

Keen, Shelley

From: Keen, Shelley
Sent: Tuesday, January 29, 2013 4:11 PM
To: 'Scott Campbell'
Subject: RE: Supplemental Technical Report on Annual Volume for Water Right License No. 37-08575A

Scott:

Thanks for the quick turnaround. We will take a look at the report and let you know if we have any questions.

Shelley

From: Scott Campbell [<mailto:SLC@moffatt.com>]
Sent: Tuesday, January 29, 2013 3:43 PM
To: Scott Campbell; Keen, Shelley
Cc: Silva,Tim; Stearns, Peter; 'Charles E. Brockway'; Charles G. Brockway; smayeda@sinclairoil.com
Subject: RE: Supplemental Technical Report on Annual Volume for Water Right License No. 37-08575A

Shelley:

Correction: 456+ acre feet.

Scott

Scott L. Campbell
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slc@moffatt.com
(208) 345-2000

From: Scott Campbell
Sent: Tuesday, January 29, 2013 3:42 PM
To: 'Keen, Shelley'
Cc: 'Silva,Tim'; Stearns, Peter; 'Charles E. Brockway'; 'Charles G. Brockway'; smayeda@sinclairoil.com
Subject: Re: Supplemental Technical Report on Annual Volume for Water Right License No. 37-08575A
Importance: High

Dear Shelley:

I am providing you with the final Supplemental Technical Report prepared by Brockway Engineering. This report analyzes the actual operation of the snowmaking system on Mt. Baldy and derives a more accurate calculation of the amount of water needed to produce a ski surface if no appreciable natural snow is available. The Sun Valley Company strongly believes this calculation produces the most accurate indication of the amount of water which will be necessary for snowmaking if a repeat of the 1976-77 drought period occurs.

In view of the critical importance of the Department's decision regarding the annual volume limitation for the licensing of this water right, the Sun Valley Company desires to meet with the Department officials to provide

additional information and clarification of any questions remaining after the Department's review of the Brockway Supplemental Technical Report. If the Department has any reservations with the final calculation of 453+ acre feet of water for the annual volume of this water right, I respectfully request that we be provided with the opportunity to meet with you and seriously discuss these issues.

Thank you for your anticipated cooperation in this matter.

Best regards,

Scott

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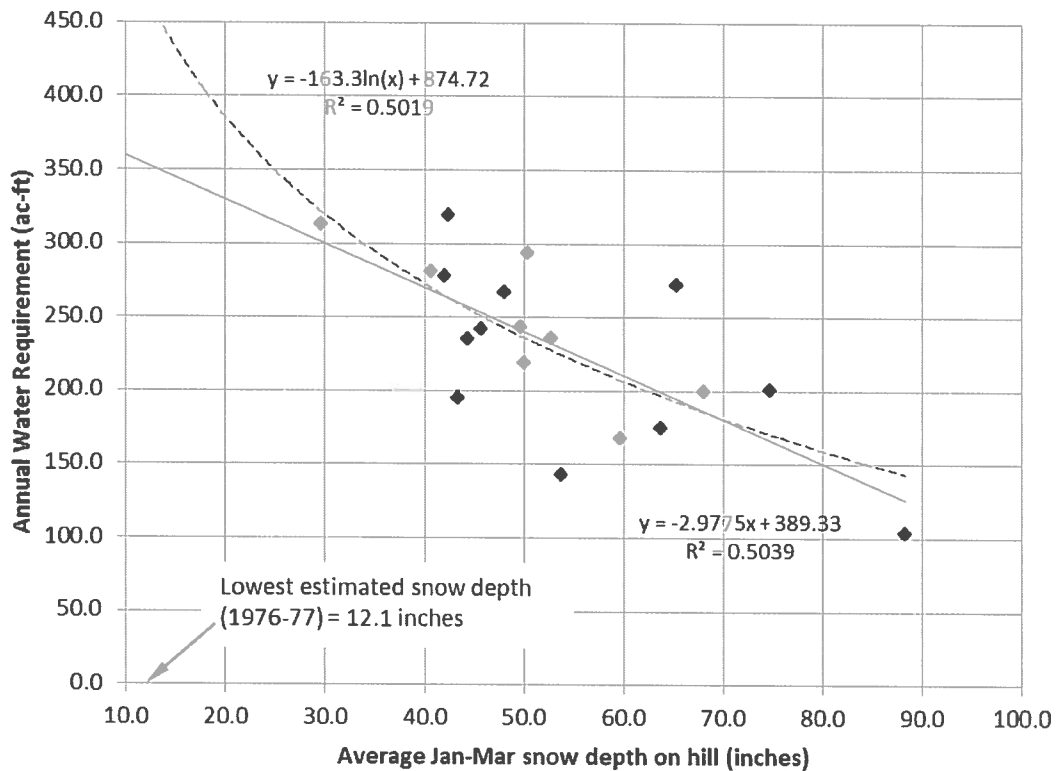
Technical Memorandum

DATE: January 25, 2013
TO: Scott Campbell
FROM: Charles G. Brockway, Ph.D., P.E.
SUBJECT: Analysis of Annual Water Usage for Snowmaking at River Run
Sun Valley Company / Water Permit 37-8575A

This memo has been prepared to supplement the information provided in a technical memo dated January 8, 2013 relative to snowmaking water requirements on the River Run side of Sun Valley.

