McElhanney

REPORT

TO

PHEIDIAS PROJECT MANAGEMENT CORPORATION

FOR

CRYSTAL MOUNTAIN RESORT EXPANSION – PHASE 1

PRELIMINARY WATER DEMAND SUPPLY

ASSESSMENT REPORT

2111 02219-0

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April 2006

24 April 2006
Our File: 2111 02219-0

Pheidias Project Management Corporation
1660 – 1188 West Georgia Street
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Attention: Oberto Oberti, B.Arch., M.Arch., M.A.I.BC, M.R.A.I.C.
President

Dear Sir:

Crystal Mountain Resort Expansion:
Preliminary Water Demand and Supply Assessment Report – Phase 1

1.0 INTRODUCTION

McElhanney is pleased to submit this preliminary assessment of water demand and water supply for the Crystal Mountain Resort Expansion Phase 1.

The primary purpose of this preliminary assessment is to determine the quantity of water required for the resort's proposed expansion to Phase 1 and to compare this with available sources. It provides an analysis and assessment based on the available and/or interpreted data for the proposed resort's expansion.

2.0 SITE DESCRIPTION

Crystal Mountain is located approximately 9 km west of Westbank, BC, at an elevation of approximately 1200 m above sea level. Both the resort and the Westbank community lie in a generally semi-arid desert climate region. The resort area is situated in the northeast corner of the Jack Creek watershed, which covers an area of approximately 37 km^2. Two small tributaries of the creek flow through the existing ski area in a southerly direction. Two adjacent and much larger watersheds, Powers Creek and Trepanier Creek, are located to the northeast and southwest, respectively. The proposed development at Crystal Mountain calls for the construction of additional ski lifts, ski runs and resort accommodations.

3.0 PHASE 1 DEVELOPMENT

Phase I development for the expansion of Crystal Mountain Resort is divided into two stages (see **Appendix A**).

Stage 1 development is planned to include the building of a new daylodge with 25 associated condominiums, 42 single family chalets, 139 townhomes, 25 condominiums and 4 bed-and-breakfast establishments.

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Stage 2 development adds a further 74 condominiums.

Based upon indications of interest by a golf course developer, the golf course is currently planned to begin development during Phase 1 of the resort expansion. Phase 1 is intended to be developed using water supplied by existing and recently drilled wells to allow an early start to the expansion project.

The wells will pump water to a ground-level concrete reservoir hidden in the trees above the resort. Due to the difference in elevation across the site, the service area will be divided into pressure zones. These will be fed from the reservoir by gravity through pressure-reducing valve stations. The water mains throughout the base area will be sized for fire flow as well as domestic use. All the major buildings will be sprinklered.

Crystal Mountain is aware of the concerns of nearby water users, and it is clear that the expansion will be dependent upon and limited by future permissible wells and by the potential connections to the Westbank Irrigation District that may be permitted in the future.

4.0 WATER DEMAND

It was originally proposed that the first phases of the resort expansion occur prior to the development of the golf course. As a potential developer has expressed interest in the golf course, it is now proposed that it be developed concurrently with Phase 1. This significantly alters the proposed water demands for the resort expansion.

This section of the report will determine water demands for Phase 1 of the development based upon winter use, followed by determination for summer use, which is primarily driven by the golf course, and, finally, a summary of total combined annual water demand for all uses.

4.1 Winter Demand

The water demand for the proposed ski resort expansion is affected by several major factors:

1. The operation of the resort will, by its nature, result in significant water demand in the winter. Thus, to some extent, the normal published figures for water use, including the one used by the approving agencies, are not appropriate since they are significantly weighted by summer outdoor use conditions, such as lawn watering, which are not applicable to Crystal Mountain where lawns are not part of permissible landscaping. The golf course will be dealt with separately in the estimate of summer demand.

2. Ski resorts are typically never close to maximum occupancy. For example, the highly successful Whistler / Blackcomb resort has an overall high season room

occupancy ranging from 70% in 1987 / 88 to 57% in 1997 / 98. Its occupancy averaged less than 65% over this 11-year period. Bed unit occupancy is in the range of 40 to 50%.

3. This resort, in recognition of concerns of nearby users and general public awareness of scarcity of water in the area, will employ water conservation strategies to minimize its overall water consumption. This distinguishes this resort from most others. Again, these measures are not accounted for in the normal published figures for water use.

4.1.1 Average Winter Day Water Demand

For the purpose of determining the required quantity of water supply for the resort, an appropriate type of water demand is an Average Winter Day Water Demand, which allows comparison with data from urbanized areas. This method of calculation may overstate the requirements for Crystal Mountain, which is planned to be a tourist resort rather than part of a permanent settlement with its related uses.

It is assumed that the resort's water distribution system will be designed to provide for peak flow requirements, such as instantaneous and daily / hourly domestic flow variations, fire suppression, etc. This would be accomplished through incorporation of a potable water storage reservoir within the water distribution system. The volume of water stored in a water reservoir is not considered an additional water demand. It represents an "off-line" quantity of water available for withdrawal for operational / flow equalization purposes, which is slowly replenished from the water source.

