Subdivision Development Investigation
Casa Grande
(NW & SW 26-35-5 W3M)
Grasswood, Saskatchewan

File S1607 29 August 2008

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1.0 Introduction

1.1 Background

This report presents results of the investigation conducted for the proposed Casa Grande subdivision located south of Saskatoon on Preston Avenue. A site location plan is presented in Drawing No. S1607-01. The legal description of the area is NW and SW26-35-5-W3M. The proposed subdivision would consist of 70 – 80 lots ranging in size from 1 – 5 acres on both quarters being considered for development. The site is primarily used as pastureland. There are currently two residences located on each quarter section.

No previous geotechnical and hydrogeological investigations have been performed at the proposed Casa Grande subdivision development.

1.2 Objectives

The objectives of the subdivision investigation were to evaluate slope stability, determine wastewater disposal characteristics, and to provide preliminary foundation and construction recommendations based on a geotechnical investigation.

The investigation is to provide a preliminary assessment of site conditions which will be a first step in developing data to support subsequent applications to regulators. The level of detail is intended to provide basic site characterization. Further detail may be required for regulators such as Saskatchewan Health or Saskatchewan Environment.

1.3 Scope of Work

The scope of the investigation included:

- Compilation of local and regional geological information for the area;
- Assessment of the stratigraphy and hydrology at the site;
- Visual investigation of the site and aerial photograph analysis for evidence of slope instability;
- Preliminary geotechnical and hydrogeological investigations to assist with permit applications for installation and construction of wastewater disposal systems;

- Foundation recommendations and restrictions arising from the geotechnical investigation; and,
- Reporting, including stratigraphic cross-sections identifying the geology and definition of the piezometric surface of the site.

1.4 Existing Information

Various sources of information are available which were used to develop a general assessment of the geological and hydrogeological features of the subject site and its surrounding area. The following information was used for an assessment of the area around this site:

- Christiansen, E.A., 1970. Physical Environment of Saskatoon, Canada
- Saskatchewan Geomatics aerial photographs, 1990
- SaskWater Well Data provided by SaskWater

2.0 Physical Environment

2.1 Regional Geology

The bedrock surface in the region consists of the Cretaceous Bearpaw Formation which is overlain by a succession of Quaternary deposits of till and stratified drift from the Saskatoon Group. The Bearpaw Formation is the youngest bedrock in the area, and has a varying thickness near the study area of 45 to 62 m thick. It is a non-calcareous, silt and clay. The uppermost glacial deposit consist of the Saskatoon Group that includes the Floral and Battleford Formations and the surficial stratified drift deposits. In the area the Floral Formation is absent along with the Sutherland Group. The Saskatoon Group Formation is approximately 100 m to 110 m thick and consists of clay till. The surficial stratified drift deposits consist of stratified silt, clay, sands and gravels.

2.2 Regional Hydrogeology

The mapped aquifers are mainly surficial stratified deposits. The Moose Woods Flats Aquifer is the most extensive aquifer in the region. The aquifer at the site is approximately 37 m bgs. A search of the SaskWater Corporation Database (current to May 2007) indicated 133 water withdrawal well and five water test hole records within a one mile radius of the site. These

records provided a good sample of water use for the area. The majority of the boreholes were complete below 5.5 m bgs in surficial deposits and sand layers and lenses present in the Saskatoon Group. The borehole lithology logs showed that the stratigraphy in the area consisted primarily of sand, silt and clay layers.

3.0 Field and Laboratory Investigation

Subsurface geology was investigated by a total of 19 test borings on the site, designated as Bore Holes 101 to 119. The locations of bore holes are shown on Drawing No. S1607-02. Bore holes were drilled to a depth of 6 m to 20 m. Drilling was conducted on 17 January and 8 February 2008 using a truck-mounted Brat drill rig and 125 mm solid stem continuous flight auger. Bore holes were logged and sampled at a 1.5 m interval.

Piezometers were installed in Bore Holes 101, 104, 108, and 111. Water levels in piezometers were measured on 25 February 2008.

Moisture contents were determined for all samples, and Unified Soil Classifications and particle size analyses were performed on select representative samples.

Observations made during the field investigations, visual descriptions and the results of laboratory tests are recorded in the Bore hole Logs and Summary of Sampling and Laboratory Test Data, and are appended to this report. An explanation of the symbols and terms used in the bore hole logs is included in the Symbols and Terms section of this report.

3.1 Stratigraphy

The site is located on a glacial lake basin, with subsurface soil consisting primarily of sand and silt with some clay. Some dune sand is present along the southern edge of SW26.

Stratigraphy consisted of stratified sand, silt and clay. Table 3.1 provides a summary of index properties of soil encountered, including moisture content and results of Atterberg limits and Unified Soil Classification testing. Silty sand covered the majority of the site to varying depth. Sand was generally moist and compact, with standard penetration testing ‘N’ values of 9 to 16 blows for 300 mm penetration.

Clay strata varied in thickness, and generally possessed medium to high plasticity. It was moist and stiff to very stiff in consistency, with an undrained shear strength of about 160 kPa.

Silt and clayey silt strata with some sand were encountered in some areas.

Table 3.1
Index Properties of Representative Samples

Sample Tested	Natural Water Content (%)	Plastic Limit	Liquid Limit	Plasticity Index	Unified Soil Classification*
BH101 @ 0.8 to 1.0 m	5.3	NP	NP	NP	SM
BH101 @ 1.5 to 1.8 m	25.8	23.9	68.2	44.3	CH
BH101 @ 2.3 to 2.4 m	9.8	NP	NP	NP	SM
BH101 @ 4.6 to 4.8 m	17.8	NP	NP	NP	SM
BH101 @ 7.5 to 7.6 m	34.0	23.6	57.9	34.3	CH
BH101 @ 10.6 to 10.7 m	38.9	28.7	77.9	49.2	CH
BH101 @ 12.1 to 12.2 m	34.6	24.0	74.6	50.6	CH
BH104 @ 0.7 to 0.8 m	9.2	NP	NP	NP	SM
BH104 @ 1.4 to 1.5 m	11.8	19.5	43.3	23.8	CL
BH104 @ 2.2 to 2.3 m	16.5	18.9	49.1	30.2	CL
BH104 @ 3.1 to 3.4 m	23.4	26.4	63.7	37.3	CH
BH104 @ 4.6 to 4.8 m	9.1	NP	NP	NP	SM
BH104 @ 7.5 to 7.6 m	28.7	NP	NP	NP	SM
BH108 @ 1.4 to 1.5 m	36.0	NP	NP	NP	SM
BH108 @ 2.2 to 2.3 m	6.7	NP	NP	NP	SM
BH108 @ 3.0 to 3.1 m	22.4	19.9	33.7	13.8	CL
BH108 @ 6.6 to 6.7 m	35.1	16.4	51.9	37.3	CH

*CL – low plasticity clay, CH- high plasticity clay, SM – silty sand, NP- non-plastic

3.2 Groundwater

Groundwater levels were measured on 25 February 2008. The water elevation in each piezometer is presented in Table 3.2 and on Drawing No. S1604-02. Groundwater elevations were utilized to determine the horizontal hydraulic gradient. The groundwater flow direction at the site was determined to be towards the southeast.