Sun Valley Company staff has reviewed the earlier information and discussions have been held regarding the actual nature of snowmaking operations that prevail during extreme drought periods, and whether the mathematical model developed earlier could adequately represent these conditions. Evidence provided by company staff with knowledge about snowmaking operations indicates that when the natural snowfall is very low, e.g. 12 inches or less, essentially all of snow must be artificially made. Accounting for consolidation of the pack, erosion by skiers, and spatial variability in the natural pack which will leave some areas with bare ground, natural snowfall cannot reasonably be relied upon to provide any of the snow depth during extreme drought periods. This is in contrast with normal years when snowmaking is essentially employed to augment the natural pack.

In other words, the mathematical model developed earlier is likely invalid at extremely low values of natural snowfall. Rather than following a straight line as initially assumed, the actual water requirement likely becomes nonlinear when natural snowfall is low and could look something like a logarithmic fit shown as a dashed line in the graph below:



Because of this finding, an alternative physically-based method was used to estimate the maximum water requirement assuming all of the snowpack within the delineated snowmaking area is made artificially.

The snowmaking area has been delineated by the company and is shown on the attached figure. Within this general delineation, certain areas – the ski runs, areas around the lifts, etc. – receive intense artificial snow while others, such as within the trees, receive little. The areas receiving snow and the acreage of each are shown in the table below.

Data provided by Ecosign Mountain Resort Planners, Whistler, B.C., 2005	
Upper College	21.6
Lower River Run	26.7
Ridge	19.0
Round House Sl.	16.4
Cristins Silver	26.0
Muffy'S Medals	26.7
Gretchen'S Gold	25.2

Data provided by SnoMatic Controls and Engineering, Lyme, NH, 2010	
Sunset Strip	1.1
Round House Lane	2.5
Gun Tower Lane	2.6
River Run Base	1.25
Kinderspilplatz	0.65
Top Lift #1	1.4
Top Lift #2	1.4

Broadway	49.0
Upper Warm Spr.	26.0
Mid River Run	24.5
Blue Grouse	11.0
Cutoff	4.6
Xmas Ridge	25.3
Canyon	14.5
Upper Limelight	18.7
Mid Xmas Bowl	7.8
TOTAL	343

Top Seattle Ridge	1.8
Ego Flats	1.5
Top Baldy	1.0
TOTAL	15.2
GRAND TOTAL	358.2

Over the 358.2 acres of snowmaking area, the minimum initial depth of snow needed to sustain a season is 2.0 feet, according to Sun Valley staff. The average initial water content (density) of man-made snow is higher than the initial density of natural snow and was assumed to be 0.45 based on various studies of artificial snow characteristics as listed below. Various reductions must be accounted for to compute the actual water content needed to be delivered to the snowmaking guns for an entire season. Reduction percentages are based on field studies by Eisel et al (1986, 1989, 1990), which appear to be the most comprehensive studies to date and were adopted by the New Mexico state engineer for analyses of snowmaking water rights. The attached spreadsheet illustrates these calculations.

This analysis indicates that a total annual volume of 456.3 acre-feet or 148.7 MG would be needed to place and maintain the artificial snowpack during an extreme drought situation assuming negligible assistance from natural snowfall. This value is very close to the value predicted by the logarithmic fit shown in the graph above using a snowfall of 12.1 inches.

References

Eisel, Leo M., Bradley, Kimberly M., and Charles F. Leaf (1990). Estimated runoff from man-made snow. Water Resources Bulletin, 26(3), June 1990.

Eisel, Leo M., Mills, Kimberly D., and Charles F. Leaf (1988). Estimated runoff from man-made snow. Water Resources Bulletin, 26(3), June 1990.

Initial density of artificial snow – literature review:

Stockli and Rixen (2000), Swiss Federal Institute for Snow and Avalanche
ResearchResearch study of 10 in-situ sloping plots, average density 0.52

Mountain View Technologies (snowmaking equipment & services dealer), typical densities 0.38 to 0.48 (no reference given)

Smart and Fleming (1985), New Mexico State Engineer's Office Study of a single man-made plot, density 0.54

Keller, et al. (2004), Annals of Glaciology (38-2004) Research study of thermodynamic properties of man-made and natural snow, 0.36 to 0.53.