For the purpose of initial water demand calculations, we have assumed full ski season occupancy and water demand based on the Health Act Regulation (BC Reg. 411/895) Appendix 1. We used this water demand criteria recently for the Kicking Horse Mountain Resort in Golden, BC. We understand the Ministry advocates the use of these criteria, and that projects are approved by the approving agencies on that basis. These criteria also apply to water use tariffs set by water utilities and approved by the Ministry, at least in the first years of operation until actual measured water use data can be demonstrated. The water demand calculated under these conditions is tabulated in the following table:

Item	Facility Type / Service	No. of Facilities	Demand Unit Type	No. of Demand Units	Demand (m^3/unit/day)	Total Demand (m^3/day)
Phase 1 – Stage 1						
1	Day Employees	n/a	Employee	70	0.09	6
2	New Day Lodge	1	m^2 Catering	250	0.11	28
3	Single Family Chalets	42	Bed Unit	252	0.23	58
4	Townhomes	139	Bed Unit	556	0.23	128
5	Condominiums – Daylodge	25	Bed Unit	75	0.23	17
6	Condominiums	25	Bed Unit	75	0.23	17
7	B&B	4	Bed Unit	32	0.23	7
					Total Phase 1 – Stage 1	**261**
Phase 1 – Stage 2						
8	Condominiums	74	Bed Unit	222	0.23	51
					Total Phase 1 – Stage 2	**51**
TOTAL PHASE 1 (Stages 1 + 2)						**312**

Table 1: Estimated Average Winter Day Water Demand at Full Occupancy (Without Water Conservation Measures)

The following notes apply to the above water demand estimate:

1. In the estimate, “bed units” are intended to equal the number of people. The number of facilities to be constructed and the allocation of the number of bed units for each facility is in accordance with the resort’s Master Development Plan.

2. The estimate of water demand for each bed unit is 230 litres per day (50 igpd). This is estimated to be the total daily demand regardless of whether or not the units have kitchen facilities. It is assumed that the residents will either eat in the units or in the restaurants and, in either case, the water consumption will be similar. The water demand for a day-employee is estimated at 90 litres per day. The water demand for common areas (i.e., day lodge and hotel catering areas) is estimated at 110 litres per m^2.

The average winter day demand (without water conservation measures) is proposed to be established as 312 m^3/day at full occupancy, although data from established resorts such as Sun Peaks, which has adopted water conservation measures, indicate an actual demand of 125 litres daily per person. This is confirmed by data from European resorts such as Lenzerheide, Switzerland. Using this demand per person, and the total of 1532 demand units (people) at full occupancy for Phase 1, the average winter day demand would be 191.5 m^3/day.

4.1.2 Reduction of Average Day Water Demand

It is realized that in the absence of an adequate, and usually relatively inexpensive, groundwater supply within the resort area, the cost of developing or bringing supplementary water to the resort area will likely be higher. With that in mind, and in recognition of concerns of the nearby water users about the general scarcity of water and the need for conservation in the region, Crystal Mountain has incorporated water conservation and sustainable design concepts into the Master Plan. The water conservation strategy for Crystal Mountain is presented in **Appendix B**.

4.1.3 Average Day Demand with Water Conservation Measures

While there are many areas in North America that have adopted water conservation strategies, the scope of these strategies varies widely. In most of those areas, these strategies are applied to existing built-up areas through gradual replacement of plumbing fixtures and change in personal use habits. Consequently, there are no published water use rates reflecting water conservation measures that could be readily applied to a new development such as Crystal Mountain.

In order to assess the water demand at Crystal Mountain under the water conservation scenario, it was necessary to estimate the effect the various water saving measures might have on the published water use rates (without the water conservation measures). It is acknowledged that this method is not supported by statistical data of flows actually measured from similar developments in published water use rates, except at Sun Peaks It is also acknowledged that the skiers, whether day-skiers or resident-skiers in owned or rented units, represent a relatively more affluent segment of society. They may be less receptive to water saving strategies than other segments of society. The developer, however, has a large degree of control, especially through restrictive covenants that may be established at the beginning of each project component and through metering.

The reduced water rates, therefore, represent the fixed or built-in measures, such as water saving plumbing fixtures, domestic / commercial appliances and building envelope equipment; mandatory landscaping provisions designed to enhance water conservation; and uses adjusted by a perceived change in personal water use habits.

The water demand calculated under these conditions is tabulated in the following table:

Item	Facility Type / Service	No. of Facilities	Demand Unit Type	No. of Demand Units	Demand (m^3/unit/day)	Total Demand (m^3/day)
Phase 1 – Stage 1						
1	Day Employees	n/a	Employee	70	0.068	5
2	New Day Lodge	1	m^2 Catering	250	0.083	20
3	Single Family Chalets	42	Bed Unit	252	0.161	41
4	Townhomes	139	Bed Unit	556	0.161	90
5	Condominiums – Daylodge	25	Bed Unit	75	0.173	13
6	Condominiums	25	Bed Unit	75	0.173	13
7	B&B	4	Bed Unit	32	0.184	6
					Total Phase 1 – Stage 1	**188**
Phase 1 – Stage 2						
8	Condominiums	74	Bed Unit	222	0.173	38
					Total Phase 1 – Stage 2	**38**
TOTAL PHASE 1 (Stages 1 + 2)						**226**

Table 2: Estimated Average Winter Day Water Demand at Full Occupancy (With Water Conservation Measures)

Therefore, the reduction of the water demand due to the incorporation of a water conservation program would be estimated at approximately 27 percent.

4.1.4 Fire Flows

The fire flows for Phase 1 are based upon a rate of 95 l/sec for a duration of 120 minutes, as determined by the Insurance Service Office Method for unsprinklered buildings. However, mandatory sprinklers will be part of the development. Providing adequate fire flows is primarily a matter of ensuring adequate storage volume for the required flow and adequate design of the distribution system to ensure the capability of delivering the required volume and pressure. The detail design of Phase 1 should ensure that the distribution system can deliver both this and domestic needs. The potable water storage reservoir will also be sized and located to meet this requirement.

4.1.5 Peak Water Demands

The normal ratios used for calculating peak day water demands from average day water demands are not appropriate for a ski resort. The usages generating peak flows are mostly associated with outdoor summer use such as lawn / garden irrigation, cooling, car and driveway washing, etc.

We would expect that the peak day flow for the residential / commercial components of the resort, which would occur in the winter, would be in the order of 1.25 times the average day flow, specifically 283 m^3/day.