Table 3.2
Water Elevations

Piezometer	Water Elevation (m)	Ground Elevation (m)	Casing Elevation (m)	Depth to Water (m)
BH101	482.572	487.448	488.412	4.88
BH104	482.262	489.012	489.896	6.75
BH108	482.400	486.440	487.390	4.04
BH111	485.264	487.281	488.094	2.02

4.0 Slope Stability

Landforms in the area were defined on the basis of aerial photography. An aerial photograph showing the site is presented in Drawing No. S1607-2. This area was part of Glacial Lake Saskatoon during the last deglaciation. While under water, sand, silt and clay was deposited. Sand dunes are present along the southern edge of the area being developed. The site has approximately 5 m of relief. Large scale landsliding is not an issue in this area.

5.0 Wastewater Disposal

5.1 Scope

The site was assessed in terms of the geotechnical and hydrogeological site characteristics required to install wastewater disposal systems as per the regulations and guidelines set out in the *Saskatchewan Onsite Wastewater Disposal Guide* (First Edition, 2007, Saskatchewan Health), and the *Onsite Wastewater Management: Review Process for Developments and Subdivisions* (Saskatoon Health Region, Public Health Services). These documents will be referenced as SOWDG and OWM, respectively, for the purposes of this report.

5.2 Regulatory Requirements

The proposed development falls within the High Sensitivity Area section as per the OWM. As such, only holding tanks, pressure chamber systems, package sewage treatment plants and Type II Mounds will be permitted at the Casa Grande site due to the proposed size and number of lots on each quarter section. It also states that any existing wastewater disposal

systems in use or intended for use would need to be upgraded to comply with current requirements for high sensitivity developments.

The SOWDG states that there should be a minimum isolation distance of 1.5 m between a wastewater disposal system and the water table. All setback requirements listed in the SOWDG must also be met. Replacement disposal areas, if ever needed, should be located adjacent to the existing disposal area.

The SOWDG states that a Type II mound may be constructed on a natural slope provided that:

- The slope is less than 3% and the percolation rate is not slower than 60 minutes per 25 mm to a depth of at least 600 mm below the sand layer;
- The slope is less than 6% and the percolation rate is not slower than 30 minutes per 25 mm to a depth of at least 600 mm below the sand layer;
- The slope does not exceed 12% regardless of percolation rate.

A chamber system may also be constructed on a slope provided that distribution devices or step-downs are used.

Package sewage treatment plants such as three-cell septic tanks provide a greater level of treatment therefore may allow for a reduction in the treatment area required; however, they are not mandatory in a High Sensitivity Area.

5.3 Soil Loading Rates

As per the SOWDG, wastewater disposal systems are sized based on the soil loading rate. Soil loading rates are determined either via percolation testing or soil texture classification. Soil texture classification was used to determine appropriate soil loading rates for the various surficial soil types encountered at the proposed Casa Grande subdivision.

5.3.1 Soil Texture Classification

The results of the particle size analysis and hydrometer testing performed on select samples that are representative of the material in the upper strata are presented in Table 5.1. Based on the percentage of silt and clay versus sand, the soil was classified as per the Soil Texture Classification Triangle in Appendix 15 of the SOWDG.

Table 5.1
Summary of Particle Size Analysis
and Soil Texture Classification of Upper Soil Units

Soil Type	Sample Number	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Soil Texture as per SOWDG
Sand	KB13	0.0	76.7	13.2	10.1	Sandy Loam
Silty Clay	KB41	0.0	14.9	16.3	23.8	Silt Loam
Clay	KB82	0.0	25.4	36.2	38.5	Clay Loam
Silt	MN19	0.0	32.3	50.4	17.2	Loam
Sand	MN25	0.0	74.6	12.6	12.8	Sandy Loam

The corresponding loading rates as per Appendix 15 of the SOWDG can be applied to size the wastewater disposal systems:

- Clay Loam (Clay) 10.78 L/m^2
- Silt Loam (Silty Clay) 13.72 L/m^2
- Loam (Silt) 17.15 L/m^2
- Sandy Loam (Sand) 22.05 L/m^2

It is important to note that the soil texture classifications provided in this report are based upon a single hydrometer test for each surficial soil unit encountered. Also, the classifications do not account for secondary structure within the soil unit such as fracturing, which can greatly increase the permeability of a soil.

5.4 Groundwater

Water level measurements taken at the site (Table 3.2) indicate that the water table at the site ranges from 6.75 m to 2.02 m below ground surface, which ranges in elevation from 485.26 m to 482.26 m.

Assuming an average water table location of about 2 to 5 m below ground surface, the minimum separation distance of 1.5 m will be met.

A water sample was taken from the standpipe piezometers in BH101 and 108 and analyzed for routine water chemistry to obtain background groundwater data. The results are presented in Appendix A.

5.5 Conclusions

The following recommended wastewater disposal systems for the proposed development are described in relation to the soil type of the disposal area:

- Type II mound systems with two-cell septic tanks would provide adequate wastewater disposal for areas where the surficial material is sand, silt, or clay.

- Type II mound systems, with three-cell septic tanks would provide adequate wastewater disposal for areas where the surficial material is sand, silt, or clay.

The soil loading rate used to size the selected system should be determined based on the lowest soil loading rate of any of the materials encountered in the upper 900 mm of soil (excluding topsoil).

6.0 Foundation Design and Construction Recommendations

It is our understanding that the subdivision will primarily consist of single family dwellings. Structures will likely be one or two storeys over a full basement with a grade supported concrete floor. Geotechnical issues associated with this type of structure are foundations to support the proposed structures and construction of a grade supported floor on a variable subgrade that could be silt, sand or high plasticity clay. Groundwater levels measured were 2.0 m to 6.8 m below existing ground surface (Table 3.2), and vary in elevation from 485.26 m to 482.26 m. Groundwater levels can be expected to vary with time, and may increase as a result of development.

Although fill material was not noted during this field investigation, its presence and condition should be noted during construction since it is not desirable to place foundations or floors on fill material of unknown composition and consistency. Foundations or floors should not be constructed on organic topsoil or organic soil.

6.1 Waterproofing and Subdrainage

The quantity of seepage and groundwater levels will vary seasonally, with precipitation or snowmelt, and with development due to irrigation and other factors. Rates of flow can be relatively high through sand and sandy strata. Groundwater levels are variable across the site, and were at least 2.0 m below ground surface.

Typically, basement floors will be about 1.5 m to 2.0 m below finished grade. On this basis, it is not likely that hydrostatic pressures will develop on basement walls and floors. However, basement walls can be waterproofed to accommodate any future increases in groundwater levels that could lead to seepage into basements. At a minimum, walls must be damp-proofed; floors should be damp-proofed.

A perimeter subdrainage system should be installed at the base of the footing. This requirement can be reviewed depending on specific conditions for any home. The excavation should be backfilled with a free draining granular soil to within about 0.6 m of surface to ensure that water can freely drain to a perimeter weeping tile system. Free draining means that there is less than 3 percent silt and clay particles. Clay or clayey soil can be placed on the surface to reduce the amount of infiltration.

