6.0 Irrigation of Golf Course Lands

6.1 METHODOLOGY

Chinook proposes to use both treated municipal wastewater and stormwater as source water for irrigation. The priority will be given to wastewater as this is the proposed disposal option. Only when the treated wastewater is completely disposed will stormwater be used for irrigation.

Treated wastewater reuse is an option in Alberta when it is environmentally acceptable and agriculturally beneficial. Construction of a spray irrigation system requires authorization under the Alberta Environmental Protection and Enhancement Act. The reference document is entitled *Guidelines for Municipal Wastewater Irrigation*, *April 2000*. It outlines all the necessary requirements for irrigation approval.

Spray irrigation systems can be constructed and operated in a number of ways. Methods of spray irrigation range from permanently installed sprinkler heads to individual movable water reels. Subsurface drip irrigation as a method of irrigation for the proposed areas of the golf course is being considered. The basic infrastructure required for wastewater reuse includes:

- A storage pond for treated water
- Pumping station
- Distribution piping
- Irrigation equipment
- Disinfection (depending on irrigation type and vegetation)
- Land to irrigate

Irrigation using stormwater is currently not well defined in Alberta. Chinook recognizes that regulatory, treatment design, irrigation design and operational issues regarding the use of stormwater water need to be addressed. Currently no approvals will be required under the Water Act (WA) and Environmental Enhancement and Protection Act (EPHA). We understand this may change in the future. Despite this, Chinook Ridge will adhere to the guidelines listed below and, if required, will treat the stormwater to the irrigation standard required for treated wastewater.

- Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems 2006, Alberta Environment
- CSA Non-potable Water Regulation B128.1, B128.2 and B128.3 (in draft)
- 2005 National Plumbing Code (in effect) and the 2010 National Plumbing Code (not in effect, however must be considered for the future)

- Activity Designation Regulations AR 276/2003

An Alberta Classification of Land for Irrigation was completed for this project as required by Alberta Environment when using treated municipal wastewater for irrigation. This report is included in **Section 6.3**.

6.1.1 Design Considerations for Wastewater Irrigation

The design flow for wastewater treatment is based on number of factors but for this system Alberta Environment requires seven months of storage (including a 25% carryover for wet year provisions) and primary treatment before effluent is applied to the fields.

This land must meet the following criteria:

- An appropriate land classification according to an accredited land irrigation classifier.
- Moderately permeable (Land Class 3 or better) soils that are not considered saline, compacted or organic (wetland) soils.
- Soils with a percolation rate between 2.0 and 24 minutes per centimeter.
- Topographic mapping with a contour interval of 0.5 meters

Table 6.1
Treated Effluent Quality Standards for Wastewater Irrigation

Parameter	Standard	Type of Sample	Comments
Total Coliform*	<1000/100 mL	Grab	Geometric mean of weekly samples (if storage is provided as part of the treatment) or daily samples (if storage is not provided), in a calendar month
Fecal Coliform*	<200/100 mL	Grab	Geometric mean of weekly samples (if storage is provided as part of the treatment) or daily samples (if storage is not provided), in a calendar month
CBOD (carbonaceous biological oxygen demand)	<100 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
COD (chemical oxygen demand)	<150 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
TSS (total suspended solids)	<100 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
EC (electrical conductivity)	<2.5 ds/m	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
SAR (sodium absorption rate)	<9	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
pH	6.5 to 9.5	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event

* For golf courses and parks only.

** Grab sample would suffice if storage is provided; Composite sample is required if storage is not provided.

6.2 STORAGE

Alberta Environment's *Guidelines for Municipal Wastewater Irrigation, 2000*, requires a minimum storage capacity of seven months (including a 25% overdesign for wet year provisions). Chinooks treated wastewater storage capacity has been determined to be 13,000

m^3. The storage pond will be lined with either clay or a synthetic liner based on the materials available and final design requirements The storage pond will be constructed to a depth of 2m and designed to meet the *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*, *Alberta Environment, 2006 and Alberta Environments Guidelines for Municipal Wastewater Irrigation*. In the event of abnormally wet weather, the storage system is over designed by 25% with the ability to irrigate additional land on the property.

6.3 LAND CLASSIFICATION FOR IRRIGATION

Stantec Consulting was requested to conduct a level ll Irrigation Assessment for a property located 35 minutes northwest of Calgary, Alberta. The property was located at SE 31-TWP 28-RNG 3-W5 (the study area) and is 60.3 ha in extent. The objective of the assessment was to evaluate the property for irrigation suitability. This assessment is complementary to other studies examining the feasibility of the site to support the development of an integrated tourism-based initiative. Development plans include an 18 hole golf course and associated tourist lodge. This irrigation suitability assessment complements other studies in support of gaining an irrigation license for the property. The purpose of the irrigation license if approved will be to allow the landowner to provide supplementary water for certain aspects of the development, including the golf green and tee locations.

The property currently serves as rural dwelling for the landowner and for hay production. A small portion of the land is forested and will remain as such. Golf course development will include import of materials needed to develop special soil mix for the golf greens, so as to match standard requirements for such features. Irrigation is intended for golf greens and tees only, using specialized procedures such as drip irrigation or subsurface dispersal of moisture.

The property is currently divided into numerous small fields and parcels. These features are permanent and the proposed golf course has been designed around their existing arrangement. The property also contains one farmstead and one outbuilding, which will not be modified if the development proceeds as planned. A conceptual fairway design has been completed and further infrastructure design is underway for such features as the Lodge. Groundwater studies and applications needed to provide water for the proposed irrigation have been completed and submitted.

6.3.1 Description of Activity

In addition to the 18-hole golf course, Chinook Ridge Lodge & Golf Course will include 21 Room Boutique Hotel on the upper level, a Banquet Hall with seating for up to 500 people with a Commercial Kitchen, His and Hers Spas, exercise/weight-room, 2 esthetician stations, Locker Rooms, Spike Room, meeting and break-out rooms and a Pro-shop. The Lodge will require water for showering, toilets, food preparation, cleaning and laundry. An RV (stall style) camp-site will consist of 15 RV stalls and there will be 15 solar powered sleeping cabins. None of these will have individual hook ups. A potable water filling station will be provided upon entry.

6.3.2 Methods Used for Land Classification

A desktop review of baseline conditions was conducted to obtain information on geology, surficial materials, climatic conditions, and soil resources of the study area. Aerial photographs, both stereo and mosaic, were used for preliminary analysis. Stereo photographs were digitized and loaded into an electronic platform that allowed soil unit mapping on a computer screen. The use of digital imagery allowed zooming in to scales of 1:2,500 and allowed very precise delineation of units and features.

Field work was conducted to provide sufficient data to complete a level II Irrigation Classification analysis and report (Alberta Agriculture Food and Rural Development, 2004). Ground disturbance procedures were followed, primarily through the Alberta First Call program, to identify and mark buried facilities. Soil inspections were completed by hand auger, drill truck, or by tractor-mounted backhoe at 12 locations distributed over the ~ 60 ha study area. Sites were selected to be representative of potential soil map units. In addition to these soil inspection points, drilling records for approximately 5 groundwater wells in the study area were available to augment deeper inspection site data. Although groundwater well driller logs were not a substitute for soil inspections, they did provide another source of information to assist in the soil interpretations.

Six of the 12 inspection sites were completed by hand auger and shovel. Soil profiles were described according to standard procedures (Expert Committee on Soil Survey, 1982) and classified to the subgroup (Soil Classification Working Group, 1998). Correct series names were applied with the most recent provincial soil names file (Brierley et al., 2006) and through contact with Agriculture Canada (Tony Brierley, per. Comm., 2011). Soil samples were collected from four inspection sites, in increments of 50 cm starting at the surface to a depth of 200 cm. Samples were collected from deeper horizons at two additional sites. Samples were analyzed for salinity parameters and particle size at EXOVA labs.

Results of point inspections were overlaid in ARCGIS to assist in map unit delineation. Map units were rated for irrigation suitability based on field and laboratory observations and measurements. Parameters described during map unit development included landform, texture, subgroup, depth to bedrock, depth of water table, and salinity. Each unit was rated based on modal profile and topographic indices, and the results were presented in tabular and figure form.

6.3.3 Environmental Setting

The study area is underlain by Tertiary age bedrock belonging to the upper Paskapoo formation (Alberta Geologic Survey, 1999). The study area has an elevation of approximately 1225 meters. In terms of physiography, the study area occurs on the Nosehill Benchland of the Southern Alberta Uplands (Pettapiece, 1986). The materials in this physiographic district are primarily morainal blankets to veneers overlying rolling bedrock. Shetsen (1990) has mapped the area as draped moraine, with till deposits generally less than 5 m in thickness. The study area occurs within SCA 8, the Foothills Parkland zone, with Black Chernozemic soils dominant. Soils of the immediate area are primarily of the Dunvargan series (Alberta Soil Information

Center, 2001), with land capability class 4, limited by heat inputs (4H). The property is within the Red Deer River basin.
Frost free period is generally 95 to 105 days (Alberta Agriculture, Food, and Rural Development, 2005). Climate normals (1971-2000) for Madden, AB, are an average of 466 mm precipitation per year, with 1307 degree days above 5C (Environment Canada, date of access May 31, 2011).

6.3.4 Results

Most inspection sites were classified as Black Chernozemic, with Orthic and Gleyed subgroups most common, reflecting climate and vegetation influence of the parkland ecoregion (Appendix A). Depressional areas were typically classified as Gleysolic Order soils. The distribution of Orthic and Gleyed subgroups was somewhat related to slope position, but was in addition likely influenced by differential permeability of underlying saprolite and the thickness of overlying till. Soil drainage for Chernozemic soils ranged from moderately well to imperfectly drained, whereas Gleysolic soils in depressional areas were typically poorly drained.