We would expect that the peak hour domestic flow for the residential / commercial component of the resort, which would occur in the winter, would be approximately 2.00 times the peak day flow, specifically 566 m^3/day.

The Master Development Plan for Crystal Mountain expects a maximum winter season operation of 110 days. It is also expected that the average winter resort occupancy will not exceed 75 percent of rooms and 50% of beds. Therefore, the winter season cumulative water demand would be calculated as follows:

Total Volume By Bed = (226m^3/day) x (110 days) x (50% occupancy) =
12,430 m^3 Total Volume by Persons

4.2 Summer Demand

It is assumed that only the greens of the planned 18-hole golf course would be irrigated during the months of April through October. The area of the 18 holes is approximately 26.30 hectares.

Rainfall data for Crystal Mountain was not available during the preparation of this report; therefore, records from the Kelowna Airport weather station were used instead. The monthly evapotranspiration at that station is 677 mm. Based on consumptive use, precipitation, monthly mean temperature and percent annual daytime hours per month, as per the Blaney-Criddle Method, the annual required irrigation is 543 mm. Thus, the total yearly volume of water required for the irrigation of the golf course can be determined as follows:

Total Yearly Volume = (26.30 ha) x (10,000 m^2/ha) x 0.543 m = 142,809 m^3

On a monthly basis, this volume is distributed as shown below:

Month	Required Irrigation (mm)	Required Irrigation (% Total)	Monthly Required Irrigation (m^3/mth)
April	35	6.40	9,140
May	54	9.90	14,138
June	89	16.35	23,349
July	152	27.95	39,916
August	118	21.72	31,018
September	59	10.87	15,523
October	37	6.81	9,725
	543	**100.00**	**142,809 m^3**

Table 3: Volume Distribution by Month

Thus, the highest average daily irrigation demand occurs in the month of July and is approximately 1,288 m^3/day. An additional volume of water would be required if more than the greens, or a larger area than assumed, required irrigation.

The above irrigation requirements are based on the Kelowna Airport weather data. The airport is at an elevation of 429 m, while the golf course is at an approximate elevation of 1,100 m. The golf course may have somewhat heavier rainfall patterns and a lower evapotranspiration. This should result in a somewhat smaller irrigation demand than is estimated in the above table.

The final irrigation demands will be set at the detailed design stage and should respect the water conservation measures outlined in **Appendix B**.

Peak flow rates due to the combination of summer resort residents / visitors and irrigation will be driven by the golf course.

4.3 Monthly Distribution of the Water Demand

Month	**Days**	**Irrigation Required / Day** m3/day	**Total Available Supply / Day** m3/day	**Monthly Required Irrigation** (m3/mth)	**Total Monthly Supply Available** m3/month	**Net Change / Month** m3/month	**Storage Balance (Irrigation Pond)** m3
November	30	0.0	305.5	0	9,165	9,165	9,165
December	31	0.0	305.5	0	9,471	9,471	18,636
January	31	0.0	305.5	0	9,471	9,471	28,106
February	28	0.0	305.5	0	8,554	8,554	36,660
March	31	0.0	305.5	0	9,471	9,471	46,131
April	30	304.7	305.5	9,140	9,165	25	46,156
May	31	456.1	305.5	14,138	9,471	-4,668	41,488
June	30	778.3	305.5	23,349	9,165	-14,184	27,304
July	31	1287.6	305.5	39,916	9,471	-30,446	-3,142
August	31	1000.6	305.5	31,018	9,471	-21,548	-24,689
September	30	517.4	305.5	15,523	9,165	-6,358	-31,047
October	31	313.7	305.5	9,725	9,471	-255	-31,302
Total	**365**			**142,809**	**111,507.5**	**-31,301.5**	

denotes period of required irrigation

Table 4: Irrigation Balance

4.4 Demand Summary

The total estimated winter demand for completed Phase 1 is 12,430 m^3.

This is based upon an assumed bed occupancy rate of 50% for a winter season of 110 days and compliance with the water conservation measures listed in **Appendix B**.

Primary focus of providing the potable water supply will obviously be the ski resort operation. The water demand for the resort can be summarized as follows:

1. Average winter day demand at full occupancy (without water conservation measures) — 312 m^3/day
2. Average winter day demand at full occupancy (with water conservation measures) — 226 m^3/day
3. Average winter day demand at maximum expected occupancy of 75% (with water conservation measures) — 170 m^3/day
4. Peak winter day demand at full occupancy (with water conservation measures) — 282 m^3/day
5. Peak winter day demand at maximum expected occupancy of 75% (with water conservation measures) — 213 m^3/day

The “Canadian Drinking Water Standards and Guidelines” recommend that water supply should be designed for at least 110% of the projected peak daily design flow. Therefore, we suggest that the water supply source should have a total sustained capacity of approximately 235 m^3/day.

The total estimated summer demand for completed Phase 1 is 142,809 m^3.

This is based upon the estimated irrigation requirements of the golf course development and an assumption of tertiary treatment of wastewater and its subsequent reuse as irrigation for the golf course. This means that the golf course is the end recipient of all water used during the irrigation period and, therefore, no additional allowance is made for prior domestic or commercial use.

Assuming that the proposed irrigation pond has sufficient capacity and that storage losses are not too severe, it is anticipated that golf course needs will be met through re-use of treated wastewater supplemented by first-use well water and surface run-off water. Given that, at completion of Phase 1, the cumulative golf course irrigation demand is much larger than the domestic and commercial demand, the cumulative annual golf course irrigation requirement can be taken as the total annual resort demand for Phase 1, as the golf course will be the end recipient of all water supplied to the resort. There is no provision for additional demand due to non-irrigation golf course infrastructure, on the assumption that any such use would also ultimately be re-used and stored for irrigation purposes.