6.2 Foundations

The proposed structures may be supported on shallow spread footings or augered cast-in-place concrete piles. Lightly loaded structures supported on shallow spread footings on medium to high plasticity clay will experience some vertical movement associated with changes in soil moisture. Total vertical movement is estimated to be as much as 150 mm for foundations on medium to high plasticity clay, with differential movement less than half of the total vertical movement. The anticipated vertical movement for foundations on sand will typically be less than about 25 mm.

Assuming that the basement or crawlspace will be insulated, the footing must be constructed below the anticipated depth of frost, estimated to be about 1.8 m in this area. This depth can be reduced on the basis of local experience and on the performance of similar foundations in the area. The foundation should not be allowed to freeze, particularly during construction, as frost heave may occur.

The allowable bearing capacity for a shallow spread footing will depend on the type of soil at the footing elevation. The information provided in this report is for preliminary purposes, only, and should not be relied upon for detailed design due to the variation in conditions across the site. Site specific investigations are recommended for buildings on this development. Foundation conditions, soil type, and allowable bearing capacity should be confirmed for specific sites. For preliminary design, the allowable bearing capacity for a spread footing constructed on compact sand will be 100 kPa (2,100 lb/ft^2). For shallow spread footings constructed on stiff clay, the same value can be used. Sand encountered at the foundation elevation should be well compacted to minimize the potential for settlement. If

sand or sandy soil is wet and excessive pumping is encountered during compaction, the sand may be subcut 300 mm or more and replaced with a well graded, pit run material. A geotextile may be used as a separator at the base of the fill to reduce pumping of fines up into the fill, while allowing water to escape.

Structures can be supported on augered cast-in-place concrete piles designed on the basis of skin friction. However, standup conditions in sand will not be good and sleeving will likely be necessary to keep excavations open for concreting. Settlement of piles is expected to be less than 5 mm for a properly designed and constructed pile foundation. The skin friction contribution of the upper 2.0 m of pile below finished grade should be ignored in the determination of pile capacity for perimeter piles supporting a grade beam. This can be reduced to 1.0 m for interior piles.

An allowable skin friction value of 25 kPa may be used for design of piles in clay. A value of 15 kPa may be used where sand is encountered. The minimum length of pile should be 5 m. Grade beams should be constructed with a minimum 100 mm void space so that any heaving of the subgrade soil does not exert an upward force on piles, which can result in separation of the grade beam from the pile and distortion of the structure.

For augered piles, concrete should be placed within 2 hrs of excavation to minimize softening of clay or silt which can reduce pile capacity, or excessive sloughing and squeezing of soil, which can result in necking of the pile. The aspect ratio of a pile, defined as the ratio between length and diameter, should not exceed about 30. This should ensure that good contact is maintained between the concrete and soil and that no voids are created.

The use of water to facilitate excavation of piles should be avoided, since this will result in softening of the soil in contact with the concrete, reducing pile capacity. Inspection during construction is suggested to ensure compliance with specifications.

Landscaping around the structures should consider potential effects on foundation performance. Plantings of trees and large shrubs immediately adjacent the foundation should be avoided. Grading around the building should ensure positive drainage. Care should be taken to ensure that downspouts divert water away from the foundation.

6.3 Floors

Floors placed on a medium to high plasticity clay subgrade will experience some vertical movement associated with heave or shrinkage due to changes in soil moisture. The presence

of fill material of unknown or variable type and consistency may result in differential settlement of a grade supported floor. It is estimated that as much as 150 mm of heave may occur for floors constructed on medium to high plasticity clay. Little vertical movement is expected for a well constructed floor constructed on a sand subgrade.

The specification for compaction of clay subgrade soil should specifically indicate that the water content should be at optimum to optimum + 2 percent, since clay compacted wet of optimum will have a lower potential for heave. This will not, however, eliminate the potential for heave.

6.4 Potential for Sulphate Attack

The water soluble sulphate content of soil was measured to be 0.01 percent by dry weight of soil in sand and 0.14 percent in clay. On this basis, the potential for sulphate attack will be moderate to severe for concrete in contact with clay. Sulphate resistant (Type 50 or HS) cement must be specified for all concrete in contact with clay soil. Recommendations regarding sulphate resistant cement may be found in CSA A23.1.

7.0 Closure

This report was prepared by Clifton Associates Ltd. for the use of Mr. Neil Ketilson and his agents for specific application to the proposed Casa Grande subdivision south of Saskatoon. The material in it reflects Clifton Associates Ltd. best judgment available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Clifton Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted engineering practice common to the local area. No other warranty, expressed or implied is made

Our conclusions and recommendations are preliminary and based upon the information obtained from the referenced subsurface exploration. The boreholes and associated laboratory testing indicate subsurface and groundwater conditions only at the specific locations and times investigated, only to the depth penetrated and only for the soil properties tested. The subsurface conditions may vary between the boreholes and with time. The subsurface interpretation provided is a professional opinion of conditions and not a certification of the site conditions. The nature and extent of subsurface variation may not become evident until

construction or further investigation. If variations or other latent conditions do become evident, Clifton Associates Ltd. should be notified immediately so that we may re-evaluate our conclusions and recommendations. Although subsurface conditions have been explored, we have not conducted analytical laboratory testing on samples obtained nor evaluated the site with respect to the potential presence of contaminated soil or groundwater conditions.

The enclosed report contains the results of our investigations as well as certain recommendations arising out of such investigations. Our recommendations do not constitute a design, in whole or in part, of any of the elements of the proposed work. Incorporation of any or all of our recommendations into the design of any such element does not constitute us as designers or co-designers of such elements, nor does it mean that such design is appropriate in geotechnical terms. The designers of such elements must consider the appropriateness of our recommendations in the light of all design criteria known to them, many of which may not be known to us. Our mandate has been to investigate and recommend which we have completed by means of this report. We have had no mandate to design, or review the design of, any elements of the proposed work and accept no responsibility for such design or design review.

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Symbols and Terms

Soil Descriptive Terms

A soil description for geotechnical applications includes a description of the following properties:

- texture
- color, oxidation
- consistency and condition
- primary and secondary structure

Texture

The soil texture refers to the size, size distribution and shape of the individual soil particles which comprise the soil. The Unified Soil Classification System (ASTM D2487-00) is a quantitative method of describing the soil texture. The basis of this system is presented overleaf. The following terms are commonly used to describe the soil texture.

Particle Size (ASTM D2487-00)

Boulder	300 mm plus
Cobble	75 - 300 mm
Gravel	4.75 - 75 mm
Coarse	19 - 75 mm
Fine	4.75 - 19 mm
Sand	0.075 - 4.75 mm
Coarse	2 - 4.75 mm
Medium	0.425 - 2 mm
Fine	0.075 - 0.425 mm
Silt and Clay	Smaller than 0.075 mm

Relative Proportions (CFEM, 3rd Ed., 1992)

Trace	1 - 10 %
Some	10 - 20 %
Gravelly, sandy, silty, clayey, etc.	20 - 35 %
And	>35 %
Gravel, Sand, Silt, Clay	>35 % and main fraction

Gradation

Well Graded	Having a wide range of grain sizes and substantial amount of all intermediate sizes.
Uniform or Poorly Graded	Possessing particles of predominantly one size.
Gap Graded	Possessing particles of two distinct sizes.

