	1.4
Out of Basin Total					**81.5**			**244.1**	**1.1**	**-0.1**
Nevada Total					**121.0**			**373.2**	**-3.4**	**-12.3**
Grand Total					**309.4**			**970.1**	**-8.6**	**-26.4**

Notes:

(1) Acre feet of water needed per acre of ski run to achieve complete snow coverage. 2.7 indicates a ski run will require 2.7 acre feet of water per ski run acre per year to achieve snow coverage of ground cover. This number is assumed to be worst case for a ski season.

(2) Total acre feet of water required for complete snow coverage of the ski run for a ski season. This number is calculated by multiplying the Snowmaking Acreage by the Acre ft/Acre column.

(3) Change from Master Plan (1996) Approved to Master Plan Amendment (2007) Proposed build out.

(4) Additional water requirements of Master Plan Amendment (2007) from Master Plan (1996).

* All or partially implemented since adoption of the Master Plan in 1996.

** Approved to be implemented but not yet constructed.

Table 5-4

2007 Master Plan Amended Facilities - Snowmaking at Buildout

2007 Master Plan Amendment Trail #	1996 Master Plan Trail #	Trail Name	2007 Master Plan Amendment Snowmaking Action (1)	Length (feet)	Width (feet)	Acreage (acres)	Ability (skill class)	Acre ft. / Acre (2)	Acre ft. (3)	Change from Master Plan '96 Acres (4)	Change from Master Plan '96 Acre ft. (5)
California											
In Basin											
'pod' trails											
B1	1	EAST BOWL -THE FACE	EXISTING	3,220	220	16.3	EXP	5	81.3	*0*	*0.0*
B2	2	GUNBARREL	EXISTING	2,030	175	8.2	EXP	5	40.8	*0*	*0.0*
B3	3	PISTOL	REMOVE	1,220	130	0.0	EXP	5	0.0	*-3.6*	*-18.2*
B4	4	WEST BOWL	REMOVE	2,040	100	0.0	ADV	5	0.0	*-4.7*	*-23.4*
D1	5	WORLD CUP	EXISTING	1,000	260	6.0	LOW	2.7	16.1	*0*	*0.0*
E1	7	PATSY'S	EXISTING	1,730	200	7.9	NOV	2.7	21.4	*0*	*0.0*
E2	8	GROOVE	RETAIN	1,640	100	3.8	NOV	2.7	10.2	*0*	*0.0*
G1	9	MAGGIES	EXISTING	5,210	80	8.4	NOV	2.7	22.7	*0*	*0.0*
G2	10	CAT TRACK	EXISTING	1,070	40	1.0	LOW	2.7	2.7	*0*	*0.0*
G3	11	SWING TRAIL	NO ACTION	1,190	30	0.0	LOW	0	0.0	*0*	*0.0*
G4	12	WATERFALL	RETAIN	760	200	3.5	ADV	5	17.4	*0*	*0.0*
G5	13	MOMBO MEADOWS	EXISTING	1,190	170	4.1	LOW	2.7	11.1	*0*	*0.0*
G6	14	MOMBO	EXISTING	1,700	25	1.0	LOW	2.7	2.6	*0*	*0.0*
G7	14	LOWER MOMBO	EXISTING	1,200	90	2.5	LOW	2.7	6.7	*0*	*0.0*
G8	15	POWDERBOWL	RETAIN	1,540	100	3.5	NOV	4	14.1	*0*	*0.0*
G9	NC	NEW - POWDERBOWL II (GLADED)	NEW	1,640	50	1.9	INT	2.7	5.1	*1.9*	*5.1*
H1	17	WOODS TRAIL	NO ACTION	2,960	25	0.0	NOV	0	0.0	*0*	*0.0*
H2	18	BETTY'S SWING	NO ACTION	1,080	30	0.0	INT	0	0.0	*0*	*0.0*
H3	19	RIDGE BOWL	NO ACTION	1,400	100	0.0	INT	0	0.0	*0*	*0.0*
H4	19	RIDGE CHUTE	NO ACTION	860	50	0.0	INT	0	0.0	*0*	*0.0*
H5	20	HIGH ROLLER (BETTY'S RUN)	RETAIN	3,680	150	12.7	INT	2.7	34.2	*0*	*0.0*
H6	20	DOUBLE DOWN (BETTY'S BOWL)	NO ACTION	400	180	0.0	EXP	0	0.0	*0*	*0.0*
H7	21	LOWER BETTY'S	NO ACTION	710	50	0.0	INT	0	0.0	*0*	*0.0*
H8	22	BETTY'S CUTOFF	NO ACTION	570	130	0.0	INT	0	0.0	*0*	*0.0*
H9	23	CANYON - SKY CANYON	EXISTING	2,400	128	6.1	LOW	2.7	16.5	*0*	*0.0*