Therefore, the total water demand for Phase 1 development including the golf course is 142,809 m^3 annually.

The peak demand for irrigation water is in July, requiring approximately 1,288 m^3/day.

5.0 EXISTING SOURCE OF WATER SUPPLY

The existing water supply comes from a well drilled in 1991 by Capri Drilling, to a depth of 67 m, flowing (at the time it was constructed) under artesian conditions. Golder Associates conducted a 46-hour pump test on this well in October, 2001. The maximum capacity is 30.0 igpm (163 m^3/day), and the long-term yield was established to be 3.0 igpm (20 m^3/day).

This well is located in the Jack Creek watershed. The Golder Associates "Report on Assessment of Aquifer Pumping Test Existing Well near Proposed Crystal Mountain Expansion, Westbank, BC", dated January 17, 2002, estimates the total recharge rate of this watershed to be in the order of 85 to 425 l/min. (122 to 612 m^3/day)

Based on the limited size of the Jack Creek watershed and the relatively low rate of the existing well, Golder also recommended investigating the nearby Powers Creek watershed and identified four potential locations for new wells. All of these candidate drilling locations were estimated to have a recharge rate adequate for the initial phase of the proposed resort expansion. Golder Associates has completed site reconnaissance and test drilling to further investigate one of these locations. Golder Associates "Report on Test Well Drilling and Groundwater Development Potential Evaluation, Crystal Mountain Resort, Westbank, British Columbia", dated February 17, 2006, documents the drilling and testing of two test wells at a location approximately 7.5 km north of the resort in the Powers Creek watershed. The first well (TW1) proved promising, but a failure in the casing weld required it's abandonment as a potential potable water supply. A second well (TW2) was drilled in close proximity to TW1 and was successfully completed.

Pump testing was conducted on this well in accordance with BC MoE guidelines published in "Evaluating Long-Term Well Capacity for a Certificate of Public Convenience and Necessity (CPCN)," (1999), and included a 72-hour duration pump test during the low water winter months.

Testing and analysis resulted in a recommended rating of 40.0 usgpm (218.0 m3/day) for long-term yield. This report also concluded that another well 1 km away from TW2 would likely yield an additional 40 usgpm without effecting water levels at TW2 or other users.

The resort also has a license to draw water from Sitmar Creek. The license is for 2000 ig/day (67.5 m^3/day), and this water is suitable for irrigation or other auxiliary purposes.

5.1 Supply Summary

The cumulative annual water supply from known identified sources is as follows:

Existing Well Drilled in 1991	20.0 m^3/day	
New Well	218.0 m^3/day	
Total Potable Water	238.0 m^3/day	86,870 m^3/annually
Sitmar Creek Water License (irrigation and other auxiliary uses)	67.5 m^3/day	24,638 m^3/annually
Total Water Supply Currently Available	**305.5 m^3/day**	**111,508 m^3/annually**

6.0 COMPARISON OF SUPPLY AND DEMAND

The combined supply of potable water from the earlier and newly drilled wells equals 238.0 m^3/day and 86,870 m^3/annually.

The peak demand is 282 m^3/day at full occupancy with water conservation measures in place. This peak demand drops to 212 m^3/day with the expected room occupancy rate of 75%, and is estimated at 170 m^3/day at this conservative occupancy level on an average day. With the anticipated 50% bed occupancy level, the peak demand would be 141 m^3/day, and 113 m^3/day for an average day.

Without water conservation measures, the average day at 100% occupancy (a statistical impossibility) requires 312 m^3, and 390 m^3 for a peak day. At the assumed 75% room occupancy, these rates drop to 234 m^3/day for an average day and 292.5 m^3/day for a peak day.

It is anticipated that there would be few, if any, occurrences of full occupancy. In addition, many of the water conservation measures proposed are not dependent upon the consumer's choice, but are within the control of the developer through restrictive covenant. The projected sustained capacity required, based upon 75% room occupancy and effective water conservation measures, as determined by “Canadian Drinking Water Standards and Guidelines”, is estimated at 235 m^3/day.

The combined sustained well capacity of 238.0 m^3/day should therefore prove adequate for the domestic and commercial requirements proposed as Phase 1 of the resort development.

The additional water license supply from Sitmar Creek Is 2000 igpd, or 67.5 m^3/day, bringing the total available irrigation amount to 305.5 m^3/day when combined with the potable well supplies.

The irrigation demands for the golf course are in excess of this combined total supply flow for the months of May through September inclusive, assuming steady flow of well water throughout the year.

The total available flow from direct well supply and re-use from tertiary treated wastewater is available for impoundment in the irrigation pond planned for Phase 1. As shown in **Table 4**, this non-irrigation season storage equals 46,157 m^3 from November through the end of April. Preliminary assessments of this irrigation pond location indicate that this volume can be accommodated.

The current well and water license supplies may be short of the estimated requirement for the irrigation of the golf course. There is an estimated annual cumulative shortfall of 31,301 m^3, even assuming re-use of the tertiary treated wastewater from the domestic and commercial uses. Without this re-use, the estimated cumulative shortfall increases to 43,731 m^3 annually. As noted before, it is possible that due to elevation there may be no shortfall.

7.0 RECOMMENDATIONS

The addition of the recently drilled well water supply brings the total supply available to an amount sufficient to supply all domestic and commercial demands planned within the Phase 1 development, excluding the proposed golf course and assuming a few conditions. These assumed conditions are that the potable water storage reservoir should be designed to provide not only fire flow and emergency amounts, but also contain a balancing storage volume based upon the unlikely condition of full room and bed occupancy and low water conservation compliance (see below)

Fire Storage	0.095 x 60 x 120	684 m^3
Balancing Storage	Peak Day * x 0.25	98 m^3
Emergency Storage		200 m^3
Total Storage		**982 m^3**
* Peak Day flow = 283 m^3		
* For estimation purposes, taken to be 390 m^3 (full occupancy without water conservation measures)		

Table 5: Recommended Potable Water Storage

Consideration may be given to designing and constructing this potable water storage reservoir in a modular fashion to allow for expansion, if required, as the project develops further.