Parent materials encountered at inspection sites were typically some combination of till and saprolite, with the exception of the deeper till sites where saprolite was not encountered (Appendix A). Till ranged in thickness from being absent (exposed Saprolite) to a blanket (1 to 2 m thick) to approximately 5 m thickness, as reported in completed water wells drill logs. Water well drilling records for the property show that bedrock was encountered at depths below surface ranging from 2 to 28 feet (Appendix D). Till was typically moderately fine textured while saprolite ranged from medium to moderately fine, occasionally fine textured. Till was typically friable whereas saprolite ranged from friable to very firm, or sticky when wet. In general, saprolite became firmer with depth such that it is probably impermeable at some depth below surface. Mapping was successful at separating areas of land based on estimated thickness of till over the saprolite. In general, the more level the topography the thinner the overlying till deposits. Undulating to hummocky areas and inclined surfaces in the southwest corner had the deeper till deposits.

Topsoils were present at all sites and were typically less than 20 cm thickness (Appendix B). Carbonate content was relatively high reflecting the carbonate abundance in the region. Laboratory analyses show that soils are non-saline, non-sodic, and that field and lab textures were in reasonable agreement (Appendix C). All sampled profiles had EC less than 0.5 dS/m, and SAR consistently less than 0.5. Salinity and sodicity was therefore not a concern in this setting, as would be expected in this combination of tertiary aged bedrock and relatively well leached profiles. Soil pH usually neutral to alkaline reflecting high carbonate contents in parent materials.

Surface flow from an emphemeral channel on the property flows to the northwest. A series of linear sloughs located in the southwest of the property also send surface flow to the northwest. Supporting groundwater records are presented in Appendix D. Several of the wells at the SW corner of the property indicate till is relatively thick (Stantec Consulting, 2010). Well logs from elsewhere on the property mirror results obtained in this soil survey, that bedrock occurs relatively close to the surface. The results of soil mapping and irrigation classification are

presented in Appendix E. Areal extents of each irrigation class are shown in Table 1 below. Finally, Appendix F shows the laboratory results as received from EXOVA Laboratories.

Profiles were rated in two primary groups, those with soil rating of class 3 and those with soil rating of class 4. Those in Class 3 are typically of the Dunvargan and related variants. Class 3 soils usually had two meters or more of till overlying saprolite. Soils of class 4 included both the Hatfield series for Chernozemic soils on saprolite material. Class 4 soils usually had less than 2 meters of till and for much of the area had weathered saprolite near of at the land surface. There were also two delineations of class 4 areas dominated by Gleysolic soils, and these were rated as 4 due to wetness, shallowness to saprolite, or both. All the delineations with class 4 soils were rated as class 6 for irrigability, or as non-irrigable. The delineations with Class 3 soils were also rated as Class 3 for irrigability.

Slopes were usually 9% and less, with most of the property being undulating or level. Areas near an incised drainage system were inclined. Areas with shallower saprolite tended to have level topography, whereas thicker till deposits were associated with undulating to hummocky land surface expression. Due to the relatively shallow slopes, topography ratings for delineations were class 2. These ratings reflect the expectation that irrigation will be conducted by specialized means, rather than through sprinkler irrigation using large diameter pivots. The specialized irrigation procedures mean that the current small field sizes and irregular shape are not limiting to the kind of irrigation system that would be put in place.

Table 6.2. Summary of Irrigation Rating Extents						
Irr Rtg	**Soil Rtg**	**Topo Rtg**	**Depth to Bedrock Class**	**Drainability**	**Limitation**	**Area (ha)**
3	3	2	S2	Y	Limited by weathered saprolite that is greater than 2 m but often less than 3 m depth	22.4
Subtotal						22.4
6	4	2	S3	Y	Limited by weathered saprolite within 2 m (R)	9.8
6	4	2	S4	Z	Limited by weathered saprolite within 2 m (R)	21.5
6	4	2	S4	Z	Limited by combination of weathered bedrock within 1 m and of wetness and shallow water table (R,W)	2.9
6	4	2	S1	Y	Limited by wetness and/or shallow water tables (W)	0.9
6	4	2	S4	Z	Limited by heavy brush and trees and weathered saprolite within 1 meter (R,B)	2.0
Subtotal						37.1
Non-classified					Farmyards, forest, driveway, miscellaneous	0.7
				Total		60.3

Results of irrigation classification are shown in **Figure 6.1**. The soil map on which the classification is based is shown in **Figure 6.2**. Map unit descriptions are provided in **Table 6.3**.

Table 6.3: Map Unit Description for Legend	
Rating	Extent (ha)
3 S:3 T:2 Y, R	22.4
Fair irrigation capability, suitable for specialized irrigation only. The soils are dominantly Orthic Black, with Gleyed Black Chernozem's of significant extent. Parent materials consist of a blanket of moderately fine textured till that overlies weathered bedrock (saprolite). However the saprolite typically occurs between 2 and 3 m depth. The unit is thus limited by the presence of saprolite usually greater than 2 m depth. Topography ranges from undulating to hummocky to inclined, with slopes ranging from 2 to 9%. This irrigation class makes up 22.4 ha of the property. There is a large sandstone bedrock erratic just below surface in the vicinity of site CL09, occupying an area of about 10 m diameter. The presence of this rock should be incorporated into any design feature.	
Rating	Extent (ha)
6 S:4 T:2 Z,R	21.5
Nonirrigable, pending implementation of improvements or other reclamation measures. Soils include both Orthic and Gleyed Black Chernozemic. The major limitation to irrigation in these areas is the presence of nearly impermeable saprolite at or very close to the land surface. While upper layers of saprolite are usually friable, medium to moderately fine textured, deeper depths tend to have firmer consistence and will likely have much reduced permeability as compared to upper depths. The use of these areas for irrigation will likely require specific irrigation measures such as drip irrigation as well as construction of thicker soil covers for the golf greens. The effect of thicker soil at the golf green will be to effectively achieve a thicker cover of permeable soil above the saprolite. This class of irrigation land makes up 21.5 ha of the total.	
Rating	Extent (ha)
6 S:4 T:2, Z,B,R	2.0 ha

Nonirrigable, pending implementation of improvements or other reclamation measures. There are two major limitations to irrigation in this area. The first is the presence of nearly impermeable saprolite at or very close to the land surface. While upper layers of saprolite are usually friable, medium to moderately fine textured, deeper depths tend to have firmer consistence and will likely have much reduced permeability as compared to upper depths. The second limitation is the current mature forest cover that precludes the development of irrigation.

The decision to remove parts of the forest and include these as part of the golf course development has not been made yet. Therefore, the use of these areas for irrigation will likely require specific irrigation measures such as drip irrigation as well as construction of thicker soil covers for the golf greens, besides removal of the trees. The effect of thicker soil at the golf green will be to effectively achieve greater soil thickness above the saprolite. This class of irrigation land makes up 2.0 ha of the total.

Rating	Extent (ha)
6 S:4 T:2, Y,W	0.9 ha

Non-irrigable pending an improvement, which for this would be enhanced surface drainage. Water well records from this area indicate till deposits are considerably deeper than elsewhere on the property. However, this land is nonirrigable, due to high water tables. Soils are Rego Humic Gleysols, non-saline, but are poorly drained because of the landscape position. Although golf fairways will likely cross this linear feature, golf tee and green construction will likely be planned to avoid this low area. This unit makes up less than 1 ha of the total.

Rating	Extent (ha)
6 S:4 T:2, Y	9.8 ha

Non-irrigable pending further improvement. The soils are dominantly Orthic Black, with Gleyed Black Chernozem's of significant extent. Parent materials consist of a blanket of moderately fine textured till that overlies weathered bedrock (saprolite). However the saprolite typically occurs between 1 and 2 m depth. The unit is thus limited by the presence of saprolite that can be nearly impermeable at some locations. The use of these areas for irrigation will likely require specific irrigation measures such as drip irrigation as well as construction of thicker soil covers for the golf greens. The effect of thicker soil at the golf green will be to effectively achieve sufficient cover of permeable soil above the saprolite. Topography is undulating with slopes

ranging from 2 to 5%. This irrigation class makes up 9.8 ha of the property.	
Rating	Extent (ha)
6 S:4 T:2, Z,W	2.9 ha
Non-irrigable, due to the combination of shallow saprolite, high watertables and poorly drained soils, pending further improvement,. The major limitation to irrigation in these areas is the presence of nearly impermeable saprolite at or very close to the land surface. While upper layers of saprolite are usually friable, medium to moderately fine textured, greater depths tend to have firmer consistence and will likely have much reduced permeability as compared to upper depths. In addition to the material limitations, soils are poorly drained. The high water tables are likely due to seepage from adjacent springs that outcrop from shallow bedrock upslope. It would be possible to improve the irrigation rating of this land by providing surface drainage, simply by ditching the land to drain into the natural drainage to the north. Implementation of additional drainage is feasible given the topographic position of the site. In addition, greens will be developed with imported soil, such that soil cover above the saprolite will be thicker than it now is. The unit makes up 2.9 ha of the property.	
Land Not rated.	0.7 ha
The property contains two farmsteads, neither rated for irrigability. Development of golf course facilities will not likely impinge on these features. However they can be moved if necessary.	