H10	24	JACKPOT (RUSUTSU)	EXISTING	1,860	125	4.3	LOW	2.7	11.6	*0*	*0.0*
H11	26	HIGH ROLLER (STEAMBOAT)	EXISTING	1,430	130	3.3	INT	2.7	8.9	*0*	*0.0*
H12	NC	NEW - BETTY'S CUTOFF	NO ACTION	600	150	0.0	LOW	0	0.0	*0*	*0.0*
H13	NC	NEW - BETTY'S ESCAPE	NO ACTION	250	60	0.0	NOV	0	0.0	*0*	*0.0*
I1	25	LIZ'S	EXISTING	4,630	100	9.6	INT	2.7	25.9	*0*	*0.0*
I2	27	ELLIE'S SWING - EXTENSION	RETAIN	2,740	70	3.4	INT	2.7	9.2	*0*	*0.0*
I3	27	UPPER ELLIE'S / ELLIE'S	EXISTING	4,490	130	12.4	ADV	4	49.6	*0*	*0.0*
I4	NC	NEW - SKIWAYS 1 (GLADED)	NO ACTION	3,089	50	0.0	INT	0	0.0	*0*	*0.0*
I5	NC	NEW - SKIWAYS 2 (GLADED)	NO ACTION	2,982	50	0.0	INT	0	0.0	*0*	*0.0*
K1	30	PERFECT RIDE (WEST BOWL)	EXISTING	1,260	300	8.7	NOV	2.7	23.4	*0*	*0.0*
*L1	31	LOWER SKI SCHOOL	EXISTING	500	200	2.3	BEG	2.7	6.2	*-1.4*	*-3.8*
M1	32	CHILDRENS SKI CENTER	EXISTING	390	100	0.9	BEG	2.7	2.4	*0*	*0.0*
N1	33	PIONEER PLATTER PULL	EXISTING	700	150	2.4	BEG	2.7	6.5	*0*	*0.0*
O1	34	LEARN TO SKI CENTER	EXISTING	400	150	1.4	BEG	2.7	3.7	*0*	*0.0*
*GG1	29	(UPR.) CALIFORNIA TRAIL	EXISTING	2,900	145	7.4	LOW	2.7	20.0	*-1.3*	*-3.4*
**GG2	29A	SAM'S DREAM	EXISTING - UNBUILT	1,430	130	4.3	LOW	4	17.1	*0.2*	*0.8*
*GG3	29B	TAMARACK RETURN	EXISTING	650	50	0.7	LOW	2.7	2.0	*0.7*	*2.0*
GG5	64	49ER	RETAIN	1,710	40	1.6	LOW	4	6.3	*0*	*0.0*
*GG6	82	CASCADE	EXISTING	2,800	125	8.0	LOW	4	32.1	*1.2*	*4.8*
*HH1	81	EASY STREET (1/2)	EXISTING	740	200	3.4	NOV	2.7	9.2	*-12.4*	*-33.6*
HH2	81	EASY STREET II (1/2)	NO ACTION	300	300	0.0	NOV	2.7	0.0	*0*	*0.0*
non 'pod' transport trails											
1	6	ROUND-A-BOUT	EXISTING	17,000	40	15.6	NOV	2.7	42.1	*0*	*0.0*
1	6	ROUND-A-BOUT - REALIGNMENT	NEW	1,691	40	1.6	NOV	2.7	4.2	*1.6*	*4.2*
2	16	RIDGE RUN	EXISTING	1,200	60	1.7	LOW	2.7	4.5	*0*	*0.0*
3	16	LOWER RIDGE RUN	EXISTING	4,610	155	15.9	NOV	2.7	42.9	*0*	*0.0*
4	28	SKYLINE TRAIL	RETAIN	3,100	54	2.8	LOW	2.7	7.6	*0*	*0.0*
5	29	CALIFORNIA TRAIL	EXISTING	6,010	50	5.5	LOW	2.7	14.9	*0*	*0.0*
5A	NC	NEW- CAL. TRAIL ALTERNATIVE	NEW	1,800	40	1.7	LOW	2.7	4.5	*1.7*	*4.5*
10	67	VON SCHMIDT'S (1/4)	RETAIN	1,050	50	1.2	LOW	2.7	3.3	*0*	*0.0*
**11	83	VON SCHMIDT'S - MEADOW	RETAIN	600	300	4.1	BEG	2.7	11.1	*0*	*0.0*
12	NC	NEW - MAGGIES CANYON (GLADED)	NO ACTION	1,890	150	0.0	ADV	0	0.0	*0*	*0.0*
In Basin Total						**210.8**			**672.0**	**-16.1**	**-61.0**
Out of Basin											
'pod' trails											
V1	51	MILKY WAY BOWL (2/3)	NO ACTION	1,800	900	0.0	EXP	0	0.0	*0*	*0.0*
V3	53	DIPPER KNOB	RETAIN	1,730	30	1.2	INT	2.7	3.2	*0*	*0.0*
V4	54	BIG DIPPER (1/5)	EXISTING	1,080	150	3.7	INT	2.7	10.0	*0*	*0.0*
V7	57	DIPPER BOWL (1/2)	NO ACTION	680	450	0.0	EXP	0	0.0	*0*	*0.0*
V8	58	ORION'S (1/2)	EXISTING	1,820	200	8.4	LOW	2.7	22.6	*0*	*0.0*
*V10	72	METEOR (1/2) - (GLADED)	EXISTING - UNBUILT	970	130	2.9	INT	2.7	7.8	*0.6*	*-1.5*
**V11	75	METEOR II (1/3) - (GLADED)	REMOVE	500	100	0.0	ADV	2.7	0.0	*-1.6*	*-6.5*
GG4	61	SAND DUNES	RETAIN	1,610	80	3.0	INT	2.7	8.0	*0*	*0.0*
Out of Basin Total						**19.1**			**51.6**	**-1**	**-8.0**
California Total						**229.9**			**723.6**	**-17.1**	**-69.0**