The inclusion of the golf course at Phase 1 of development greatly increases the demand for water due to the estimated irrigation needs.

The current well and water license supplies may be short of the estimated requirement for the irrigation of the golf course. There may be an annual cumulative shortfall of 31,301 m^3, even assuming re-use of the tertiary treated wastewater from the domestic and commercial uses. Without this re-use, the estimated cumulative shortfall increases to 43,731 m^3 annually.

It has been proposed to include a tertiary treatment plant for wastewater to allow this water to be re-used for irrigation of the golf course. Although this represents only 9% of the required irrigation volume at Phase 1, it is anticipated to increase to 45% at full build-out. It is recommended to include this level of treatment for wastewater at Phase 1, to minimize as much as possible the need for first use of water from existing wells or other sources.

As the estimated golf course irrigation requirements are based upon climate data from the Kelowna Airport, it is recommended that data be obtained from the proposed site of the golf course to better refine this demand. It is anticipated that, as Kelowna Airport is more than 700m lower in elevation than the proposed golf course, the data used may have indicated a greater irrigation need than that which will actually occur. Storage estimates also did not incorporate run-off or snowmelt accumulations, which may contribute significantly. The storage estimates for the golf course irrigation demand do not include any allowance for evaporation or other losses from the irrigation pond. Further investigation of these issues may refine the estimated irrigation demands.

It is recommended that Golder Associates proceed with locating another candidate well to alleviate the potential shortfall identified in this report. Any new well would need to be rated at a sustained yield of 15.7 usgpm (85.8 m^3/day) or greater to provide the added amount required for the estimated golf course irrigation (31,301 m^3 annually). The Golder Associates report concluded that another well 1 km away from TW2 would likely yield an additional 40 usgpm.

Other options for addressing the potential irrigation shortfall should also be further investigated. These could include accessing surface sources and snowmelt impoundment.

It is anticipated that the general location of the recently drilled well will be the preferred site for any future well drilling required, to maximize the utility of the required distribution system from this site to the reservoir. It is also recommended that the location of this distribution system include a consideration of the location of the planned RDCO pipeline from the Lambly Lake area to allow the potential for any future connection to this system to provide an alternative and a back-up to the well system at this stage of development, and a potential source for future needs at later stages of development.

To ensure that the extraction of groundwater for Crystal Mountain Resort will not adversely affect other well users in the area, it is recommended that the monitoring program outlined in Section 2 (i) (v) (F) of the Master Plan continue to be implemented.

We trust that this Preliminary Water Demand and Supply Assessment Report provides Crystal Mountain with the information requested at this time.

This report is primarily an information document. The facts and recommendations presented herewith have been developed based on the best information available at this time. Further engineering will be required as the project proceeds through the next stages of the development process.

Yours very truly,

McELHANNEY CONSULTING SERVICES LTD.

Erv Newcombe
Project Manager

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EN:van

Enclosures

APPENDIX A

APPENDIX A

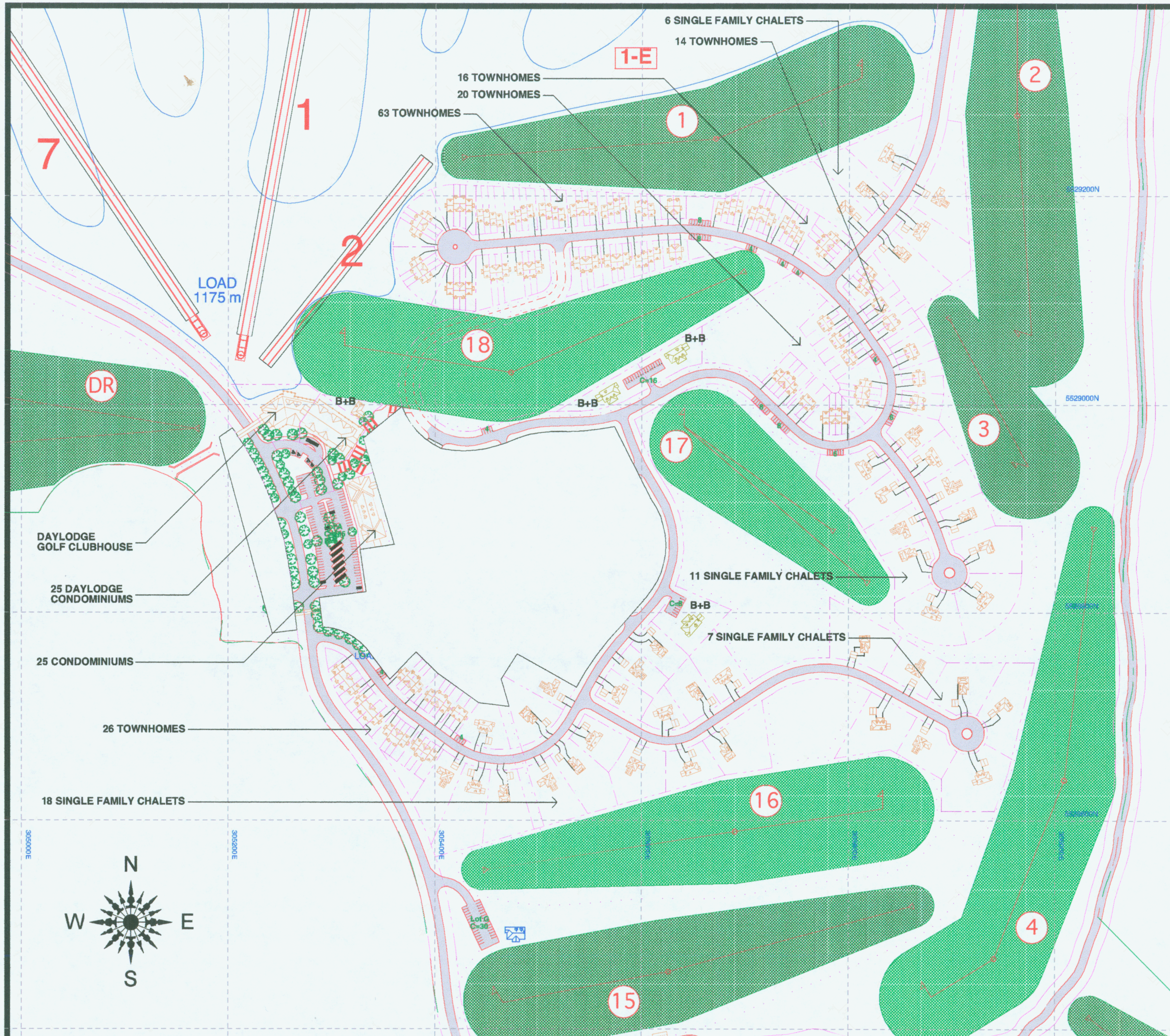
Crystal Mountain Resort - Revised Phasing Schedule - Phase 1