Particle Shape

Angular	Sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Similar to 'angular' but have rounded edges.
Subrounded	Well-rounded corners and edges, nearly plane sides.
Rounded	No edges and smoothly curved sides.

Also may be flat, elongated or both.

The term "TILL" may be used as a textural term to describe a soil which has been deposited by glaciers and contains an unsorted, wide range of particle sizes.

Color And Oxidation

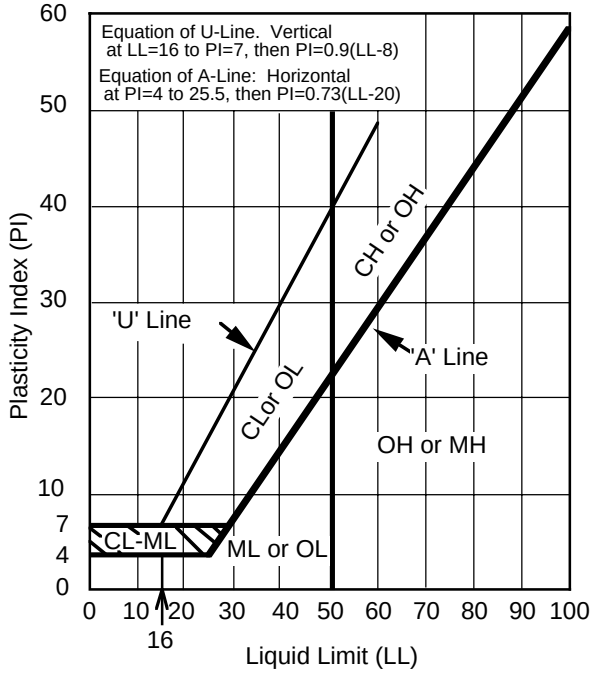
The soil color at its natural moisture content is described by common colors and, quantitatively, in terms of the Munsell color notation; (eg. 5Y 3/1). The notation combines three variables, hue, value and chroma to describe the soil color. The hue indicates its relation to red, yellow, green, blue and purple. The value indicates its lightness. The chroma indicates its strength of departure from a neutral of the same lightness.

Departure of the soil color from a neutral color indicates the soil has been oxidized. Oxidation of a soil occurs in a oxygen rich environment where most commonly metallic iron, oxidizes and turns a neutral colored soil 'rusty' or reddish brown. Oxidized manganese gives a purplish tinge to the soil. Oxidation may occur throughout the entire soil mass or on fracture/joint/fissure surfaces.

Classification of Soils for Engineering Purposes

ASTM Designation D 2487-00 (Unified Soil Classification System)

Major divisions			Group Symbols	Typical names	Classification criteria			
Coarse-grained soils: More than 50% retained on No. 200 sieve* (>0.075 mm)	Gravels: More than 50% of coarse fraction retained on No. 4 sieve(≥4.75 mm)	Clean gravels <5% fines	GW	Well-graded gravel	If ≥ 15% sand add "with sand" to group name	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve.....GW, GP, SW, SP More than 12% pass No. 200 sieve.....GM, GC, SM, SC 5 to 12% pass No. 200 sieve.....Borderline classifications requiring use of dual symbols	$C_u = \frac{D_{60}}{D_{10}} \geq 4$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravel			Not meeting either C_u or C_c criteria for GW	
		Gravels with fines >12% fines	GM	Silty gravel			Atterberg limits below "A" line or PI less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravel			Atterberg limits on or above "A" line and PI > 7	If fines are organic add "with orgnic fines" to group name
	Sands: 50% or more of coarse fraction passes No. 4 sieve(<4.75 mm)	Clean sands <5% fines	SW	Well-graded sand	If ≥ 15% gravel add "with gravel to group name		$C_u = \frac{D_{60}}{D_{10}} \geq 6$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sand			Not meeting either C_u or C_c criteria for SW	
		Sands with fines >12% fines	SM	Silty sand			Atterberg limits below "A" line or PI less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sand			Atterberg limits on or above "A" line and PI > 7	If fines are organic add "with orgnic fines" to group name
Fine-grained soils: 50% or more passes No. 200 sieve* (≤0.075 mm)	Silts and Clays: Liquid limit <50%	Inorganic	ML	Silt	If 15 to 29% coarse-grained, add "with sand" or "with gravel" as appropriate If > 30% coarse-grained , add "sandy" or "gravelly" as appropriate Class as organic when oven dried liquid limit is < 75% of undried liquid limit	Plasticity Chart		
			CL	Lean Clay -low plasticity				
		Organic	OL	Organic clay or silt (Clay plots above 'A' Line)				
	Silts and Clays: Liquid limit ≥50%	Inorganic	MH	Elastic silt				
			CH	Fat Clay -high plasticity				
		Organic	OH	Organic clay or silt (Clay plots above 'A' Line)				
	Highly organic soils		PT	Peat, muck and other highly organic soils				



*Based on the material passing the 3 in.(75 mm) sieve, if field samples contain cobbles or boulders, add "with cobbles or boulders" to group name

Consistency And Condition

The consistency of a cohesive soil is a qualitative description of its resistance to deformation and can be correlated with the undrained shear strength of the soil. The condition of a coarse grained soil qualitatively describes the soil compactness and can be correlated with the standard penetration resistance (ASTM D1586-99).

Consistency Of Cohesive Soil (CFEM, 3rd Edit., 1992)

Consistency	Undrained Shear Strength (kPa) (CFEM, 3rd Edt., 1992)	Field Identification (ASTM D 2488-00)
Very Soft	<12	Thumb will penetrate soil more than 25 mm.
Soft	12-25	Thumb will penetrate soil about 25 mm.
Firm	25-50	Thumb will indent soil about 6 mm.
Stiff	50-100	Thumb will indent, but penetrate only with great effort (CFEM).
Very Stiff	100-200	Readily indented by thumbnail (CFEM).
Hard	>200	Thumb will not indent soil but readily indented with thumbnail.
Very Hard	N/A	Thumbnail will not indent soil.

Condition Of Coarse Grained Soil (CFEM, 3rd Edt., 1992)

Compactness Condition	SPT N - Index (Blows/300mm)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	over 50

Moisture Conditions (ASTM D2488-00)

Description	Criteria
Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible, free water, usually soil is below water table

Structure

The soil structure is the manner in which the individual soil particles are assembled to form the soil mass. The primary soil structure is the arrangement of soil particles as originally deposited. The secondary soil structure refers to any rearrangement of the soil such as deformation and cracking which has taken place since deposition.