Notes:

(1) Action proposed: EXISTING = currently exists, RETAIN = approved in MP (96) - retain in MPA (07), REMOVE = approved in MP (96) - remove in MPA (07), NEW = not considered in MP (96) - proposed in MPA (07).

(2) Acre feet of water needed per acre of ski run to achieve complete snow coverage. 2.7 indicates a ski run will require 2.7 acre feet of water per ski run acre per year to achieve snow coverage of ground cover. This number is assumed to be worst case for a ski season.

(3) Total acre feet of water required for complete snow coverage of the ski run for a ski season. This number is calculated by multiplying the Snowmaking Acreage by the Acre ft/Acre column.

(4) Change from Master Plan (1996) Approved to Master Plan Amendment (2007) Proposed build out.

(5) Additional water requirements of Master Plan Amendment (2007) from Master Plan (1996).

* All or partially implemented since adoption of the Master Plan in 1996.

** Approved to be implemented but not yet constructed.

Table 5-4 cont'd

2007 Master Plan Amended Facilities - Snowmaking at Buildout

2007 Master Plan Amendment Trail #	1996 Master Plan Trail #	Trail Name	2007 Master Plan Amendment Snowmaking Action (1)	Length (feet)	Width (feet)	Acreage (acres)	Ability (skill class)	Acre ft. / Acre (2)	Acre ft. (3)	Change from Master Plan '96 Acres (4)	Change from Master Plan '96 Acre ft. (5)
Nevada											
In Basin											
'pod' trails											
Q1	40	BOULDER (EDGEWOOD) BOWL	EXISTING	3,000	250	17.2	NOV	4	68.9	*0*	*0*
S1	44	OLYMPIC DOWNHILL (3/5)	EXISTING	5,190	130	15.5	LOW	2.7	41.8	*0*	*0*
S2	45	BOULDER CHUTE (O75)	RETAIN	1,330	90	2.7	INT	4	11.0	*0*	*0*
S3	46	NORTH BOWL	RETAIN	3,770	90	7.8	ADV	5	38.9	*0*	*0*
S4	46	UPPER NORTH BOWL	RETAIN	1,260	145	4.2	ADV	5	21.0	*0*	*0*
S8	NC	NEW - NORTH BOWL 2	NEW	1,785	125	5.1	LOW	2.7	13.8	*5.1*	*13.8*
S9	NC	NEW - NORTH BOWL 3 (GLADED)	NEW	2,835	125	8.1	INT	2.7	22.0	*8.1*	*22.0*
S10	NC	NEW - NORTH BOWL 4 (GLADED)	NEW	2,730	125	7.8	INT	2.7	21.2	*7.8*	*21.2*
X1	68	BOULDER SKI SCHOOL	EXISTING	700	175	2.8	BEG	2.7	7.6	*0*	*0*