Legend for Land Irrigability Classification Figure 6.1

Land Classes

1- Excellent irrigation capability
2- Good irrigation capability
3- Fair irrigation capability
4- Restricted irrigation capability
5R- Temporarily irrigable, undergoing reclamation
5- Nonirrigable, pending further study
6- Nonirrigable

Soil Categories

1- Irrigable- Excellent
2- Irrigable- Good
3- Irrigable- Fair
4- Nonirrigable

Topography Categories

1- Irrigable- Gravity
2- Irrigable- Sprinkler
3- Irrigable- Special System
4- Nonirrigable

Soil Limitations

A- combination of minor soil limitations
B- brush/tree cover
D- low permeability/undesirable structure
E- erosion damage
K- shallow profile development
L- geological layering
M- low moisture holding capacity
N- sodicity
R- shallowness to bedrock
S- salinity
W- excessive wetness

Topography Limitations

F- surface drainage
G- steep slopes
I- periodic flooding
J- field size, shape
P- stoniness
RB- rough-broken
U- earth moving

Drainability

X- moderately to rapidly permeable
Y- slowly permeable
Z- relatively impermeable

Legend for Soil Map Figure 6.2

SOIL TAXONOMY		SOIL PHASES		GENETIC MATERIAL	
DG	Dark Grey Black	calc	calcareous	E	Eolian
BL.C	Chernozem	li	lithic	M	Morainal(Till)
G	Gleysol Humic	st	stony	R	Bedrock
HG	Gleysol	yp	saprolite > 1 m	S	Saprolite(Residual)
O	Orthic	xp	saprolite < 1 m	U	Undifferentiated
R	Rego				
CA	Calcareous				
GL	Gleyed				

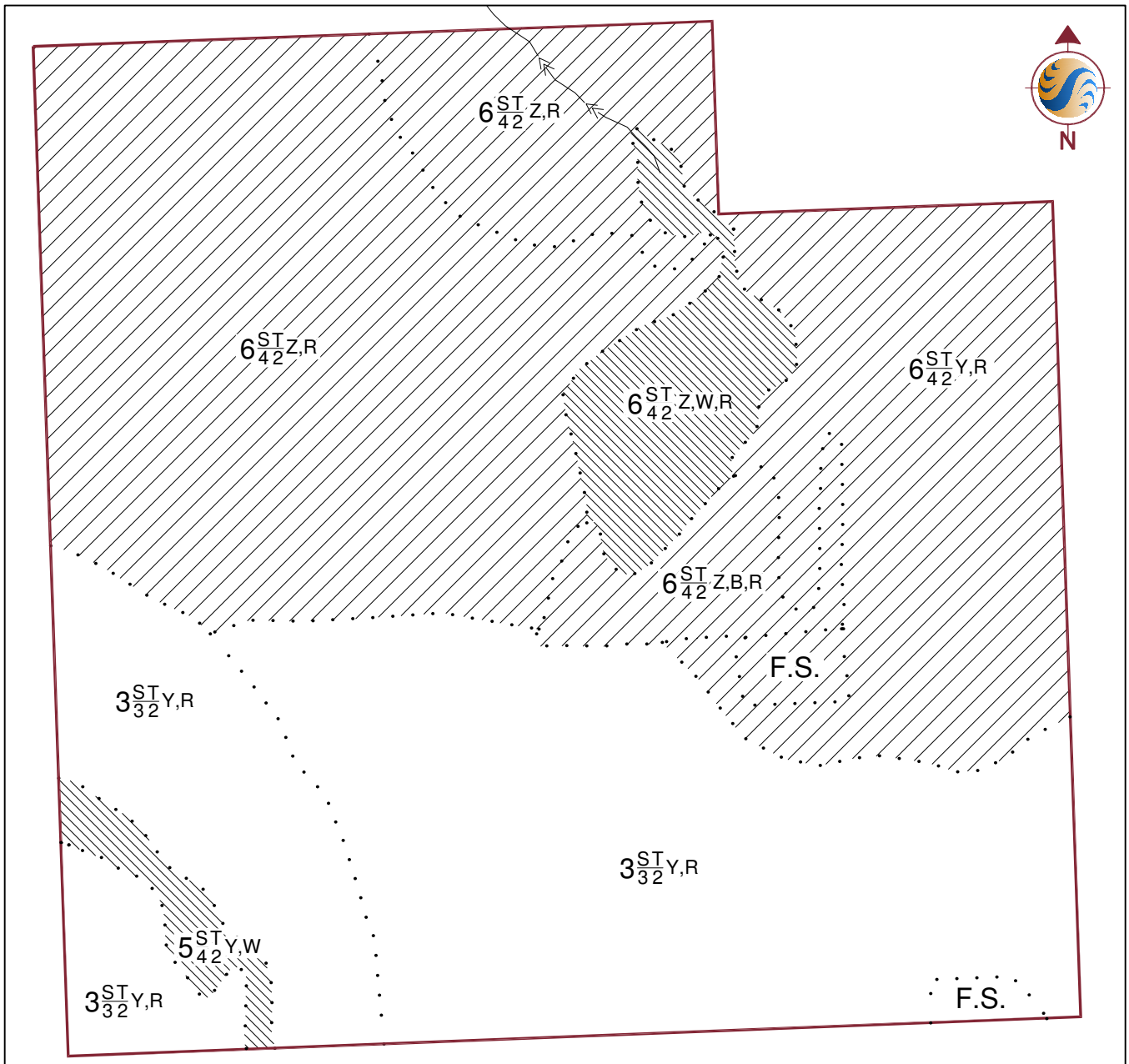
SURFACE EXPRESSION				TEXTURE	
a	apron	s	steep	0	Gravel
b	blanket	t	terraced	1	Sand
f	fan	u	undulating	2	Loamy Sand
h	hummocky	v	veneer	3	Sandy Loam, Fine Sandy Loam
i	inclined			4	Loam, Silt Loam, Very Fine Sandy Loam
l	level			5	Silty Clay Loam, Clay Loam, Sandy Clay Loam
m	rolling			6	Silty Clay, Clay, Sandy Clay
r	ridged			7	Heavy Clay

SLOPE CLASS	PERCENT SLOPE	TERMINOLOGY
1	0-0.5	Level
2	0.5-2	Nearly Level
3	2-5	Very gentle slope
4	6-9	Gentle slope
5	10-15	Moderate slope
6	16-30	Strong slope

DEPTH TO GROUNDWATER		DEPTH TO BEDROCK('R) OR SAPROLITES(S)		
CATEGORY	DEPTH	CATEGORY		DEPTH
W1	>2	R1	S1	>3
W2	1-2	R2	S2	2-3
W3	<1	R3	S3	1-2
		R4	S4	<1

ABUNDANCE DESIGNATION

~	nearly equal occurrence
:	significant
-	range
;	minor occurrence



SOIL SYMBOL
LAND CLASS
SOIL CATEGORY
$3\frac{ST}{33}Y,R$
TOPOGRAPHY SYMBOL
LIMITING FACTORS
DRAINABILITY
TOPOGRAPHY CATEGORY

Legend

INVESTIGATION BOUNDARY	SLOUGH OR WETLAND	F.S.	FARMSTEAD
LAND CLASS BOUNDARY	COULEE OR LOW AREA	D.O.	DUGOUT
FIELD BOUNDARY	DRAINAGE CHANNEL	B.P.	BORROW PIT
NON-IRRIGABLE	FARM IRRIGATION DITCH	D.L.	DISTURBED LAND

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Scale
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0 50 150 250m

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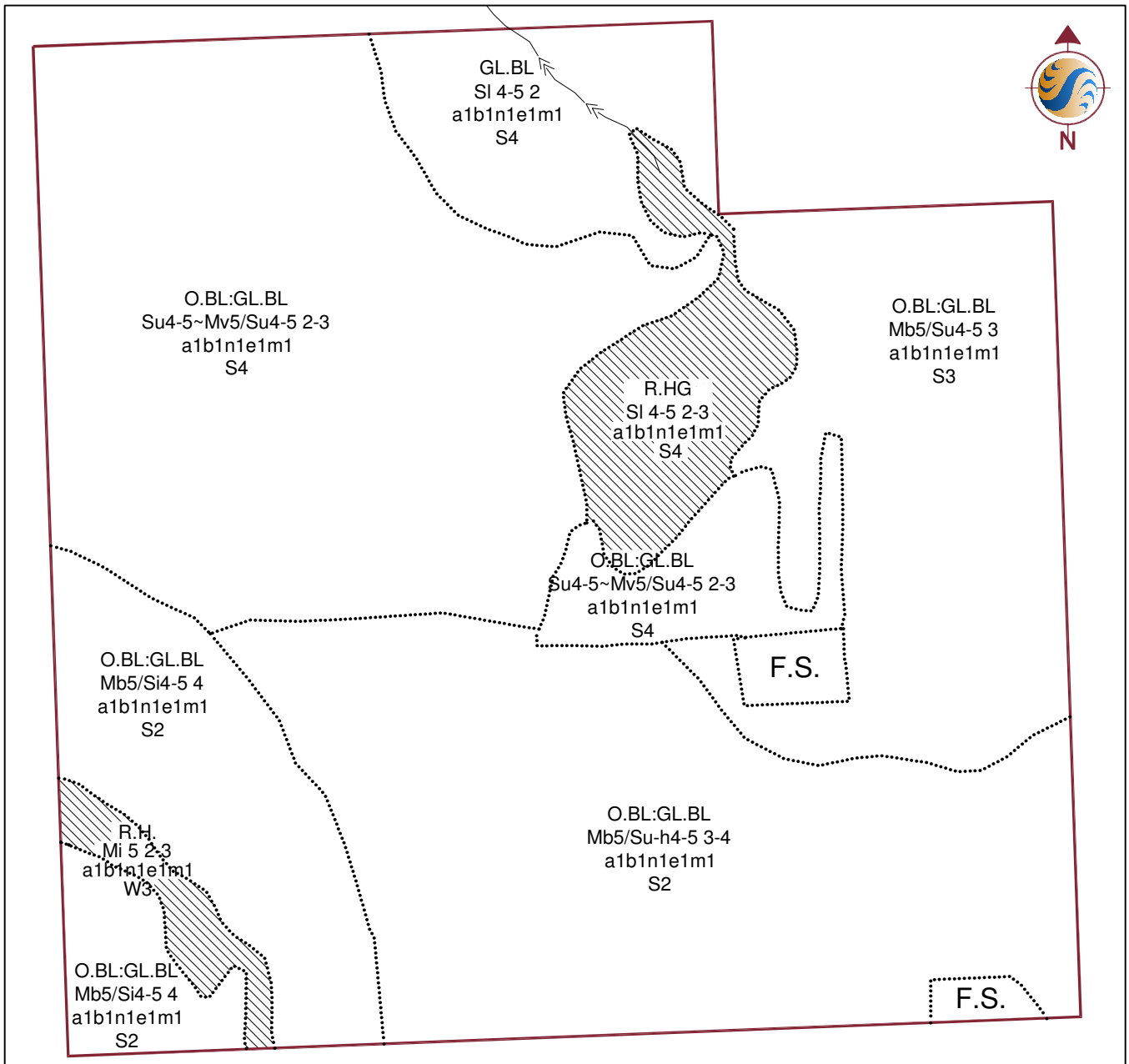
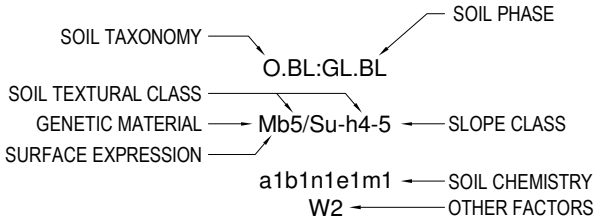
INTEGRATED WATER MANAGEMENT PLAN

Figure No.
6.1

Title
Irrigability Classification
SE 31-28-3 W5M





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0 50 150 250m

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INTEGRATED WATER MANAGEMENT PLAN

Figure No.