Phase 1 - Stage 1			
Dwelling / Building Type	**Units / Rooms**	**Bed Units / Dwelling**	**Total Bed Units**
Daylodge	1	0	0
Single Family Chalets	42	6	252
Townhomes	139	4	556
Condominiums - Daylodge	25	3	75
Condominiums	25	3	75
B+B	4	8	32
Total Phase 1 - Stage 1			**990**

Phase 1 - Stage 2			
Dwelling / Building Type	**Units / Rooms**	**Bed Units / Dwelling**	**Total Bed Units**
Condominiums	74	3	222
Total Phase 1 - Stage 2			**222**

Total Phase 1 - Stages 1 + 2	**1212**

Last Updated: Dec 06, 2005
Thomas Allan Palmer



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CRYSTAL Mountain

CRYSTAL MOUNTAIN SKI RESORT EXPANSION

BRITISH COLUMBIA

PROJECT TITLE: PROJECT NO: 2133

PHASE-1
STAGE-1
PLAN

SHEET TITLE:

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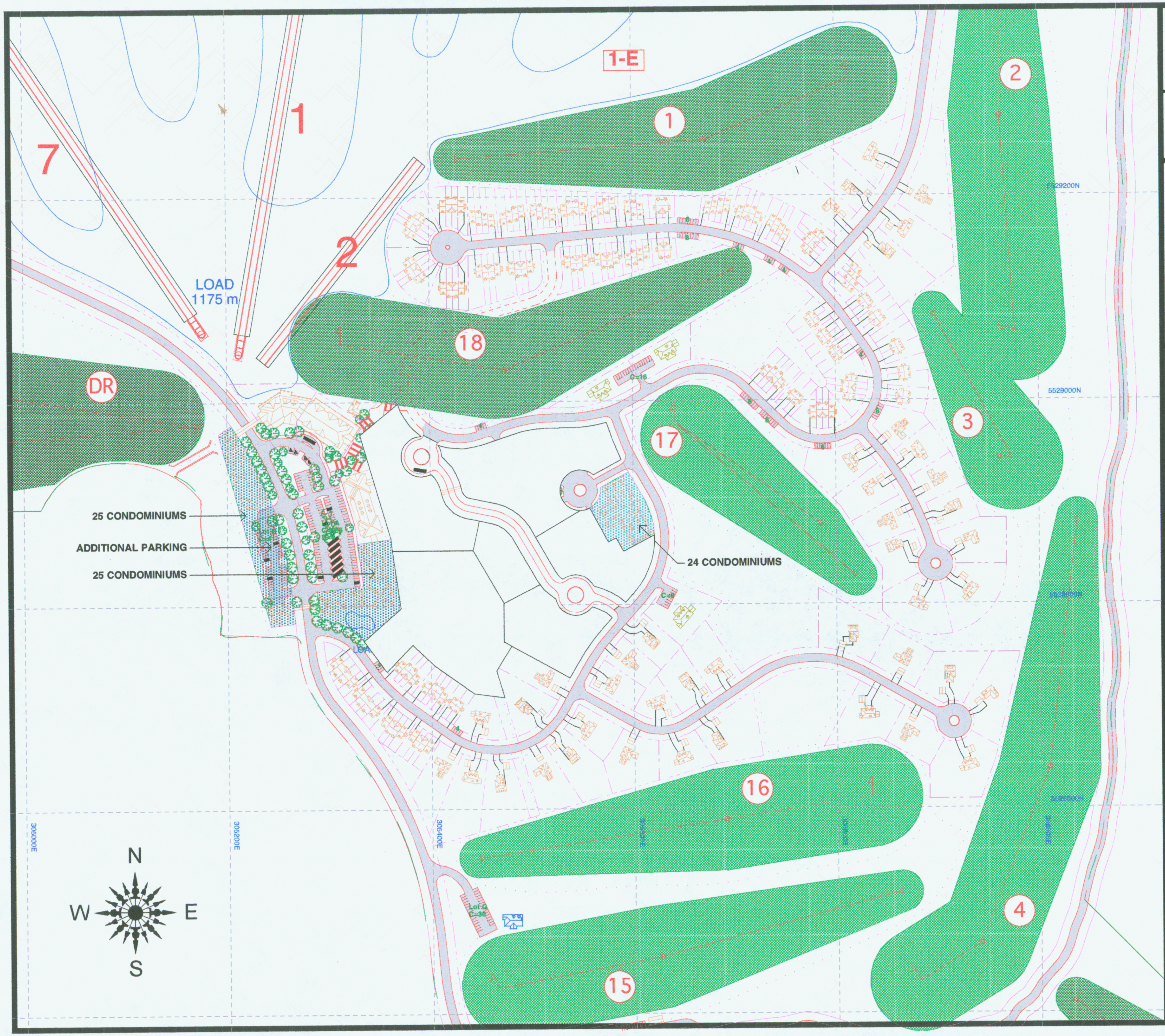