*HH1	81	EASY STREET (1/2)	EXISTING	740	200	3.4	NOV	2.7	9.2	*-12.4*	*-33.6*
HH2	81	EASY STREET II (1/2)	NO ACTION	300	300	0.0	NOV	0	0.0	*0*	*0*
non 'pod' transport trails											
9	65	STEVE'S	EXISTING	740	30	0.5	LOW	2.7	1.4	*0*	*0.00*
10	67	VON SCHMIDT'S (1/4)	RETAIN	1,050	50	1.2	LOW	2.7	3.3	*0*	*0.00*
In Basin Total						**76.5**			**259.9**	**8.6**	**23.4**
Out of Basin											
'pod' trails											
R1	42	STAGECOACH	RETAIN	4,500	120	12.4	INT	4	49.6	*0*	*0.0*
R2	43	(UPPER) STAGECOACH	RETAIN	1,810	100	4.2	INT	4	16.6	*0*	*0.0*
R3	NC	NEW - STAGECOACH 2	NO ACTION	2,070	150	0.0	INT	5	0.0	*0*	*0.0*
R4	NC	NEW - STAGECOACH 3	NO ACTION	1,245	125	0.0	INT	5	0.0	*0*	*0.0*
S1	44	OLYMPIC DOWNHILL (2/5)	EXISTING	3,460	130	10.3	LOW	2.7	27.9	*0*	*0.0*
S5	48	CROSSOVER	EXISTING	4,500	65	6.7	LOW	2.7	18.1	*0*	*0.0*
S6	66	PONDEROSA (BONANZA BOWL)	RETAIN	2,160	80	4.0	INT	4	15.9	*0*	*0.0*
S7	66a	EAST PEAK	RETAIN	2,150	80	3.9	INT	4	15.8	*0*	*0.0*
U1	49	PERIMETER	RETAIN	5,870	100	13.5	LOW	2.7	36.4	*0*	*0.0*
U2	50	GALAXY	RETAIN	4,900	90	10.1	LOW	2.7	27.3	*0*	*0.0*
U3	NC	NEW - GALAXY 1	NEW	2,520	150	8.7	NOV	2.7	23.4	*8.7*	*23.4*
U4	NC	NEW - GALAXY 2	NEW	788	150	2.7	NOV	2.7	7.3	*2.7*	*7.3*
V1	51	MILKY WAY BOWL (1/3)	NO ACTION	900	900	0.0	EXP	0	0.0	*0*	*0.0*
V2	52	UPPER PERIMETER (RIM TRAIL)	NO ACTION	3,280	50	0.0	EXP	0	0.0	*0*	*0.0*
V4	54	BIG DIPPER (4/5)	EXISTING	4,300	150	14.8	INT	2.7	40.0	*0*	*0.0*
V5	54	LOWER BIG DIPPER	RETAIN	1,600	100	3.7	INT	2.7	9.9	*0*	*0.0*
V6	55	ORION'S BELT	EXISTING	580	80	1.1	LOW	2.7	2.9	*0*	*0.0*
V7	57	DIPPER BOWL (1/2)	NO ACTION	680	450	0.0	EXP	5	0.0	*0*	*0.0*
V8	58	ORION'S (1/2)	EXISTING	1,820	200	8.4	LOW	2.7	22.6	*0*	*0.0*
V9	59	LOWER ORION'S	EXISTING	1,590	108	2.9	LOW	2.7	7.8	*0*	*0.0*
*V10	72	METEOR (1/2) - (GLADED)	EXISTING - UNBUILT	985	130	2.9	INT	2.7	7.8	*0.6*	*-1.5*
**V11	75	METEOR II (2/3) - (GLADED)	REMOVE	1,000	100	0.0	ADV	2.7	0.0	*-3.2*	*-12.9*
V12	NC	NEW - ORION'S II	NEW	1,200	125	3.4	INT	2.7	9.3	*3.4*	*9.3*
W1	56	ARIES	RETAIN	920	60	1.3	INT	2.7	3.4	*0*	*0.0*
W2	60	JACK'S	NEW	1,080	120	3.0	INT	2.7	8.0	*3*	*8.0*