Primary Soil Structure (Depositional)

A. Geometry

Stratum	-	A single sedimentary 'layer', greater than 10 mm in thickness, visibly separable from other strata by a discrete change in lithology and/or sharp physical break.
Homogeneous	-	Same color and appearance throughout.
Stratified	-	Consisting of a sequence of layers which are generally of contrasting texture or color.
Laminated	-	Stratified with layer thicknesses between 2 mm and 10 mm.
Thinly laminated	-	Stratified with layer thickness less than 2 mm.
Bedded	-	Stratified with layer thicknesses greater than 10 mm.
Very Thinly Bedded (Flaggy)	-	Stratified with layer thicknesses between 10 and 50 mm.
Thinly Bedded (Slabby)	-	Stratified with layer thicknesses between 50 and 600 mm.
Thickly Bedded (Blocky)	-	Stratified with layer thicknesses between 600 and 1200 mm.
Thick-Bedded (Massive)	-	Stratified with layer thicknesses greater than 1200 mm.
Lensed	-	Inclusions of small pockets of different soils, such as small lenses of sand material throughout a mass of clay.

B. Bedding Structures

Cross-bedding	-	Internal 'bedding' inclined to the general bedding plane.
Ripple-bedding	-	Internal 'wavy bedding'.
Graded-bedding	-	Internal gradation of grain size from coarse at base to finer at top of bed.
Horizontal bedded	-	Internal bedding is parallel and flat lying

Secondary Soil Structure (Post-Depositional)

A. Accretionary Structures

Includes nodules, concretions, crystal aggregates, veinlets, color banding and

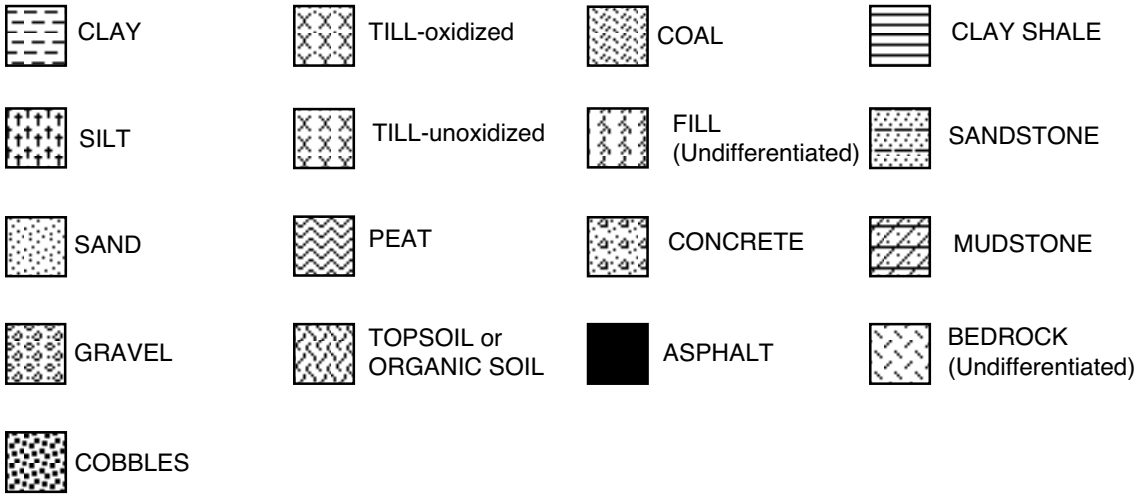
Cementation	-	Chemically precipitated material, commonly calcite ($CaCO_3$), binds the grains of soil, usually sandstone. Described as weak, moderate, strong (ASTM D2488-00).
Salt Crystals	-	Groundwater flowing through the soil/rock often precipitates visible amounts of salts. Calcite ($CaCO_3$), glauber salts ($Na_2Ca(SO_4)_2$), and gypsum ($CaSO_4*2H_2O$) are common.

B. Fracture Structures

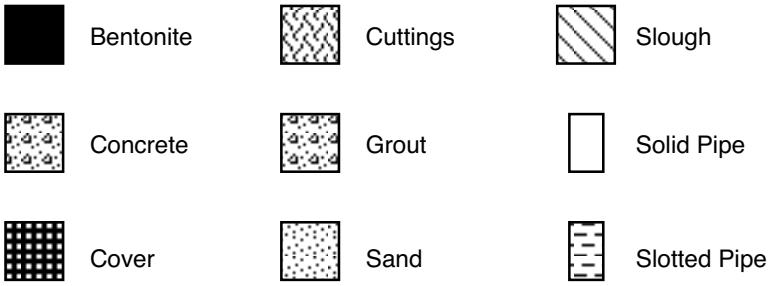
Fracture	-	A break or discontinuity in the soil or rock mass caused by stress exceeding the materials strength.
Joint	-	A fracture along which no displacement has occurred.
Fissure	-	A gapped fracture, which may open and close seasonally. Usually an extensive network of closely spaced fractures, giving the soil a 'nuggetty' structure.
Slickensides	-	Fractures in a clay that are slick and glossy in appearance, caused by shear movements.
Brecciated	-	Contains randomly oriented angular fragments in a finer mass, usually associated with shear displacements in soils.
Fault	-	A fracture or fracture zone along which there has been displacement.
Blocky	-	A cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Symbols Used on Bore Hole Logs

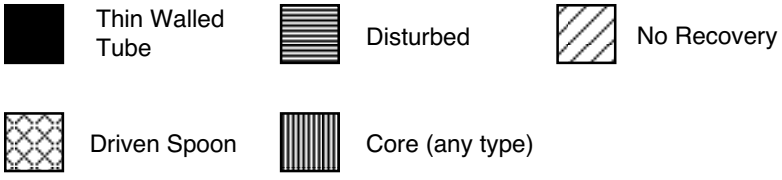
Lithology Type



Borehole Completion and Backfill Materials



Soil Sample Type



Groundwater Symbols

▼ Piezometric elevation as determined by a piezometer installation

▽ Water levels measured in borings at the time and under the conditions noted

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Bore Hole Logs
and
Laboratory Test Data

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BORE HOLE LOG

Bore Hole: 101
Page: 1 of 2

Client:	Neil Ketilson	Northing:	5,765,376.985 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,679.686 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.448 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.412 m	Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		SAND: Fine grained. Silty. Trace clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Dry.		KB1 KB2		SM				Cuttings
486 / 1		CLAY: Trace silt and sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist and stiff. Laminated.		KB3		CH				50 mm sch 40 PVC pipe; Bentonite
485 / 2		SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Stratified. Black streaks.		KB4		SM				Frac sand
484 / 3				KB5						
483 / 4		@ 4.6 m: Becoming Very dark grayish brown (2.5Y 3/2)		KB6		SM				482.572 m (25 Feb 08)
482 / 5										
481 / 6		CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and stiff. Laminated.		KB7						
480 / 7										50 mm sch 40 PVC slotted
479 / 8		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist.		KB8 KB9		CH				
478 / 9		CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and sitff. Laminated. Sand lenses.		KB10		CH				
10										