6.2

Title

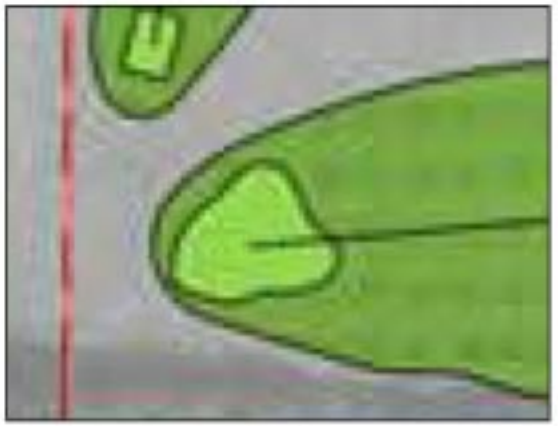
Soil Map
SE 31-28-3 W5M

6.3.5 Land Classification Discussion

Detailed field mapping show that much of the quarter section is rated as non-irrigable, usually based on shallow depth of saprolite or weathered bedrock. However, circumstances of the proposed development suggest that consideration be given towards granting an irrigation license. First, the development is for a golf course, not improved agricultural productivity. Second, the irrigation is proposed only for a limited part of the total area. Rainfall will remain the dominant form of water for the greens and Tee boxes, and irrigation will be applied only to the latter features. These features make up as little as 10% of the total area (6 ha over the quarter section) and furthermore each feature is dispersed, such that individual patch sizes receiving irrigation are a quarter hectare or less in size. Each of the 18 holes has one green of approximately 300 - 400 m^2 and three T-boxes of 175 - 225 m^2 each. Thus the total irrigation footprint is less than 600 m^2 (0.05 ha) per hole (**Figure 6.3**). Thus the patches of land receiving supplementary watering are limited in extent and highly dispersed. Third, additional soil materials are required to create the topographic and material characteristics needed for the tees and greens. These outside materials will result in thicker material depths, such that saprolite will be deeper than before. Water tables in the Gleysolic soil areas will also be further below surface, suggesting that greens and tees will be at least one moisture class drier in these presently poorly drained areas. The addition of materials and adjustment of surface contour will rely on gentle slopes currently present. Thus, potential for increased soil erosion during water application is minimized, due to orientation of fairways parallel to the slope, not perpendicular. Finally, the techniques of applying water will be more advanced that typical moisture delivery techniques that rely on pivots or gravity. This development will rely on drip irrigation and/or subsurface delivery of water through buried pipes. Moisture additions will be monitored by soil moisture sensors, such that additions will not exceed atmospheric demand and deep percolation will be minimized. Additions of water will match atmospheric demand through linking moisture additions with air temperature and soil moisture reserves. These considerations suggest that the irrigation license can be granted without compromising soil quality at this location.

6.3.6 Land Classification Conclusions

A field based Level ll assessment of the irrigation potential of the study area has concluded that some 22 ha of land rate as class 3, while a further 37 ha rates as class 6. The very limited extent of land proposed for irrigation however, coupled with very efficient irrigation system linked to precise estimates of soil water demand will ensure that irrigation can be successful in this setting. Only about 10% of the total area needs to be irrigated by special means, and only after soil profiles are artificially constructed to the standards required for golf fairways. The water supply used for irrigation will include a combination of groundwater and possibly wastewater. Irrigation supplements will be tied to atmospheric demand such that deep percolation of water will be minimized.



GREEN
300-400m²

TEE BOX
175-225m²

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INTEGRATED WATER MANAGEMENT PLAN

Figure No.
6.3

Title

The total proposed irrigation area has been determined to be less than 20 acres and as stated in the Water Act "*Guideline for Preparing Agricultural Feasibility Reports for Irrigation Reports"*, September 2002 an Agricultural Feasibility Report is not required for Golf Courses unless the irrigation water source is treated wastewater. A Water Act Application will be submitted to irrigate the greens and tee boxes. Although the Land Classification for Irrigation would deem this land as non-irrigable the the small land area and land improvements in terms of golf course construction would warrant a suitable irrigation rating and the process of irrigation would not cause deterioration of land quality. Examples of improvements will be:

- Soil amendments to increase the separation distance between the surface and limiting layers
- Utilization of irrigation spray technology to minimize over watering and reduce water demand
- The irrigation systems design will ensure only proposed areas of greens and tee-boxes to be are irrigated

6.4 IRRIGATION VOLUME REQUIREMNTS

The total annual wastewater estimated volume is 17,800 m^3. This water will not be released to the environment therefore the priority will be to use treated wastewater before using stormwater for irrigation.

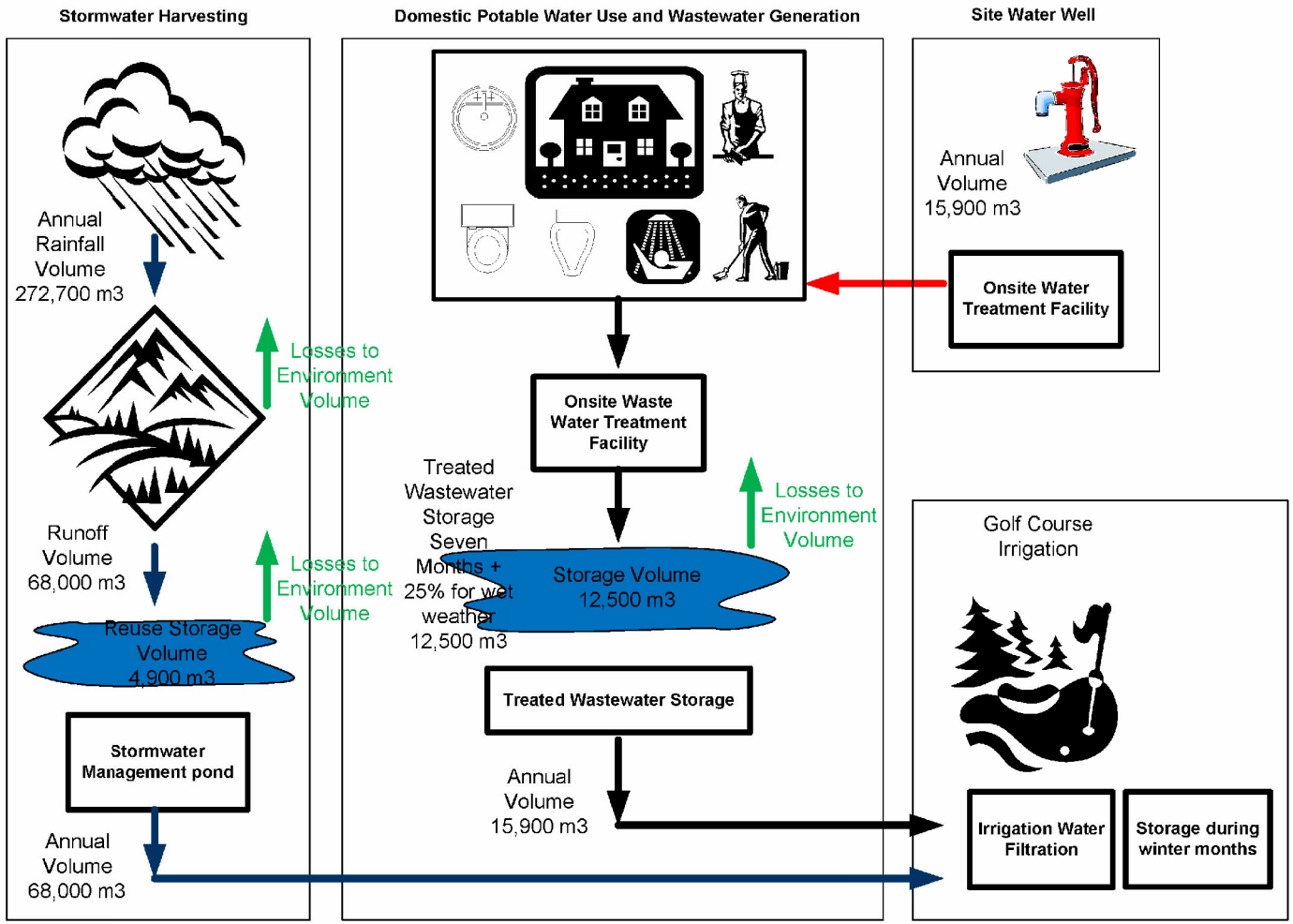
Based on comparisons to similar size golf courses in the vicinity, an 18-hole golf course irrigating its entire land area can use daily on average between 400 and 500 m^3/day of water. Chinooks Ridge plans on irrigating only the tee-boxes and putting green. This accounts for approximately 20% of the irrigable golf course area. Based on this assumption we estimate the daily average of irrigation water to be between 80 and 100 m^3/day. With the average golf course season in Alberta being 185 days, Chinook will have available for irrigation, 96 m^3/day of treated wastewater for golf course irrigation. These calculations do not account for evaporation or other losses. Once the treated wastewater availability is gone any additional water required will be made up from stormwater. The amount of available water from stormwater is summarized in **Table 5.4**

The concept water balance is shown in **Figure 6.4**

6.5 IRRIGATION SYSTEM DESIGN

The irrigation system can only be designed once the golf course design is complete therefore specific design detains are not described in this report. Much effort will be put into the design of the irrigation system to minimize the water required and in the case of irrigation with treated wastewater, protect public health and safety and the environment.