W3	62	LITTLE DIPPER	EXISTING	2,600	175	10.4	INT	5	52.2	*0*	*0.0*
W4	63	COMET	EXISTING	3,250	190	14.2	LOW	2.7	38.3	*0*	*0.0*
W5	NC	NEW - ARIES II (GLADED)	NO ACTION	1,730	150	0.0	ADV	0	0.0	*0*	*0.0*
Z1	86	NEW - WELLS FARGO 1	NEW	1,875	125	5.4	INT	2.7	14.5	*5.4*	*14.5*
Z2	87	NEW - WELLS FARGO 2	RETAIN	3,619	100	8.3	INT	2.7	22.4	*-6.1*	*-35.3*
Z3	NC	NEW - WELLS FARGO 3	NEW	3,963	125	11.4	ADV	2.7	30.7	*11.4*	*30.7*
Z4	91	NEW - WELLS FARGO 4	RETAIN	3,718	150	12.8	INT	2.7	34.6	*-0.1*	*-0.4*
Z5	NC	NEW - WELLS FARGO 5	NEW	1,203	100	2.8	INT	2.7	7.5	*2.8*	*7.5*
Z6	NC	NEW - WELLS FARGO 6	NO ACTION	1,354	85	0.0	INT	0	0.0	*0*	*0.0*
Z7	NC	NEW - WELLS FARGO 7	NEW	2,411	125	6.9	ADV	2.7	18.7	*6.9*	*18.7*
Z8	89	NEW - WELLS FARGO 8	NO ACTION	4,776	100	0.0	ADV	0	0.0	*0*	*0.0*
NA	73	MP '96 NEW - MPA '04 ELIMINATED	REMOVE	3,280	30	0.0	NA	4	0.0	*-2.3*	*-9.0*
NA	76	MP '96 NEW - MPA '04 ELIMINATED	REMOVE	3,390	150	0.0	NA	0	0.0	*0*	*0.0*
NA	77	MP '96 NEW - MPA '04 ELIMINATED	REMOVE	2,570	150	0.0	NA	4	0.0	*-8.8*	*-35.4*
DD1	79	MOTT CANYON	NO ACTION	2,000	2,000	0.0	EXP	0	0.0	*0*	*0.0*
DD2	79	KILLEBREW	NO ACTION	1,900	1,000	0.0	EXP	0	0.0	*0*	*0.0*
*HH3	81A	SILVER SPUR	NO ACTION	450	50	0.5	LOW	2.7	1.4	*0.5*	*1.4*
Non 'pod' transport trails											
NA	41	OLD WAY HOME	REMOVE	9,090	30	0.0	BEG	2.7	0.0	*-6.3*	*-16.9*
6	41	NEW - NEVADA TRAIL (WAY HOME)	NEW	8,590	30	5.9	BEG	2.7	16.0	*5.9*	*16.0*
7	41	LOWER WAY HOME	EXISTING	1,900	120	5.2	BEG	2.7	14.1	*0*	*0.0*
8	47	PEPI'S	EXISTING	3,500	50	4.0	LOW	2.7	10.8	*0*	*0.0*
10	67	VON SCHMIDT'S (1/2)	RETAIN	2,100	50	2.4	INT	2.7	6.5	*0*	*0.0*
14	NC	NEW - GALAXY ACCESS	NEW	2,234	125	6.4	INT	2.7	17.3	*6.4*	*17.3*
15	NC	NEW - SCORPION	NEW	2,754	100	6.3	INT	2.7	17.1	*6.3*	*17.1*
16	NC	NEW - FARGO TO GALAXY	NEW	475	100	1.1	NOV	2.7	2.9	*1.1*	*2.9*
17	NC	NEW - FARGO TO STAGECOACH	NO ACTION	1,578	75	0.0	NOV	0	0.0	*0*	*0.0*
18	NC	NEW - STAGECOACH SPUR	NO ACTION	1,249	75	0.0	INT	0	0.0	*0*	*0.0*
Out of Basin Total						**222.0**			**655.2**	**38.3**	**62.7**
Nevada Total						**298.4**			**915.1**	**46.9**	**86.1**
Grand Total						**528.3**			**1,638.7**	**29.8**	**17.1**