Hjorth-Hanse et al. (2000). Snow engineering textbook, typical density 0.32 to 0.37



Bald Mountain Ski Area

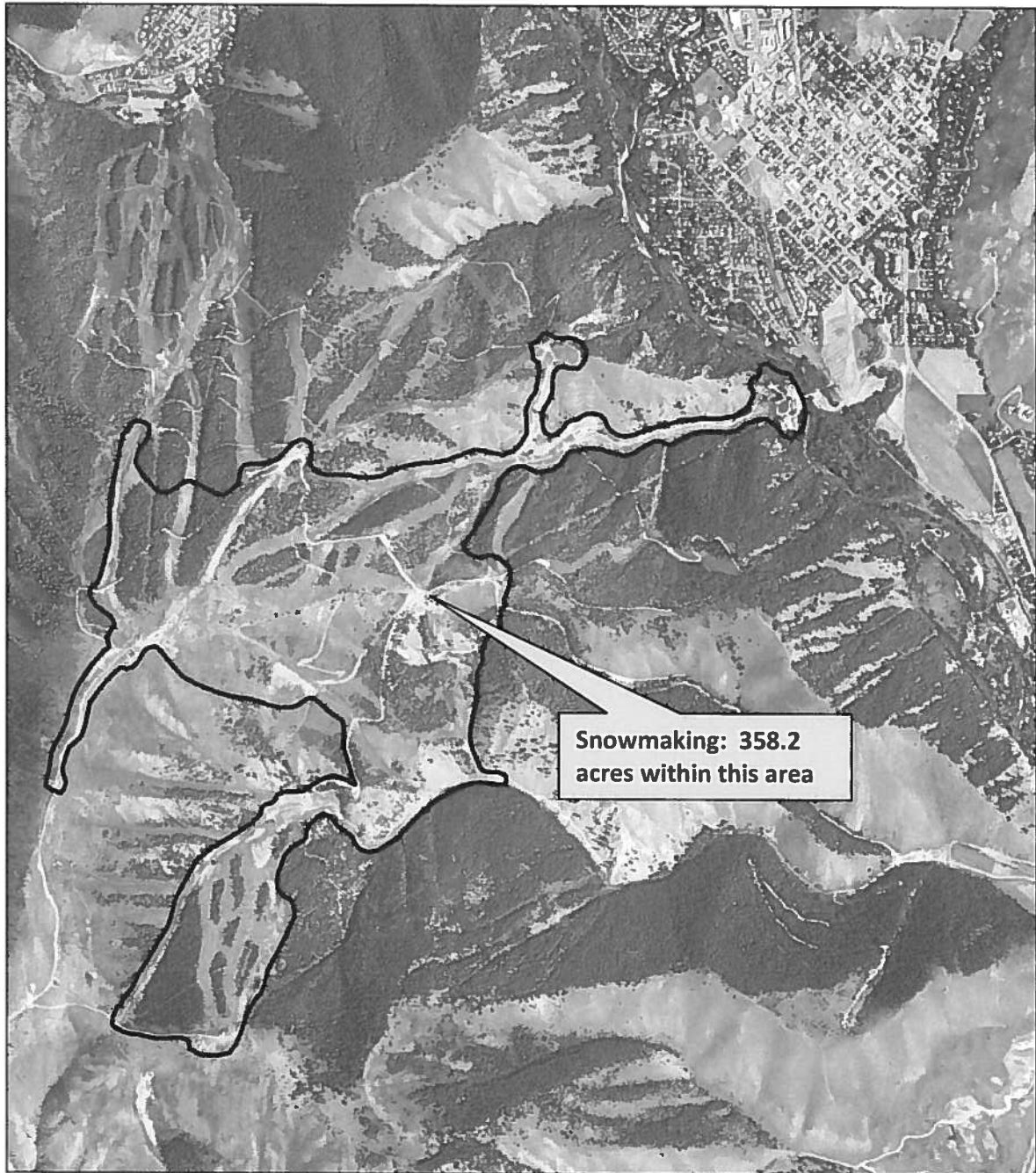


Photo Date: 2009
Map Date: 09 06 2012

Sun Valley Company

Snow Making Water Requirements - River Run System

Brockway Engineering, PLLC 1/14/2013

The calculations below represent maximum water requirement assuming 100% coverage with artificial snow. Baseline year is 1976-1977.

Total snow coverage	358.2 acres	
Required spatial average of initial snow depth	2.0 feet	
Snow depth reductions due to thaw and consolidation	10%	
Average initial snow density*	0.45	
Initial loss fraction during snowmaking process**	0.06	
Watershed loss fraction**	0.18	
Calculated:		
Snow water content - initial pack	322.4 acre-feet	
Snow water content - replenish watershed losses	70.8 acre-feet	
Snow water content - replenish thaw losses	35.8 acre-feet	
Total water volume requirement to hill	429.0 acre-feet	
Total water volume requirement to gun	456.3 acre-feet or	148.7 MG

* Various studies, see attached

** Eisel and Leaf, et al. (1986, 1989, 1990) average, adopted by NM State Engineer