Chinook Lodge IWM Concept



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2011-08-15 12:24PM By: lgrebaz

August, 2011
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Stantec

Client/Project

CHINOOK RIDGE LODGE AND GOLF COURSE LTD.

INTEGRATED WATER MANAGEMENT PLAN

Figure No.

6.4

Title

IWM Concept

6.6 IRRIGATION SCHEDULE

The irrigation schedule for both treated wastewater and treated stormwater will be the same. The intent of developing a schedule is to ensure public health and safely during an irrigation event.

Effluent irrigation is allowed from May 1st to September 30th and is not allowed during periods of rain, excessive wind and when temperatures are below freezing. This system requires a moderate level of operator attention during the irrigation season. In addition, regular coordination with golf course personnel is required. It will be necessary to provide routine maintenance for the disinfection system and media filters. The treated wastewater will be stored in a pond during non-irrigating winter months from October 1st to April 30th. The facility has considered in its design, elements to prevent damage to the system due to freezing during winter months such as drains, cleanouts, vacuum relief, insulation and isolation valves.

Irrigation events will be restricted to the following conditions:

- Notification to adjacent land owners of when the irrigation season is to begin
- Irrigation will only occur between 21:00 hours and 07:00 hours unless the watering is done manually
- The golf course must be closed for use by golfers
- The soil must not be frozen nor be snow on the ground
- Wind speeds will not exceed 30 kph

Irrigation will not occur if either the soils management report or groundwater reports indicate adverse affects to the environment or to the adjacent land owners.

6.7 IRRIGATION SETBACKS

The setback for irrigation of the golf course tee boxes and greens including the storage pond will be designed as shown in **Table 6.4**:

Table 6.4
Setback Distances for Treated Wastewater Irrigation

Setback from:	Irrigation Fields		Storage Pond
	Minimum	Preferred	
Surface Waters/Lakes/Reservoirs	30 meters	50 meters	50 meters
Residential Dwelling	60 meters	100 meters	100 meters
Roads/Public Corridors/Wells	30 meters		30 meters
Property Boundaries	15 meters		15 meters

6.8 SOIL AND GROUNDWATER MONITORING PLAN

A soil monitoring plan will be prepared by a qualified professional environmental engineer and a report completed annually that addresses the nutrient balance of the soil and overall soil conditions. The report will make recommendations on irrigation scheduling, water and nutrient loadings for upcoming irrigation events so that changes to the operating plan can be made if required.

A groundwater monitoring plan will be prepared by a qualified professional hydrogeologist to monitor any potential adverse effects on the groundwater resulting from irrigation. An annual report will be prepared and make recommendations on any required changes to the irrigation plan.

6.9 EMERGENCY OPERATION AND CONTINGENCY PLAN

An emergency and contingency plan will be developed to ensure environmental and public health and safety. This plan will include a description on bypassing the system, shutting down the system and repairing the system. The plan will include contingencies for times when nutrient loadings are high and if irrigation water is not required due to higher than average precipitation.

6.10 ANNUAL IRRIGATION REPORTING

An annual report will be prepared by a qualified professional environmental engineer that summarized the previous year activities and will include but not limited to:

- Review of description of activities
- Review of equipment design and layouts

- Soil and groundwater reports
- Water and nutrient balance summaries
- Operational data
- Equipment maintenance logs and records

7.0 Operations

7.1 POTABLE WATER OPERATION

Typical water treatment systems are equipped with basic operational controls which can be configured according to the operational demands of the system. These control systems will include level sensors, alarms, pressure sensors etc. More advanced control systems have smart features such as digital programmable panels and remote telemetry panels. These advanced controls can allow setting of multiple parameters, and monitoring and communication system operation to suit the system requirements. However, the selection on type of control systems shall be made based on detailed design of the proposed system.

7.1.1 Back-up systems

Back up pumps and supporting equipment shall be stored on site and potable water can be hauled to the site and stored in the storage tank.

7.2 WASTEWATER OPERATION

The *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Alberta Environment, 2006,* outline the treatment plant classification, operator classification and monitoring requirements.

Seasonal operation – Canada's four distinct seasons need to be considered in the design phase. Insulation strategies in the design will ensure the systems do not freeze during the winter months. Additional design considerations include water infiltration during summer precipitation and spring thaw. The design will consider the significantly reduced occupancy during the winter months and its effect on flow, loading and treatment.

The wastewater treatment (WWT) plant classification is Level 2 for the Chinook Lodge treatment system. Guidelines to determine the classification of the plant, the operator class and operation, monitoring and compliance requirements are outlined in the *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Alberta Environment, 2006.*

These tables from this standard are included in **Appendix B**:

7.2.1 Back-up Systems

In an event of non-compliance water quality or mechanical problems, the wastewater will be hauled from the septic tank to the nearest treatment facility for disposal. The ATU system will be comprised of modules than can be taken off-line and repaired individually.

7.3 STORMWWATER SYSTEM

The stormwater system will be operated as per the irrigation demands and drainage requirements. Both rate control and water quality are important considerations for stormwater leaving the site. It is important to collect as much water required for irrigation and still allow for the storage of the 1:100 year storm event. Real-time control and manual level controllers (valves) will be designed to maintain storage volumes.

8.0 Conclusions

The conclusions and recommendations for the proposed Chinook Ridge Lodge and Golf Course are as follows:

Water

- The source water for the development will be high quality groundwater.
- The total maximum daily potable water demand has been determined to be 45 m^3/day.
- Based on the well logs, the pumping Well #3 is currently capable of producing the daily demand and can also be pumped for short periods at rates up to 98 m^3/day.
- Due to the hardness levels of the groundwater, it will be treated for hardness using ion exchange.
- To address public health and safety, an inline chlorination system will add residual chlorine to the water and will be pumped to the lodge and RV filling station.
- The potable water system will be designed in accordance with all regulatory requirements summarized in this report.

Wastewater

- The total maximum wastewater flow for the treatment system are assumed to be same as water demand at 45 m^3/day.
- The recommended wastewater system for this facility is Orenco's Advantex system which will meet the standards for reuse. The proposed system will also require installation of on-lot facilities such as septic tank, pumps, alarms, control panels and service connection to the lodge.
- The wastewater disposal method will be golf course irrigation.
- The winter storage pond for reuse will be sized to hold 12,500 m^3 which will be disposed of during the summer months as golf course irrigation.
- To address public health and safety, treated wastewater used for irrigation water will be disinfected prior to use.

- The domestic waste water system will be designed in accordance with all regulatory requirements summarized in this report.

Stormwater Management System

- The storm runoff volume and peak flow rates will increase with the development of the study site as a lodge and golf course.
- Two wet ponds for stormwater management are proposed on the site to facilitate the storage, treatment, reuse and controlled discharge of storm runoff. The pond in Basin 1 requires an active detention volume of 6,100 m^3 and the pond in Basin 2 requires an active detention volume of 5,900 m^3, based on the storage requirements for a 1:100 year 24 hour rainfall event.
- Grass swales will be used to convey storm runoff from the site to the wet ponds.
- Storm runoff from the contributing area south of the study site should be diverted around the edge of the study site. By doing so, the required size of the wet ponds will be reasonable.
- The golf course should be designed to maintain the existing natural topography as much as possible. The golf course design should also accommodate the recommended drainage facilities that have been recommended (i.e. ponds, swales, berm)
- Best management practices and LID features for stormwater management on the proposed golf course, as indicated in this report, should be implemented during the design and operation of the proposed golf course and lodge.
- Stormwater will be used for irrigation if the demand requires and only once the treated wastewater is no longer available.
- Based on the above findings of the storm drainage requirements, it is recommended that the proposed development of the study site be approved.

9.0 References

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- Potable Water Regulation
- Environmental Protection and Enhancement Act
- Water Act
- Alberta Safety Codes Act

- Alberta Private Sewage Systems Standard of Practices 1999 handbook
- Guidelines for Municipal Wastewater Irrigation, April 2000
- Wastewater Engineering Treatment and Reuse, Metcalf and Eddy, Fourth edition

10.0 Appendices

Appendix A. Profile Results

Figure 5.1 .1. Profile Results

Site ID	Zone	Easting	Northing	Materials	Soil Subgroup	Series and Phase	Slope(%)	Surface Expression	Slope Position	Site Drainage
CL01	11U	680589	5701355	Medium textured till	GL.BLC	DVGgl	2	Undulating	Mid	I
CL02	11U	680604	5701557	Medium textured till overlying fine textured saprolite	O.BLC	DVGyp	2	Undulating	Crest	W
CL03	11U	680204	5701087	Moderately fine textured till	OBLC	DVG	7	Undulating	Upper	W
CL04	11U	679950	5701225	Moderately fine textured till	RBLC	DVGzr	8	Inclined	Mid	W
CL05	11U	680057	5701538	Medium textured residual overlying fine textured residual	OBLC	HFD	1	Undulating	Mid	W
CL06	11U	680390	5701156	Moderately fine textured till	OBLC	DVG	8	Hummocky	Crest	W
CL07	11U	680393	5701069	Moderately fine textured till overlying moderately fine textured residual	OBLC	DVGxp	7	Undulating	Crest	MW
CL08	11U	680390	5701156	Large sandstone bedrock erratic just below surface					Crest	
CL09	11U	679952	5701011	Moderately fine textured till	GLBLC	DVGgl	8	Inclined	Mid	I
CL10	11U	680371	5701514	Moderately fine textured till overlying moderately fine textured residual	RHG		0	Undulating	Level	P

CL11	11U	680223	5701683	Moderately fine textured residual	OBLC	HFD	4	Undulating	Lower	MW
CL12	11U	679972	5701611	Medium textured residual	GLBLC	HFDgl	2	Undulating	Upper	I