Notes:

(1) Action proposed: EXISTING = currently exists, RETAIN = approved in MP (96) - retain in MPA (07), REMOVE = approved in MP (96) - remove in MPA (07), NEW = not considered in MP (96) - proposed in MPA (07).

(2) Acre feet of water needed per acre of ski run to achieve complete snow coverage. 2.7 indicates a ski run will require 2.7 acre feet of water per ski run acre per year to achieve snow coverage of ground cover. This number is assumed to be worst case for a ski season.

(3) Total acre feet of water required for complete snow coverage of the ski run for a ski season. This number is calculated by multiplying the Snowmaking Acreage by the Acre ft/Acre column.

(4) Change from Master Plan (1996) Approved to Master Plan Amendment (2007) Proposed build out.

(5) Additional water requirements of Master Plan Amendment (2007) from Master Plan (1996).

* All or partially implemented since adoption of the Master Plan in 1996.

** Approved to be implemented but not yet constructed.

5.4 INFRASTRUCTURE DESIGN RECOMMENDATIONS

Summary and Conclusions

Overall, Heavenly has focused on improving the safety, reliability, and efficiency of the snowmaking system as a whole. Heavenly Mountain Resort has made a number of specific improvements to snowmaking operations in the last two to three years including: the addition of a number of low energy fan guns, elimination of rented diesel compressors, and installation of a process control system. The existing system is presently constrained by water recharge rates to the existing reservoirs, and to adequately cover the existing snowmaking acreage on an 80/80 basis (80% of the snowmaking acreage in 80% of the years), roughly 500 gpm of additional supply is required. To accommodate the expansion of snowmaking terrain, the water supply system will need to be revamped to provide 4,000 gpm of recharge to the present reservoirs, along with the addition of 50 more fan guns.

The implications of these capacity expansion recommendations are provided in the following sections:

1. Water Supply
2. Pumping System
3. Compressed Air System
4. Piping
5. Process Control
6. Water Cooling
7. Automation

These sections include recommendations based on observations of existing system design and operation issues that presently constrain snowmaking production rates.

1. Water Supply

Two factors make the development of additional water supply critical. The first is the high cost of water, which presently amounts to $300,000 to $400,000 of operational cost per year. The second is the need to increase present recharge levels to satisfy increased pumping demands, especially during colder periods in late December. The only alternative to increasing recharge rates is to increase storage volume, an option that has been discounted as non-viable for environmental and permitting reasons.

Since snow production requirements are roughly split between California and Nevada sides in the expanded system (714 acre-feet in California vs. 759 acre-feet in Nevada), the ideal supply arrangement would provide equal flows on each side. If anything, a slightly greater supply should be developed on the California side since storage of the California Dam reservoir is substantially lower. However, groundwater resources should be developed as they become available, regardless of location since having the water is more important than having it in a certain location.

The build-out system will require an additional 2,500 gpm of recharge. This will likely be supplied by a combination of ground water supplied by new wells and purchased utility water. An obvious alternative

resource is the immense capacity of Lake Tahoe. However, water withdrawal from Lake Tahoe has significant permitting issues that need to be weighed against cost of developing groundwater and/or the ongoing cost of purchasing water from the utilities. In order to satisfy additional recharge needs, on-mountain groundwater wells should be developed near each existing reservoir or pumphouse (Lower California, California Dam and East Peak Lake).