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CRYSTAL Mountain

CRYSTAL MOUNTAIN SKI RESORT EXPANSION

BRITISH COLUMBIA

PROJECT TITLE: PROJECT NO: 2133

SHEET TITLE:

PHASE-1
STAGE-2
PLAN

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APPENDIX B

1.0 WATER CONSERVATION MEASURES

The total sustained capacity of the water supply source, as determined in Section 5.0, is contingent upon incorporation of a water conservation strategy into the Master Plan for Crystal Mountain. The details of the proposed water conservation strategy are presented below.

1.1 INTRODUCTION, OBJECTIVES AND OUTLINE OF THE WATER CONSERVATION MEASURES

The extent of the resort's expansion will depend upon the potable water production of proposed wells, the availability of external water supply from the potential connection to the Westbank Irrigation District's water supply main along Powers Creek, impoundments of runoff and snow melt water, and water conservation and re-use measures.

In recognition of the concerns of the nearby water users, and the awareness of the public of the general scarcity of water and the need for conservation in the region, water conservation principles will be incorporated as part of the sustainable design concepts into the Crystal Mountain Ski Resort Expansion development.

The water conservation strategy for Crystal Mountain should consider the following range of conservation measures at the levels of planning, design, construction, operation and maintenance by the water utility company, and public awareness and education:

- Universal water metering;
- Water accounting and loss control;
- Incentive producing water costing and pricing practices;
- Non-combustible building construction where possible;
- Sprinkler systems in all buildings;
- Impounding of runoff and snow melt water;

- Landscape efficiency;
- Water system pressure management;
- Water saving plumbing fixtures;
- Water saving domestic / commercial appliances and building envelope equipment;
- Water re-use and recycling; and
- Water conservation awareness program.

The above water conservation measures can be further described as follows:

1.1.1 Universal Water Metering

It has been shown in many studies that metered water systems typically save substantial amounts of water compared to unmetered water systems. Universal water metering includes both source water metering and service connection metering. Source water metering is essential for water accounting purposes by the water utility. Service connection metering is needed to more accurately track water use and bill customers for their usage. It also informs the customers how much water they are using. All water provided free of charge for public use should also be metered in order to accurately account for water. Source meters and service connection meters should be read at the same relative time in order to facilitate accurate comparisons and analysis. Meters should be tested for accuracy on a regular basis. It is also important that the meters are properly sized to prevent under or over-registering. These practices will allow for effective leak detection and repairs as part of the normal operation and maintenance program.

1.1.2 Water Accounting and Loss Control

A water accounting system will help track water throughout the system and identify areas that may need attention, particularly large volumes of non-account water. Non-account water includes unmetered water as well as water that is metered but not billed.

Non-account water should be analyzed to identify recoverable losses and leaks in the system. The water utility company should institute a comprehensive leak detection and repair strategy. This strategy should include regular on-site testing with leak detection equipment. A loss prevention program including pipe inspection, cleaning, lining and other maintenance efforts should compliment the loss control program.

1.1.3 Incentive Water Costing and Pricing

The value of costing and pricing as a conservation strategy is in involving the water customers in understanding the true value of water, and conveying information about that value through prices. A water utility will need to be created and operate the water system under the Certificate of Convenience and Public Necessity (CNCP). The water utility will use cost-of-service accounting, consistent with generally accepted practices established by the CNCP. The customer's bill should correspond to their water usage. Any changes in the water tariff by the water utility will require an application to and approval from the water comptroller's office. The water tariff rate should be structured to promote conservation.

1.1.4 Non-Combustible Building Construction Where Possible

The Master Plan gives serious consideration to fire suppression systems in building structures. All major buildings and buildings over four storeys in height will be non-combustible and have sprinklers. All combustible buildings will have sprinklers. We recommend that the single family and bed and breakfast buildings should also have sprinklers, as the cost of providing sprinkling for small building structures is no longer prohibitive.

1.1.5 Impounding Runoff and Snow Melt Water

Consideration will be given to strategic placement of water impoundment storage areas throughout the development. Runoff and snow melt intercepting ditches or swales should be located and graded such as to channel the surface water into the impoundments. These impoundments would, depending on their location throughout the resort development, have a dual function of storing water for irrigation and/or fire fighting purposes.

1.1.6 Landscape Efficiency

Outdoor water usage drives maximum-day demand, particularly where a part of the ski resort development is a golf course. The maximum-day demand, in turn, drives the demand for larger water supply and storage, transmission and treatment facilities. Outdoor usage is often the greatest source of water demand in a resort development; therefore, reducing the outdoor usage can be a very effective water conservation strategy. The land use vision for the Crystal Mountain’s village core area, with commercial and higher density residential component of development, will promote minimal man-made landscaped areas using hard landscaping and low water use landscaping in a natural forest setting as much as possible. The single family and bed and breakfast areas of development will be landscaped to blend with the natural forest setting and avoid a city-type grass lawn landscaping as outlined in the Master Plan. Particular attention will be paid to implementation of water conservation principles to the proposed golf course. The golf course developer must be aware of the resort’s water conservation program from the early planning stage. The golf course or landscape architect should have an extensive Xeriscape experience. Xeriscape is an efficiency-oriented approach to landscaping that encompasses the following essential principles: planning and design; limited turf areas; efficient irrigation; soil improvement; mulching; use of lower water demand plants; and appropriate maintenance. The use of turf areas should be limited to where absolutely necessary, for areas such as greens, tees, landing areas, picnic areas, outside lunch areas, etc. Turf should be limited or excluded from roughs. In non-turf areas only low water use plant material should be used. Consideration should be given to dual watering systems with sprinklers for turf and low volume irrigation for plants, trees and shrubs. Tensiometer moisture probes should be used to automatically monitor the irrigation system along with other usual metering, timing and water sensing devices. The irrigation system should maximize the use of surface water from impoundments strategically located throughout the area and properly treated wastewater. The amount of irrigation should be determined by the evapotranspiration rate. The clubhouse should employ the same conservation principles as other major buildings in the resort including sprinkling, efficient fixtures and appliances.