Notes

Phase

gl – gleyed

yp-saprolite or bedrock encountered at a depth 1 to 2 meters below surface

zr-rego phase

xp-saprolite or bedrock encountered within 1 m of the land surface

Appendix B. Horizon Characteristics

Table B.1. Horizon Characteristics

Site ID	Layer No	Horizon	UL	LL	Color	Coarse Frags %	Tex Code	Struct Grade	Struct Class	Struct Kind	Consistence	Carbonates	Mottle Abundance	Mottle Size	Mottle Contrast
CL01	1	Ap	0	17	10YR3.5/1	2	L	Mod	Med	GR	Friable				
CL01	2	Bmgj	17	36	2.5Y4/3	2	SL	Mod	Med	SB	Friable		Many	fine	Distinct
CL01	3	Ckgj	36	100	2.5Y5/2	5	L			MA	Friable	S	Common	Fine	Distinct
CL02	1	Ap	0	26	10YR2/1	1	L	Mod	Fine	GR	Friable				
CL02	2	Bm	26	41	10YR3/4	1	L	Weak	Med	SB	Friable				
CL02	3	Ck	41	100	10YR4/2	1	SiCL			MA	Firm	M			
CL02	4	IICgjk	100	200	2.5Y5/3	0	SiC			MA	Very firm	M	Common	Fine	Faint
CL03	1	Ap	0	33	10YR3/1	1	L	Weak	Fine	GR	Friable				
CL03	2	Bm	33	53	10YR4/3	1	CL	Weak	Med	SB	Friable				
CL03	3	Ck	53	120	2.5Y4/2	1	CL			MA	Firm	S			
CL03	4	Ckgj	120	300	2.5Y4/3	2	CL			MA	Firm	S	Few	Med	Faint

CL04	1	Ap	0	33	10YR2/1	1	L	Weak	Fine	GR	Friable				
CL04	2	ACk	33	58	5Y3/2	1	L	Weak	Med	SB	Friable	S			
CL04	3	Ck1	58	100	2.5Y4/3	1	CL	Weak	Coarse	PR	Firm	S			
CL04	4	Ck2	100	200	2.5Y4/3	2	CL			MA	Firm	S			
CL05	1	Ap	0	20	10YR2/1	0	L								
CL05	2	Bm	20	40	10YR3/3	0	L	Weak	Medium	SB	Friable				
CL05	3	Ck	40	80	10YR5/2	0	SL	Strong	Coarse	PL	VFI	S			
CL05	4	IICkg	80	120	2.5Y5/2	0	C			MA	Firm	S	Common	Med	Prom
CL05	5	IIICk	120	200	2.5Y5/3	0	SiL			MA	Friable	S			
CL06	1	Ap	0	16	10YR3/2	1	L	Mod	Med	GR	Friable				
CL06	2	Bm	16	39	10YR4/4	2	L	Weak	Fine	SB	Friable				
CL06	3	Ck1	39	82	10YR4/3	5	SiCL	Weak	Med	SB	Friable	S			
CL06	4	Ck2	82	200	10YR5/3	15	CL				Firm				

CL07	1	Ap	0	9	10YR3/1	1	L	Weak	Fine	GR	Friable				
CL07	2	Bm	9	35	10YR4/3	5	L	Weak	Med	SB	Friable				
CL07	3	Ck	35	82	10YR4/2	15	CL			MA	Friable	S			
CL07	4	IICkg	82	150	2.5Y5/1	0	SiCL			MA	Friable	S	Common	Coarse	Prom
CL08					/										
CL09	1	Ap	0	27	10YR2/1	1	L		Fine	GR					
CL09	2	Bmgj	27	47	10YR4/3	1	CL	Weak	Fine	SB			Common	Fine	Faint
CL09	3	Ck	47	100	2.5Y4/3	3	SiCL			MA	Firm	S			
CL10	1	Ahg	0	25	10YR2/1	0	SiCL			MA	Sticky				
CL10	2	Ckgj	25	50	2.5Y4/1	5	SiCL			MA	Sticky		Common	Fine	Distinct
CL10	3	IICkg	50	80	2.5Y5/2	20	SiCL			MA	Sticky		Many	Med	Prom
CL11	1	Ap	0	35	10YR2/1	0	L	Weak	Fine	GR	Friable				
CL11	2	Bm	35	100	2.5Y4/3		SCL	Weak	Med	SB	Friable				
CL12	1	Ap	0	25	10YR2/1	0	L				Friable				
CL12	2	Bm	25	44	10YR4/3	0	SiCL	Weak	Med	SB	Friable				
CL12	3	Ckgj	44	80	10YR5/2	0	SiL			MA	Friable	S	Common	Fine	Distinct

Notes

Kind of Structure

GR-granular

SB-subangular blocky

MA-massive

PL-platy

Appendix C. Lab Results

Table C.1. Lab Results for Site CL02, DVGyp series

Sample Label	Depth (cm)	Textural Class	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL02-1	0-50	CL	20	49	31	63	7.6	0.42	0.1
CL02-2	50-100	L	30	49	21	46	8.0	0.35	0.2
CL02-3	100-150	SiC	7	48	45	76	8.0	0.28	0.2
CL02-4	150-200	SiC	6	54	40	71	8.0	0.27	0.3

Table C.2. Lab Results for Site CL03, DVG series

Sample Label	Depth (cm)	Texture	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL03-1	0-50	CL	22	48	29	65	6.9	0.51	0.2
CL03-2	50-100	CL	25	41	33	49	7.7	0.32	0.2
CL03-3	100-150	CL	22	43	34	53	7.8	0.27	0.2
CL03-4	150-200	CL	26	40	34	49	7.8	0.27	0.2

Table C.3. Lab Results for Site CL04, DVGzr series

Sample Label	Depth (cm)	Texture	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL04-1	0-50	L	26	48	26	73	7.1	0.90	<0.1
CL04-2	50-100	CL	30	41	29	53	7.7	0.65	0.1

CL04-3	100-150	CL	28	38	34	61	8.0	0.26	0.2
CL04-4	150-200	CL	28	38	34	53	7.9	0.29	0.2

Table C.4. Lab Results for Site CL05, HFD series

	Depth (cm)	Texture	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL05-1	0-50	L	45	34	21	48	7.8	0.33	0.2
CL05-2	50-100	SiL	24	54	22	50	8.1	0.30	0.2
CL05-3	100-150	SiL	18	57	35	44	8.1	0.27	0.2
CL05-4	150-200	SiCL	5	60	35	66	8.1	0.25	0.3

Table C.5. Lab Results for partial profile, Site CL06, DVG series

	Depth (cm)	Texture	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL06-1	39-82	SiCL	18	47	34	58	7.8	0.31	0.1
CL06-2	82-200	CL	26	40	33	51	7.9	0.28	0.1

Table C.6. Lab Results for partial profile, Site CL07, DVGxp series

	Depth (cm)	Texture	% Sand	% Silt	% Clay	% Saturation	pH	EC	SAR
CL07-1	35-82	CL	24	46	29	59	7.8	0.33	<0.1
CL07-2	82-150	SiCL	12	53	34	57	7.9	0.28	0.1

Appendix D. Soil Characteristics noted from Drilling Logs of water wells

Table D.1. Soil characteristics noted from drilling logs of water wells completed in the study area

GIC Well ID	Latitude	Longitude	Description
399552	51.434730	114.405993	Hard sandstone encountered at 2 feet below surface
2023705	51.434800	114.406000	Reached brown shale at 15 feet below surface
416470	51.434730	114.405993	Reached brown shale at 28 feet below surface
2090571	51.434780	114.406001	6 feet of brown till over brown sandstone
416469	51.434730	114.405993	Reached brown shale at 28 feet below surface
399551	51.434730	114.405993	Reached hard brown sandstone at 7 feet below surface

Appendix D. Soil Unit Descriptions and Ratings

Table E.1. Soil Unit Descriptions and Ratings

Soil Unit Class	Material Description	Slope Class and surface exp	Soil Series	Proportion of unit %	Profile Rating	Geologic Material Rating	Texture Rating	Salinity Modification	Drainage Modifier	Rating	Final Rating class for soil unit	Topo Rating	Irrig rating class
O.BL (dom) GL.BL (sig)	till blanket over undulating to hummocky saprolite with S > 2 m	3-4 u-h	DVG	70	100	90	80	100	100	72			
			Gleyed DVG	30	70	90	80	100	100	50			
			Weighted by proportion							66	3[a]	2	3
O.BL (dom) GL.BL (sig)	till blanket over Inclined saprolite, S> 2 m	4i	DVG	70	100	90	80	100	100	72			
			Gleyed DVG	30	70	90	80	100	100	50			
			Weighted by proportion							66	3[a]	2	3
O.BL (dom) GL.BL (sig)	till blanket over undulating saprolite, S at 1 to 2 m	3u	DVG yp	70	100	20	80	100	100	16			
			Gleyed DVG	30	70	20	80	100	100	11			

			yp										
			weighted							15	4	2	6
O.BL (dom) GL.BL (sig)	Discontinuous till veneer over level to undulating saprolite. Saprolite to surface over about half of unit	2-3u	HFD	70	100	20	80	100	100	16			
			Gleyed HFD	30	70	20	80	100	100	11			
			Weighted by proportion							15	4	2	6
O.BL (dom) GL.BL (sig)	Discontinuous till veneer over level to undulating saprolite. Saprolite to surface over about half of unit	2-3u, currently forested	HFD	70	100	20	80	100	100	16	4	2	6
			Gleyed HFD	30	70	20	80	100	100	11			
			Weighted by proportion							15	4	2	6
R.HG	Till blanket, R>2 m	Depressional	Gley sol	100	60	90	80	100	--[b]	43	4[b]	2	6
R.HG	Saprolite	Depressional	Gley sol	100	60	20	50	100	--[b]	6	4[b]	2	6
GL.BL	Saprolite	Level	Gleyed HFD	100	70	20	80	100	100	11	4	2	6

[a] although these profiles actually calculate out as class 2, the presence of bedrock at the 2 to 3 meter depth places these soils in Soil Category 3 [b] poor drainage results in these units becoming Soil Category 4		