2. Pumping System

Both the capacity and pressure of the existing pumping system will need to be increased to provide expanded coverage and accommodate fan/external mix air/water technology. The existing pumping system provides the following operating pressures:

- **Lower California**

  Pumps generate 1,100 pounds per square inch (psi) discharge pressure at design (including 60 psi of suction pressure from water utility). This generates 250 psi pressure at the California Dam Pumphouse, allowing for 50 psi of friction loss. No change in operating pressures are required.

- **California Dam**

  Pumps generate 805 discharge pressure at design. This generates 239 psi at the top of the Sky Express lift, allowing for 25 psi of friction loss. Higher friction rates are likely given existing pipe sizing, but this can be resolved with pipe replacement. This pressure is a little low at the summit, but modifications are not recommended since only a small portion of the terrain is impacted by restrictions.

- **Stagecoach**

  Pumps generate 606 psi discharge pressure at design. This generates roughly 200 psi at the East Peak Reservoir assuming 50 psi of friction loss. However, the pipeline runs over a saddle at 9,000 foot elevation which drops pressure at the high point to 15 psi if a 50 psi friction allowance is assumed. This is a high friction allowance, but it illustrates why these pumps are used primarily for transferring water as opposed to snowmaking capacity.
  Stagecoach pumps are also run at higher pressures/lower flows to match downhill pressures generated by the East Peak Pumphouse This is not an operating mode that is recommended for future expansion

- **East Peak**

  Pumps operate at 814 psi which generates 244 psi at the summit of the Dipper Express, assuming 50 psi of friction loss. This pressure is acceptable and can be increased by lowering friction rates with piping upgrades.

Recommendations for each pump station are as follows:

- **Lower California**

Capacity of Lower California will depend on utility supply rates and any potential groundwater development. This pumphouse is marginal condition, has poor maintenance characteristics (low head room, poor access) and is not in an ideal location from a resort and guest service standpoint. Therefore, a new pumphouse is recommended (location to be determined) with capability to add two more vertical pumps, bringing total capacity to 2,000 gpm.

- **California Dam**

Existing pumps provide only 1,500 gpm of capacity for a large expanse of acreage. This capacity needs to be upgraded to roughly 2,500 to 3,000 gpm to promote efficient operation and the ability to cover upper terrain quickly when cold temperatures permit. There are two options to investigate:

1. Install 4 new vertical turbines at 400 horsepower (hp)/650 gpm each (or 500 hp/800 gpm each. These units will fit in the existing pit area, though accommodation of the existing low-pressure pump for lower mountain operation must be made.

2. Retain the existing three 250 hp units and add two or three 400 hp/650 gpm pumps in an expanded wet well.

This pumphouse pressure control has recently been converted to utilize energy efficient variable frequency drive (vfd). This addition has improved both the pressure control and effectiveness of the existing pumps.

- **Stagecoach**

The Stagecoach pumphouse has been recently converted to vfd control and remote operation. If increased water recharge volumes can be expected from either KGID or a new groundwater resource in this region, there are two options to consider:

1. Install a transfer pipeline on Way Home to allow water to be pumped from Stagecoach to East Peak reservoir without flowing over the saddle (during non-recharge periods this line could be supplied with increased pressure for snowmaking coverage on Nevada Trail). This would also supply snowmaking operations on the lower mountain (Upper Edgewood Bowl summit and below). The result would be the ability to pump 1,300 gpm per pump using 400 hp motors.

2. Increase the flow capacity at Stagecoach at the existing pressure regime. This would require new 400 hp units to match the existing 800 hp pumps.

Valving should be installed on hill piping as required to allow the Stagecoach pumps to provide snowmaking pressures directly on the lower areas of the Nevada terrain and eliminate the present

practice of running these pumps at low flow/high pressure. This provides the dual benefit of more efficient pump operation and enhanced safety for operators (using East Peak pumps generates approximately 1,350 psi at the base of the Boulder lift—this is not recommended based on coupling and hose pressure considerations).