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BORE HOLE LOG

Bore Hole: 101
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,765,376.985 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,679.686 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.448 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.412 m	Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
10 / 477		CLAY: Trace silt and sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist and sitff. Laminated. Sand lenses.		KB11		CH				
11 / 476		SILT: Sandy, trace clay. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist and stiff. Dilatant.								
12 / 475				KB12						
13 / 474		NOTES: 125 mm continuous flight auger used. Seepage @ 4.6 m.								
14 / 473										
15 / 472										
16 / 471										
17 / 470										
18 / 469										
19 / 468										
20										

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BORE HOLE LOG

Bore Hole: 102
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Client:	Neil Ketilson	Northing:	5,765,592.890 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,709.567 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	490.021 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
490 / 0		SAND: Fine grained. Silty, trace clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Dry and compact. Homogeneous.		KB13 KB14	14					
489 / 1				KB15 KB16	13					
488 / 2				KB17 KB18	17					
487 / 3				KB19 KB20	16					
486 / 4										
485 / 5		CLAY: Trace sand and silt. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist and very stiff. Laminated. Iron staining. Silt partings. Lensed with sand.		KB21 KB22	18					
484 / 6				KB23 KB24						
483 / 7		NOTES: 125 mm continuous flight auger used. No sloughing.								
482 / 8										
481 / 9										
10										

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BORE HOLE LOG

Bore Hole: 103
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Client:	Neil Ketilson	Northing:	5,765,974.919 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	388,747.079 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.299 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
489 / 0		SAND: Fine grained. Some silt and clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogeneous.		KB25						
488 / 1				KB26						
487 / 2		SILT: Some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB27						
		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB28						
486 / 3		SILT: Some clay, trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogenous. Iron staining.								
485 / 4		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB29						
484 / 5		SILT: Some clay, trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogenous.								
483 / 6		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB30						
482 / 7		NOTES: 125 mm continuous flight auger used. No sloughing.								
481 / 8										
480 / 9										
10										

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BORE HOLE LOG

Bore Hole: 104
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Client:	Neil Ketilson	Northing:	5,766,116.545 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,077.547 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.012 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	489.896 m	Logged by:	KB

Elev (m)	Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
489	0		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogenous.		KB31		SM				50 mm sch 40 PVC pipe
											Cuttings
488	1				KB32		CL				
			CLAY: Silty, sandy. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Hard. Homogeneous.								
487	2				KB33		CL				
486	3		@ 3.04m: Trace sand. Iron staining. Silt partings.		KB34 KB35		CH				Bentonite
485	4				KB36						
			SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Iron and Manganese staining.		KB37		SM				
484	5										Frac sand
483	6		@ 6.1m: Clayey.		KB38						
											482.262 m (19 March 08)
482	7										
					KB39		SM				50 mm sch 40 PVC slotted
481	8										
480	9				KB40						
			NOTES: 125 mm continuous flight auger used. Sloughing @ 5.8 m. Seepage @ 5.8 m.								
	10										

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BORE HOLE LOG

Bore Hole: 105
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Client:	Neil Ketilson	Northing:	5,765,861.154 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,077.457 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.030 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		CLAY: 300 mm organic material. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/6). Moist. Homogeneous.		KB41						
486 / 1				KB42						
		SAND: Fine Grained. Silty, some clay. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Stratified.		KB43						
485 / 2										
484 / 3				KB44						
483 / 4										
482 / 5				KB45						
481 / 6		NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m. Seepage @ 4.3 m.		KB46						
480 / 7										
479 / 8										
478 / 9										
10										

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BORE HOLE LOG

Bore Hole: 106
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Client:	Neil Ketilson	Northing:	5,765,600.569 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,053.995 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.115 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
489 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB47						
488 / 1				KB48						
487 / 2		CLAY: Silty, sandy. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Hard. Laminated.		KB49						
486 / 3				KB50						
485 / 4										
484 / 5		@ 4.6m: Trace sand. Iron and Manganese staining. Some calcium carbonate concretions.		KB51						
483 / 6				KB52 KB53						
482 / 7		NOTES: 125 mm continuous flight auger used.								
481 / 8										
480 / 9										
10										

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BORE HOLE LOG

Bore Hole: 107
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Client:	Neil Ketilson	Northing:	5,765,367.001 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,086.446 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	485.723 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
485 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/3). Moist. Homogeneous.		KB54						
484 / 1		@ 1.5m: Wet.		KB55						
483 / 2				KB56						
482 / 3				KB57						
481 / 4				KB58						
480 / 5		CLAY: Silty, sandy. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Soft. Laminated. Manganese staining.								
479 / 6		CLAY: Some silt. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist. Stiff. Laminated. Iron staining.		KB59						
478 / 7		NOTES: 125 mm continuous flight auger used. Sloughing @ 2.1 m.								
477 / 8										
476 / 9										
10										

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BORE HOLE LOG

Bore Hole: 108
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Client:	Neil Ketilson	Northing:	5,765,324.170 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,461.073 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.440 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	487.390 m	Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
486 / 0		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Compact. Homogeneous.		KB60						50 mm sch 40 PVC pipe
485 / 1				KB61		SM				Cuttings
				KB62	11					
484 / 2		CLAY: Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Soft. Iron staining. Laminated. Lensed with sand.		KB63		SM				Bentonite
				KB64						
				KB64B	9					
483 / 3		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Compact. Manganese staining. Homogeneous.		KB65		CL				Frac Sand
				KB66	12					
482 / 4				KB67						482.400 m (25 Feb 08)
481 / 5										Slough
480 / 6		CLAY: Trace silt. Oxidized. Calcareous. Very dark grayish brown (2.5Y 3/2). Moist. Firm. Laminated.		KB68						
				KB69		CH				
479 / 7		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y4/2). Wet. Homogeneous.		KB70						50 mm sch 40 PVC slotted
478 / 8										
477 / 9				KB71						
10										

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BORE HOLE LOG

Bore Hole: 108
Page: 2 of 2

Client:	Neil Ketilson	Northing:	5,765,324.170 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,461.073 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.440 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	487.390 m	Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
10 / 476		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y4/2). Wet. Homogeneous.		KB72						
11 / 475										
12 / 474				KB73						
		NOTES: 125 mm continuous flight auger used. Water @ 6.9 m. Seepage @ 4.9 m.								
13 / 473										
14 / 472										
15 / 471										
16 / 470										
17 / 469										
18 / 468										
19 / 467										
20										

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BORE HOLE LOG

Bore Hole: 109
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Client:	Neil Ketilson	Northing:	5,765,594.201 (UTM)	Date Drilled:	17 January 2007
Project:	Casa Grande Subdivision	Easting:	389,458.870 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.558 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
486 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		KB74						
485 / 1				KB75						
484 / 2				KB76						
483 / 3		CLAY: Silty, sandy. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Soft. Homogeneous. Iron and Manganese staining.		KB77 KB78						
482 / 4		@ 4.3 m: Wet.		KB79 KB80						
481 / 5		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Iron staining.								
480 / 6				KB81						
479 / 7		NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m.								
478 / 8										
477 / 9										
10										