Appendix E. Original Copy of Laboratory Results

Exova
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

T: +1 (780) 438-5522
F: +1 (780) 438-0396
E: Edmonton@exova.com
W: www.exova.com

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	10160 - 112 Street	Name:	Chinook Ridge	Date Received:	May 24, 2011
	Edmonton, AB, Canada	Location:	Cochrane, AB	Date Reported:	May 27, 2011
	T5K 2L6	LSD:	SE 31-28-3 W5M	Report Number:	1437578
Attn:	Ryan Devlin	P.O.:			
Sampled By:		Acct code:			
Company:					

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Accounts Payable Stantec Consulting Ltd.-Edm	10160 - 112 Street Edmonton, Alberta T5K 2L6 Phone: (780) 969-2033 Fax: (780) 917-7249 Email: stantec.accounts.payable.	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Merge Reports
Ivan Whitson Stantec Consulting Ltd.-Edm	10160 - 112 Street Edmonton, Alberta T5K 2L6 Phone: (780) 917-7034 Fax: (780) 917-7249 Email: ivan.whitson@stantec.com	On [Lot Verification] send (COA) by Email - Merge Reports On [Report Approval] send (Test Report, COC) by Email - Merge Reports
Ryan Devlin Stantec Consulting Ltd.-Edm	10160 - 112 Street Edmonton, Alberta T5K 2L6 Phone: (780) 969-2263 Fax: (780) 917-7289 Email: ryan.devlin@stantec.com	On [Lot Verification] send (COA) by Email - Merge Reports On [Report Approval] send (Test Report, COC) by Email - Merge Reports

Notes To Clients:

Exova
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

T: +1 (780) 438-5522
F: +1 (780) 438-0396
E: Edmonton@exova.com
W: www.exova.com

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Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

Sample Disposal Date: June 26, 2011

All samples will be stored until this date unless other instructions are received. Please indicate other requirements below and return this form to the address or fax number on the top of this page.

☐ Extend Sample Storage Until _____ (MM/DD/YY)

The following charges apply to extended sample storage:

Storage for an additional 30 days	$ 2.50 per sample
Storage for an additional 60 days	$ 5.00 per sample
Storage for an additional 90 days	$ 7.50 per sample

☐ Return Sample, collect, to the address below via:

- ☐ Greyhound
- ☐ DHL
- ☐ Purolator
- ☐ Other (specify) _____

Name _____
Company _____
Address _____
_____
Phone _____
Fax _____

Signature _____

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7217 Roper Road NW
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F: +1 (780) 438-0396
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:		Lot ID:	**804789**
Report To:	Stantec Consulting Ltd.	ID:	149104750	Control Number:	
	10160 - 112 Street	Name:	Chinook Ridge	Date Received:	May 24, 2011
	Edmonton, AB, Canada	Location:	Cochrane, AB	Date Reported:	May 27, 2011
	T5K 2L6	LSD:	SE 31-28-3 W5M	Report Number:	1437578
Attn:	Ryan Devlin	P.O.:			
Sampled By:		Acct code:			
Company:					

		Reference Number	804789-1	804789-2	804789-3	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL02-1 / 0-50 / CM	CL02-2 / 50-100 / CM	CL02-3 / 100-150 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Loam	Silty Clay	
Sand	50 µm - 2 mm	% by weight	20.4	30.0	7.4	
Silt	2 µm - 50 µm	% by weight	48.8	48.6	47.8	
Clay	<2 µm	% by weight	30.8	21.4	44.8	
Salinity						
pH	Saturated Paste	pH	7.6	8.0	8.0	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.42	0.35	0.28	0.01
SAR	Saturated Paste		0.1	0.2	0.2	
% Saturation		%	63	46	76	
Calcium	Saturated Paste	meq/L	3.97	2.99	1.56	0.01
Calcium	Saturated Paste	mg/kg	49.8	27.7	23.8	
Magnesium	Saturated Paste	meq/L	0.71	0.70	1.12	0.02
Magnesium	Saturated Paste	mg/kg	5.4	3.9	10.3	
Sodium	Saturated Paste	meq/L	0.22	0.27	0.30	0.04
Sodium	Saturated Paste	mg/kg	3	3	5	
Potassium	Saturated Paste	meq/L	0.07	0.07	0.05	0.03
Potassium	Saturated Paste	mg/kg	2	1	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:	
Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

			Reference Number	804789-4	804789-5	804789-6	
			Sample Date				
			Sample Time				
			Sample Location				
			Sample Description	CL02-4 / 150-200 / CM	CL03-1 / 0-50 / CM	CL03-2 / 50-100 / CM	
			Matrix	Soil	Soil	Soil	
Analyte		**Units**		**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties							
Texture				Silty Clay	Clay Loam	Clay Loam	
Sand	50 µm - 2 mm	% by weight		6.0	22.4	25.4	
Silt	2 µm - 50 µm	% by weight		53.6	48.2	41.2	
Clay	<2 µm	% by weight		40.4	29.4	33.4	
Salinity							
pH	Saturated Paste	pH		8.0	6.9	7.7	
Electrical Conductivity	Saturated Paste	dS/m at 25 C		0.27	0.51	0.32	0.01
SAR	Saturated Paste			0.3	0.2	0.2	
% Saturation		%		71	65	49	
Calcium	Saturated Paste	meq/L		1.48	4.42	2.67	0.01
Calcium	Saturated Paste	mg/kg		21.0	57.6	26.3	
Magnesium	Saturated Paste	meq/L		1.13	1.20	0.70	0.02
Magnesium	Saturated Paste	mg/kg		9.6	9.5	4.2	
Sodium	Saturated Paste	meq/L		0.36	0.26	0.23	0.04
Sodium	Saturated Paste	mg/kg		6	4	3	
Potassium	Saturated Paste	meq/L		0.12	0.08	0.10	0.03
Potassium	Saturated Paste	mg/kg		3	2	2	
TGR	Saturated Paste	T/ac		<0.1	<0.1	<0.1	

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Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:	
Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

		Reference Number	804789-7	804789-8	804789-9	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL03-3 / 100-150 / CM	CL03-4 / 150-200 / CM	CL04-1 / 0-50 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Clay Loam	Loam	
Sand	50 µm - 2 mm	% by weight	22.4	26.4	26.0	
Silt	2 µm - 50 µm	% by weight	43.2	39.6	47.6	
Clay	<2 µm	% by weight	34.4	34.0	26.4	
Salinity						
pH	Saturated Paste	pH	7.8	7.8	7.1	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.27	0.27	0.90	0.01
SAR	Saturated Paste		0.2	0.2	<0.1	
% Saturation		%	53	49	73	
Calcium	Saturated Paste	meq/L	2.03	1.98	6.78	0.01
Calcium	Saturated Paste	mg/kg	21.6	19.3	98.5	
Magnesium	Saturated Paste	meq/L	0.55	0.57	1.80	0.02
Magnesium	Saturated Paste	mg/kg	3.6	3.3	15.8	
Sodium	Saturated Paste	meq/L	0.24	0.26	0.19	0.04
Sodium	Saturated Paste	mg/kg	3	3	3	
Potassium	Saturated Paste	meq/L	0.09	0.09	0.83	0.03
Potassium	Saturated Paste	mg/kg	2	2	24	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:		Lot ID:	**804789**
Report To:	Stantec Consulting Ltd.	ID:	149104750	Control Number:	
	10160 - 112 Street	Name:	Chinook Ridge	Date Received:	May 24, 2011
	Edmonton, AB, Canada	Location:	Cochrane, AB	Date Reported:	May 27, 2011
	T5K 2L6	LSD:	SE 31-28-3 W5M	Report Number:	1437578
Attn:	Ryan Devlin	P.O.:			
Sampled By:		Acct code:			
Company:					

		Reference Number	804789-10	804789-11	804789-12	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL04-2 / 50-100 / CM	CL04-3 / 100-150 / CM	CL04-4 / 150-200 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Clay Loam	Clay Loam	
Sand	50 µm - 2 mm	% by weight	30.4	28.4	28.0	
Silt	2 µm - 50 µm	% by weight	40.8	38.2	37.6	
Clay	<2 µm	% by weight	28.8	33.4	34.4	
Salinity						
pH	Saturated Paste	pH	7.7	8.0	7.9	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.65	0.26	0.29	0.01
SAR	Saturated Paste		0.1	0.2	0.2	
% Saturation		%	53	61	53	
Calcium	Saturated Paste	meq/L	5.01	1.85	1.94	0.01
Calcium	Saturated Paste	mg/kg	53.5	22.5	20.7	
Magnesium	Saturated Paste	meq/L	1.24	0.59	0.72	0.02
Magnesium	Saturated Paste	mg/kg	8.0	4.4	4.7	
Sodium	Saturated Paste	meq/L	0.20	0.19	0.20	0.04
Sodium	Saturated Paste	mg/kg	2	3	2	
Potassium	Saturated Paste	meq/L	0.18	0.17	0.18	0.03
Potassium	Saturated Paste	mg/kg	4	4	4	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:	
Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

		Reference Number	804789-13	804789-14	804789-15	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL05-1 / 0-50 / CM	CL05-2 / 50-100 / CM	CL05-3 / 100-150 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Loam	Silt Loam	Silt Loam	
Sand	50 µm - 2 mm	% by weight	45.4	24.4	18.4	
Silt	2 µm - 50 µm	% by weight	34.2	53.6	57.2	
Clay	<2 µm	% by weight	20.4	22.0	24.4	
Salinity						
pH	Saturated Paste	pH	7.8	8.1	8.1	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.33	0.30	0.27	0.01
SAR	Saturated Paste		0.2	0.2	0.2	
% Saturation		%	48	50	44	
Calcium	Saturated Paste	meq/L	3.05	2.48	1.73	0.01
Calcium	Saturated Paste	mg/kg	29.4	24.6	15.2	
Magnesium	Saturated Paste	meq/L	0.67	0.68	0.93	0.02
Magnesium	Saturated Paste	mg/kg	3.9	4.1	4.9	
Sodium	Saturated Paste	meq/L	0.23	0.19	0.29	0.04
Sodium	Saturated Paste	mg/kg	2	2	3	
Potassium	Saturated Paste	meq/L	0.05	0.04	0.07	0.03
Potassium	Saturated Paste	mg/kg	<1	<1	1	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Analytical Report