- **East Peak**

East Peak Pumphouse is the newest facility and has a capacity of 2,800 gpm. No modification is necessary for these pumps except for the recommended integration of a vfd for pressure control. However, low-pressure pumps are recommended for lower mountain operations to decrease operating pressures and increase efficiencies. These pumps should develop 300 psi at the top of the North Bowl lift, resulting in a discharge pressure requirement of 500 psi. This will require two 300 hp pumps, each with 800 gpm capacity (alternative: one 400 hp pump to provide 1,000 gpm). Dropping the pressure for the lower mountain will require a different strategy for covering the top of the Olympic Chair (9,500 feet). This can be achieved by running a separate feed line to the top of North Bowl or installing piping on Ponderosa or Bonanza to feed the top of Olympic.

3. Compressed Air System

No modifications are recommended on the compressed air system at this time. However, temperature measurements should be collected to determine the effectiveness of:

- Spray cooling of existing compressor cooling water. If the compressor cooling water is warming up the reservoir temperatures, cooling towers should be integrated prior to dumping the water into the reservoir.

- Effectiveness of the tube coolers are installed at the California Dam compressor location. If these coolers do not achieve adequate cooling/moisture separation, they should be replaced with either radiator style coolers or a cooling tower/shell and tube combination.

4. Piping

The existing piping at Heavenly Mountain Resort is undersized and will need a significant amount of upgrading to achieve the desired capacities. Piping modification recommendations are included in the Snowmaking Master Plan.

5. Process Control

The large expanse of terrain covered with snowmaking, coupled with a relatively complicated water supply configuration (two reservoirs, four pumphouses) makes snowmaking operations at Heavenly complex. This situation is exacerbated by the lack of remote operating capability at each pump and

compressor location. It is critical that the present process control system at Heavenly be upgraded to provide the following functionality:

- Remote operating capacity for each location. This is most critical for pumphouses that do not need to be manned on a permanent basis (specifically Stagecoach, California Dam, and Lower California). An individual snowmaking operations supervisor should be able to control all equipment from a central location (or locations)

- Monitoring and logging of system flows, including the multiple flow monitoring sites required for environmental compliance (indicating flows entering and leaving California/Nevada and In-Basin/Out-of-Basin).

- Effective reporting and logging of temperatures and performance values that will provide for effective crew management as well as evaluation of the true impact of technology improvements.

A new process control system was installed in 2003 to accomplish these tasks. This process control system will improve the operating efficiency of the system and decrease the complexity of operations.

6. Water Cooling

Water cooling provides an efficiency benefit for all types of snowguns due to improved nucleation efficiency (sources indicate 15-30% benefit). There is an existing water cooler at the STPUD intake, however capacity of this cooler is limited. As water flows increase, additional cooling capacity will be required at this location. In addition, water from KGID (which is not presently cooled) should be provided with cooling equipments, as will any newly developed well sites. Specific equipment recommendations on water cooling will depend on the location of new well sources.

7. Automation

Automation will play a critical role in providing the system at Heavenly with the ability to efficiently react to temperature conditions over a wide area. However, the prevalence of surface piping reduces the potential benefits of automation since lines must be charged and drained after usage. While automation alternatives in snowmaking change each year, the following are recommendations for implementation within the next one to three years:

- All pump stations and compressor plants should be automated to the extent that one supervisor can efficiently operate each plant. This was described in the process control section, but can easily include the automatic sequencing of pumps to maintain pressures; thereby simplifying the task of the control supervisor.

- Fan guns should be supplied with automatic performance capability for locations that are frequently used in areas where access is difficult, dangerous, or time consuming.

- Tower guns should be installed on spur lines where appropriate so that operating a single set of valves will turn an entire string of guns on, similar to typical operations on a golf course irrigation system. This technique is limited to areas where wind conditions permit the operation of multiple guns consistently[5], but offers a very cost-effective manner of automating large areas.

Automation of individual internal mix air/water guns is possible, but the capital cost to implement this type of automation is high, as are the typical maintenance requirements. For this reason this type of automation is not recommended at the present time.

[5] Any individual gun can be turned off manually, but this requires a manual operation which somewhat decreases the utility of the system.