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BORE HOLE LOG

Bore Hole: 110
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Client:	Neil Ketilson	Northing:	5,765,865.177 (UTM)	Date Drilled:	17 January 2008
Project:	Casa Grande Subdivision	Easting:	389,397.072 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.043 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	KB

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		CLAY: Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		KB82						
486 / 1		SAND: Silty. Oxidized. Calcareous. Dark olive brown (2.5Y 3/3). Moist. Homogeneous.		KB83						
485 / 2		CLAY: With silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Firm. Laminated. Iron staining.		KB84						
484 / 3				KB85						
483 / 4		SAND: Fine grained. Silty, some clay. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		KB86						
482 / 5										
481 / 6				KB87						
		NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m.								
480 / 7										
479 / 8										
478 / 9										
10										

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BORE HOLE LOG

Bore Hole: 111
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Client:	Neil Ketilson	Northing:	5,766,906.065 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,475.333 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.281 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.094 m	Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		SAND: Some silt, some clay. Calcareous. Oxidized. Olive brown (2.5Y 4/3). Moist. Homogeneous.		MN25						Cuttings
486 / 1				MN26						50 mm sch 40 PVC pipe
485 / 2				MN27						Bentonite
484 / 3		CLAY: Some silt, some sand. Calcareous. Oxidized. Olive gray (5Y 4/2). Moist. Firm. Iron and manganese stains. Homogeneous.		MN28						485.264 m (25 Feb 08)
483 / 4		SAND: And silt. Calcareous. Oxidized. Olive gray (5Y 4/2). Moist. Manganese stains. Homogeneous.		MN29						Frac sand
482 / 5										
481 / 6		CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.		MN30						50 mm sch 40 PVC slotted
480 / 7										
479 / 8				MN31						
478 / 9				MN32						
10										

Geotech BH m Elev CAL v03.tdf

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BORE HOLE LOG

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Client:	Neil Ketilson	Northing:	5,766,906.065 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,475.333 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.281 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:	488.094 m	Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
10 / 477		CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.		MN33						
11 / 476										
12 / 475				MN34						
13 / 474										
				MN35						
14 / 473		NOTES: 125 mm continuous flight auger used. Sloughing @ 4.3 m. Seepage @ 5.8 m.								
15 / 472										
16 / 471										
17 / 470										
18 / 469										
19 / 468										
20										

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BORE HOLE LOG

Bore Hole: 112
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Client:	Neil Ketilson	Northing:	5,766,912.968 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,067.950 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.154 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/4). Moist. Homogeneous.		MN13						
486 / 1										
		@ 1.5 m: And silt. Light olive brown (2.5Y 5/4). Salt inclusions.		MN14						
485 / 2										
		CLAY: Silty. Trace sand. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Homogeneous. Iron staining.		MN15						
484 / 3				MN16						
		@ 4.3 m: Wet.		MN17						
483 / 4										
482 / 5		CLAY: Some silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Blocky.								
481 / 6				MN18						
		NOTES: 125 mm continuous flight auger used. Seepage @ 4.3 m.								
480 / 7										
479 / 8										
478 / 9										
10										

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BORE HOLE LOG

Bore Hole: 113
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Client:	Neil Ketilson	Northing:	5,766,642.442 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,078.575 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.616 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
487 / 0		CLAY: Silty, sandy. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Dry. Homogeneous.		MN19						
486 / 1				MN20						
485 / 2		SAND: Fine grained. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Dry. Homogeneous. @ 2.3 m: Moist.		MN21						
484 / 3		CLAY: And silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Very soft. Homogeneous. Iron and manganese staining. Salt inclusions. @ 3.7 m: Trace silt.		MN22						
483 / 4				MN23						
482 / 5		CLAY: Trace silt. Unoxidized. Calcareous. Dark gray (2.5Y 4/1). Moist. Stiff. Homogeneous. Iron and manganese staining.		MN24						
481 / 6		NOTES: 125 mm continuous flight auger used.								
480 / 7										
479 / 8										
478 / 9										
10										

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BORE HOLE LOG

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Client:	Neil Ketilson	Northing:	5,766,644.763 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,462.535 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.131m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
486 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		MN36						
485 / 1		@ 1.5 m: Iron staining.		MN37						
484 / 2		CLAY: Silty, trace sand. Oxidized. Calcareous. Light olive brown (2.5y 5/3). Moist. Stiff. Homogeneous. Blocky. Iron and manganese staining.		MN38						
				MN38A						
483 / 3				MN39						
482 / 4										
				MN40						
481 / 5		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Wet. Very soft. Homogeneous.								
480 / 6				MN41						
		NOTES: 125 mm continuous flight auger used.								
479 / 7										
478 / 8										
477 / 9										
10										

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BORE HOLE LOG

Bore Hole: 115
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Client:	Neil Ketilson	Northing:	5,766,653.031 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,734.367 m (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	487.645 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
0 / 487		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.		MN58			0.01			
1										
1.5 / 486		CLAY: Silty. Trace sand. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Stiff. Homogeneous. Iron staining. Salt inlcusions.		MN59			0.14			
2				MN60						
2.19 / 485		@ 2.19 m: Light olive brown (2.5Y 5/3). Very stiff. Blocky.								
3				MN61						
4 / 484										
4.5 / 483				MN62						
5										
6 / 482				MN63						
6.5 / 481		NOTES: 125 mm continuous flight auger used.								
7										
8 / 480										
9 / 479										
10 / 478										

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BORE HOLE LOG

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Client:	Neil Ketilson	Northing:	5,765,643.118 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,291.604 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.963 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
0		SAND: Fine grained. Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous. Iron staining. Salt inclusions.		MN1						
486 – 1		CLAY: Silty. Oxidized. Calcareous. Dark olive brown (2.5Y 3/3). Moist. Stiff. Homogeneous. Iron staining. Salt inclusions.		MN2						
485 – 2				MN3						
484 – 3				MN4						
483 – 4										
				MN5						
482 – 5		@ 5.2 m: Interbedded clay and silt.								
481 – 6				MN6						
		NOTES: 125 mm continuous flight auger used. Seepage @ 5.8 m.								
480 – 7										
479 – 8										
478 – 9										
477 – 10										

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BORE HOLE LOG

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Client:	Neil Ketilson	Northing:	5,765,569.269 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,792.867 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	486.094 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
486 / 0		SAND: 900 mm organic material. Silty, trace clay. Oxidized. Calcareous. Olive brown (2.5Y 4/4). Moist. Homogeneous.		MN7						
485 / 1				MN8						
484 / 2		CLAY: Some silt. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous. Iron staining. Salt inclusions. Blocky.		MN9						
483 / 3				MN10						
482 / 4										
481 / 5		@ 4.6 m: Very dark grayish brown (2.5Y 3/2). @ 5.5 m: Sand lense. Wet.		MN11						
480 / 6				MN12						
479 / 7		NOTES: 125 mm continuous flight auger used.								
478 / 8										
477 / 9										
10										