Bill To:	Stantec Consulting Ltd.	Project:	
Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

		Reference Number	804789-16	804789-17	804789-18	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL05-4 / 150-200 / CM	CL06-1 CK1 / CM	CL06-2 CK2 / CM	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Silty Clay Loam	Silty Clay Loam	Clay Loam	
Sand	50 µm - 2 mm	% by weight	5.4	18.4	26.4	
Silt	2 µm - 50 µm	% by weight	59.8	47.2	40.2	
Clay	<2 µm	% by weight	34.8	34.4	33.4	
Salinity						
pH	Saturated Paste	pH	8.1	7.8	7.9	
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.25	0.31	0.28	0.01
SAR	Saturated Paste		0.3	0.1	0.1	
% Saturation		%	66	58	51	
Calcium	Saturated Paste	meq/L	1.38	2.78	2.11	0.01
Calcium	Saturated Paste	mg/kg	18.1	32.1	21.4	
Magnesium	Saturated Paste	meq/L	0.80	0.64	0.62	0.02
Magnesium	Saturated Paste	mg/kg	6.3	4.4	3.8	
Sodium	Saturated Paste	meq/L	0.35	0.13	0.16	0.04
Sodium	Saturated Paste	mg/kg	5	2	2	
Potassium	Saturated Paste	meq/L	0.14	0.12	0.10	0.03
Potassium	Saturated Paste	mg/kg	4	3	2	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	

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Analytical Report

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Report To:	Stantec Consulting Ltd.	ID:	149104750	Control Number:	
	10160 - 112 Street	Name:	Chinook Ridge	Date Received:	May 24, 2011
	Edmonton, AB, Canada	Location:	Cochrane, AB	Date Reported:	May 27, 2011
	T5K 2L6	LSD:	SE 31-28-3 W5M	Report Number:	1437578
Attn:	Ryan Devlin	P.O.:			
Sampled By:		Acct code:			
Company:					

		Reference Number	804789-19	804789-20		
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	CL07-1 / 35-82 / CM	CL07-2 / 82-150 / CM		
		Matrix	Soil	Soil		
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Silty Clay Loam		
Sand	50 µm - 2 mm	% by weight	24.4	12.4		
Silt	2 µm - 50 µm	% by weight	46.2	53.2		
Clay	<2 µm	% by weight	29.4	34.4		
Salinity						
pH	Saturated Paste	pH	7.8	7.9		
Electrical Conductivity	Saturated Paste	dS/m at 25 C	0.33	0.28		0.01
SAR	Saturated Paste		<0.1	0.1		
% Saturation		%	59	57		
Calcium	Saturated Paste	meq/L	3.11	2.01		0.01
Calcium	Saturated Paste	mg/kg	36.7	22.7		
Magnesium	Saturated Paste	meq/L	0.66	0.81		0.02
Magnesium	Saturated Paste	mg/kg	4.7	5.5		
Sodium	Saturated Paste	meq/L	0.12	0.16		0.04
Sodium	Saturated Paste	mg/kg	2	2		
Potassium	Saturated Paste	meq/L	0.09	0.08		0.03
Potassium	Saturated Paste	mg/kg	2	2		
TGR	Saturated Paste	T/ac	<0.1	<0.1		

Approved by:

Randy Neumann, BSc
General Manager

Exova
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

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F: +1 (780) 438-0396
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Quality Control

Bill To: Stantec Consulting Ltd.
Report To: Stantec Consulting Ltd.
10160 - 112 Street
Edmonton, AB, Canada
T5K 2L6
Attn: Ryan Devlin
Sampled By:
Company:

Project:
ID: 149104750
Name: Chinook Ridge
Location: Cochrane, AB
LSD: SE 31-28-3 W5M
P.O.:
Acct code:

Lot ID: **804789**
Control Number:
Date Received: May 24, 2011
Date Reported: May 27, 2011
Report Number: 1437578

Physical and Aggregate Properties

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Sand	% by weight	76.0	75.4	10	0.1	yes
Silt	% by weight	20.6	21.2	10	0.1	yes
Clay	% by weight	3.4	3.4	10	0.1	yes
Date Acquired:	May 25, 2011					

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Sand	% by weight	40.0	31.6	46.6	yes
Silt	% by weight	37.2	31.1	43.1	yes
Clay	% by weight	22.8	17.8	29.8	yes
<50 um	% by weight	60.0	53.400	68.400	yes
Date Acquired:	May 25, 2011				

Salinity

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Calcium	mg/L	0.1069	-0.5	0.8	yes
Magnesium	mg/L	0.0331	-0.2	0.2	yes
Sodium	mg/L	1.427	-0	2	yes
Potassium	mg/L	0.2123	-0.9	0.9	yes
Date Acquired:	May 25, 2011				

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
pH	pH	7.6	7.5	0	0.3	yes
Electrical Conductivity	dS/m at 25 C	0.42	0.42	10	0.01	yes
Calcium	mg/kg	49.8	51.3	10	0.6	yes
Magnesium	mg/kg	5.4	5.4	10	0.6	yes
Sodium	mg/kg	3	3	10	1	yes
Potassium	mg/kg	2	2	10	1	yes
Date Acquired:	May 25, 2011					

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
pH	pH	6.6	0.0	0.0	yes
Electrical Conductivity	dS/m at 25 C	1.80	0.00	0.00	yes
% Saturation	%	51	-8	8	yes
Calcium	mg/L	291	243.7	324.1	yes
Magnesium	mg/L	74.9	60.9	86.1	yes
Sodium	mg/L	58	49	66	yes
Potassium	mg/L	16.0	12.7	16.9	yes
Date Acquired:	May 25, 2011				

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Methodology and Notes

Bill To:	Stantec Consulting Ltd.	Project:	
Report To:	Stantec Consulting Ltd.	ID:	149104750
	10160 - 112 Street	Name:	Chinook Ridge
	Edmonton, AB, Canada	Location:	Cochrane, AB
	T5K 2L6	LSD:	SE 31-28-3 W5M
Attn:	Ryan Devlin	P.O.:	
Sampled By:		Acct code:	
Company:			

Lot ID:	**804789**
Control Number:	
Date Received:	May 24, 2011
Date Reported:	May 27, 2011
Report Number:	1437578

Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Particle Size Analysis - GS	Carter	* Hydrometer Method, 55.3	25-May-11	Exova Edmonton
Saturated Paste in General Soil	Carter	* Electrical Conductivity and Soluble Salts, Chapter 15	25-May-11	Exova Edmonton

** Reference Method Modified*

References

Carter	Soil Sampling and Methods of Analysis.
McKeague	Manual on Soil Sampling and Methods of Analysis

Comments:

Exova

LOT: 804789 COC

Control Number A164540

ronmental Sample Information Sheet

www.exova.com

Note: Proper completion of this form is required in order to proceed with analysis

See reverse for your nearest Exova location and proper sampling protocol

Billing Address:	Copy of Report: ✓	**Copy of Report To:**	Copy of invoice:
Company: Stantec Consulting		Company: Stantec Consulting Ltd.	Send invoice to this address for approval ☐
Address: 10160 - 112 St.	QA/QC Report ☐	Address: 10160 - 112 St Edmonton, Alberta	
Attention: Ryan Devlin	Report Result:	Attention: Ivan Whitson	MAY 24 AM 8:48
Phone: 780-969-2263	e-mail ☐	Phone: 780-917-7034	Report Result: e-mail ✓
Fax:	Results Online ☐	Fax:	Results Online ☐
Cell:	Fax ☐	Cell:	Fax ☐
e-mail: ryan.devlin@stantec.com	Mail ☐	e-mail: ivan.whitson@stantec.com	Mail ☐

Information to be included on Report and Invoice

Project ID: 149104750
Project Name: Chinook Ridge
Project Location: Cochrane, AB
Legal Location: SE 31-28-3-W5
PO#:
Proj. Acct. Code: 149104750
Agreement ID:

PRIORITY

Please contact laboratory prior to submitting any RUSH samples.

Upon filling out this section, client accepts that surcharges will be applied to this analysis.

If not all samples require RUSH, please indicate in special instructions.

Date Required: _____
Signature: _____

Sample Custody (Please Print)
Sampled by: Ivan Whitson
Company Stantec Signature Ivan Whitson

I authorize Exova to proceed with the work indicated on this form:

Date: Initial:

Received by: J. NUNEZ — Sample Temp.
Waybill #: H.D. — Date
Company — Time

Special Instructions / Comments

please call so that I can pickup samples, after analyses. (left over)

Please indicate which regulations you are required to meet:

- ☐ Health Canada Drinking Water Quality
- ☐ Alberta Tier 1
- ✓ Other: AB Irrigation Standards

	Sample Identification	Location	Depth IN / CM / M	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	Enter tests above (✓ relevant samples below)
	CL02-1	31-28-3-5	0-50	05/18/11	Soil		1	✓ ✓ ✓
	CL02-2		50-100	05/18/11			1	✓ ✓ ✓
	CL02-3		100-150	05/18/11			1	✓ ✓ ✓
	CL02-4		150-200	05/18/11			1	✓ ✓ ✓
	CL03-1		0-50	05/18/11			1	✓ ✓ ✓
	CL03-2		50-100	05/18/11			1	✓ ✓ ✓
	CL03-3		100-150	05/18/11			1	✓ ✓ ✓
	CL03-4		150-200	05/18/11			1	✓ ✓ ✓
	CL04-1		0-50	05/18/11			1	✓ ✓ ✓
	CL04-2		50-100	05/18/11			1	✓ ✓ ✓
	CL04-3		100-150	05/18/11			1	✓ ✓ ✓
	CL04-4		150-200	05/18/11			1	✓ ✓ ✓

Number of Containers: 05 Dry & Grind; PS1-S20

NOTE: All hazardous samples must be labeled according to WHMIS guidelines.

ED 077-00

Appendix F. Ground Water Evaluation – Chinook Ridge Lodge and Golf Course