1.1.7 Water System Pressure Management

Reducing water pressure in the distribution system can save a significant quantity of water. It can decrease leakage, amount of flow through the open fixtures, as well as stresses on pipes and joints, which may result in leaks. System-wide pressure management during the design stage should ensure that pressures in the system exceeding 45 – 50 psi are eliminated through a proper placement of pressure-reducing valve stations in the system. The reductions in pressure should obviously not compromise the integrity of the water system or quality of service for customers. Pressure-reducing valves or regulators in the buildings should fine-tune the best pressure range in individual buildings.

1.1.8 Water Saving Plumbing Fixtures

The importance of water conservation through the installation of water conserving plumbing fixtures is generally recognized by the public. In British Columbia, it is now identified in a separate building regulation, pursuant to Section 692 of the Municipal Act, entitled “Water Conservation Plumbing Regulation”. At the present time, the regulation addresses the demand side of water efficiency measures only through the inclusion of water efficient devices and fixtures by specifying maximum flow rates and flush cycles. Sanitary piping systems within the buildings that control the use of other water-efficient measures (i.e., graywater re-use) are not yet included in the regulation.

The design and construction of commercial and residential components of the resort, from single-family homes to hotels, should feature the following water-saving plumbing fixtures:

- High efficiency lavatory and kitchen faucets. These devices use 1.9 to 8.3 l/min compared with standard faucets using 11 to 19 l/min.
- High efficiency showerheads. These devices use 3.8 to 9.5 l/min compared with standard showerheads using 11 to 19 l/min.
- Low consumption direct type or flush type toilets. These devices do not use more than 6 l/flush compared to the watersaver water closets, which use 13.35 l/flush.
- Low consumption direct type or flush type urinals. These devices do not use more than 5.7 l/flush. The water supply to urinal flush tanks equipped for automatic flushing should be controlled with a timing device in order to limit operation during normal working hours.
- Low flow aerators should be used on faucets where applicable / possible.

1.1.9 Water Saving Domestic/Commercial Appliances and Building Envelope Equipment

Consideration and encouragement should be given to the use of water-saving appliances, equipment and measures including the following:

- Front loading, horizontal axis, clothes washing machines. Such machines typically use 30 percent less water and 40 – 50 percent less energy than the top loading machines.
- High water (and energy) efficient automatic dishwashers. This refers to both domestic and commercial dishwashers.
- Air conditioning units and cooling equipment. Water used in cooling equipment, such as air compressors, should be minimized in accordance with the manufacturer's recommendations.
- Hot water instant demand system. Some of these systems typically utilize electronically controlled pump / recirculating loop and gas heat.
- Installation of water heaters as close to the point of use as possible and well insulated hot water piping.

- User of water softeners should be restricted due to the frequent refresh cycling and high water consumption. As well, the water softeners could jeopardize the potential of the effluent to be used for the irrigation of the golf course.

1.1.10 Water Re-Use and Recycling

Water re-use, also synonymously known as reclamation or recycling, is re-using treated wastewater for beneficial purposes such as agricultural, golf course and landscape irrigation; cooling and industrial processes; groundwater recharge, toilet flushing, wetlands and recreational water impoundments; etc. Commonly, the source of recycled water is municipal wastewater. Recycled water requires adequate treatment (settling, filtering, disinfection, etc.) before it can be used again. As with any water source that is not properly treated, health problems could arise from exposure or drinking due to disease-causing organisms and other contaminants.

The current preferred option in the Master Plan is to utilize tertiary wastewater treatment and to re-use the treated wastewater for the irrigation of the golf course. The golf course will require the single highest water demand within the resort. This could free considerable amounts of water from potable water sources, which will have to be developed (groundwater and/or surface water from the Westbank Irrigation District's planned supply main to be located in the proximity of the resort).

Utilization of graywater re-use systems was also considered, but is not recommended for the following reasons:

- Most graywater re-use systems thus far are abandoned or achieve less than 10% re-use efficiency within five years.
- The economic payback time is often longer than the system life.
- Many such systems consume so much energy and extra materials, while saving comparatively little water, that they do not make sound investment sense. Many such systems are often technologically overbuilt using additional pumps, valves, filters, dual plumbing, and often use a lot of electricity.

- Claims made for package systems on the market are often greatly inflated and difficult to verify. While there are exceptions to the rule, they are generally very expensive, especially for small housing units, and many do not work.
- Water re-use standards and plumbing codes and regulations in British Columbia do not adequately govern the design and operation of graywater systems.

1.1.11 Water Conservation Awareness Program

Public information and education are critical to the success of any conservation program. It is recommended that Crystal Mountain adopt a water conservation awareness program strategy early in the resort's development stage. Direct savings can be made when customers change their water use habits. Public education alone may not produce the same amount of sustained water savings as other more direct approaches but it can greatly enhance the effectiveness of other conservation measures. Customers that are informed and involved are more likely to support the water utility company's conservation planning goals. An information and education program should explain all of the costs involved in supplying potable water to Crystal Mountain and demonstrate how water conservation practices will provide water users with long-term savings.