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BORE HOLE LOG

Bore Hole: 118
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Client:	Neil Ketilson	Northing:	5,766,549.263 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	388,851.487 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	489.390 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
489 / 0		SAND: Fine grained. Some silt. Oxidized. Calcareous. Light olive brown (2.5Y 5/4). Moist. Homogeneous.		MN52						
488 / 1		CLAY: Sitly, trace sand. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Very stiff. Homogeneous.		MN53						
487 / 2		@ 2.2 m: Silt partings. Iron staining.		MN54						
486 / 3		SAND: Fine grained. Silty. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Laminated.		MN55 MN55A						
485 / 4		CLAY: And silt. Oxidized. Calcareous. Dark grayish brown (2.5Y 4/2). Moist. Very soft. Homogeneous. Iron staining. Organic inclusions.		MN56						
484 / 5		SAND: Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Wet. Homogeneous.		MN56						
483 / 6		NOTES: 125 mm continuous flight auger used. Seepage @ 5.8 m.								
482 / 7										
481 / 8										
480 / 9										
10										

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BORE HOLE LOG

Bore Hole: 119
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Client:	Neil Ketilson	Northing:	5,766,577.427 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,262.166 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	488.243 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample Type	Sample No.	SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000); Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
488 / 0		SAND: Fine grained. Silty. Oxidized. Calcareous. Light olive brown (2.5Y 5/6). Moist. Homogeneous.		MN42						
487 / 1				MN43						
486 / 2				MN44						
				MN44A						
485 / 3				MN45						
484 / 4				MN46						
483 / 5		CLAY: Silty. Oxidized. Calcareous. Olive brown (2.5Y 4/3). Moist. Homogeneous.								
482 / 6		CLAY: Silty. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Moist. Homogeneous.		MN47						
481 / 7		SAND: Fine grained. Silty, trace clay. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Wet. Homogeneous.		MN48						
480 / 8										
479 / 9				MN49						
10										

Geotech BH m Elev CAL v03.tdf

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BORE HOLE LOG

Bore Hole: 119
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Client:	Neil Ketilson	Northing:	5,766,577.427 (UTM)	Date Drilled:	08 February 2008
Project:	Casa Grande Subdivision	Easting:	389,262.166 (UTM)	Drill:	Brat 22
Location:	Grasswood, SK	Ground Elev.:	488.243 m (Geodetic)	Drilling Method:	Solid Stem Auger
Project No.:	S1607	Top Casing Elev.:		Logged by:	MN

Elev (m) / Depth (m)	Symbol	Soil Description	Sample: Type	Sample: No.	Sample: SPT 'N'	USC	% Sulphate	Moisture Content (percent): Plastic Limit / Natural Moisture / Liquid Limit (0 – 50 – 100)	Dry Density - kg/m3 (1600 – 2000) / Shear Strength - kPa: Unconf. / Pocket Pen. / Lab Vane (100 – 200 – 300 – 400)	Piezometer Construction Detail
478 / 10		SAND: Fine grained. Silty, trace clay. Unoxidized. Calcareous. Very dark gray (2.5Y 3/1). Wet. Homogeneous.		MN50						
477 / 11		@ 10.7 m: Clayey. Black (2.5Y 2.5/1).								
476 / 12				MN51						
475 / 13		NOTES: 125 mm continuous flight auger used. Seepage @ 6.4 m.								
474 / 14										
473 / 15										
472 / 16										
471 / 17										
470 / 18										
469 / 19										
20										

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB1	BAG		4.4													
0.76	KB2	SY	270	5.3			NP	SM	0.0	84.2	16.8				N/A	N/A	
1.52	KB3	SY	300	25.8	23.9	68.2	44.3	CH	0.0	1.4	98.6				175	160	
2.29	KB4	SY	150	9.8			NP	SM	0.0	712.0	28.0				N/A	N/A	
3.05	KB5	SY	200	7.5											N/A	N/A	
4.57	KB6	SY	200	17.8			NP	SM	0.0	85.9	14.1				N/A	N/A	
6.10	KB7	SY	460	25.1													
7.62	KB8	BAG		34.0	23.6	57.9	34.3	CH	0.0	8.3	91.7						
7.92	KB9	BAG		24.4													
9.14	KB10	BAG		38.9	28.7	77.9	49.2	CH	0.0	1.7	98.3						
10.67	KB11	BAG		34.6	24.0	74.6	50.6	CH	0.0	1.8	98.2						
12.19	KB12	BAG		27.0													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB13	BAG		4.2					0.0	76.7	13.2	10.1					
0.76	KB14	SPT		3.8													
1.52	KB15	BAG		5.1													
2.29	KB16	SPT		4.9													
3.05	KB17	BAG		4.9													
4.57	KB18	SPT		4.7													
6.10	KB19	BAG		4.5													
7.62	KB20	SPT		4.2													
7.92	KB21	BAG		23.3													
9.14	KB22	SPT		26.2													
10.67	KB23	BAG		30.9													
12.19	KB24	SPT		27.5													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB25	BAG		6.4													
1.52	KB26	BAG		6.4													
2.29	KB27	BAG		12.6													
3.05	KB28	BAG		4.2													
4.57	KB29	BAG		11.7													
6.10	KB30	BAG		6.9													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

103

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB31	BAG		9.2			NP	SM	0.0	55.4	44.6						
1.52	KB32	BAG		11.8	19.5	43.3	23.8	CL	0.0	36.0	64.0						
2.29	KB33	BAG		16.5	18.9	49.1	30.2	CL	0.0	17.7	82.3						
3.05	KB34	BAG		18.6													
3.05	KB35	SY	310	23.4	26.4	63.7	37.3	CH	0.0	1.0	99.0				260+	290+	
4.57	KB36	BAG		13.5													
4.57	KB37	SY	260	9.1			NP	SM	0.0	57.0	43.0				260+	290+	
6.10	KB38	BAG		16.3													
7.62	KB39	BAG		28.7			NP	SM	0.0	77.3	22.7						
9.14	KB40	BAG		25.6													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

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SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB41	BAG		9.8					0.0	14.9	16.3	23.8					
1.52	KB42	BAG		4.3													
2.29	KB43	BAG		4.1													
3.05	KB44	BAG		6.8													
4.57	KB45	BAG		25.5													
6.10	KB46	BAG		28.2													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

105

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB47	BAG		5.2													
1.52	KB48	BAG		4.6													
2.29	KB49	BAG		16.3													
3.05	KB50	BAG		19.1													
4.57	KB51	BAG		26.4													
6.10	KB52	BAG		33.0													
6.10	KB53	SY	260	29.7											120	105	

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

106

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB54	BAG		5.9													
1.52	KB55	BAG		5.6													
2.29	KB56	BAG		27.8													
3.05	KB57	BAG		29.0													
4.57	KB58	BAG		31.9													
6.10	KB59	BAG		36.0													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

107

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB60	BAG		26.1													
1.52	KB61	BAG		36.0			NP	SM	0.0	79.2	20.8						
1.52	KB62	SPT		17.9													
2.29	KB63	BAG		6.7			NP	SM	0.0	79.8	20.2						
2.29	KB64	SPT		9.0													
2.29	KB64B	SPT		35.5													
3.05	KB65	BAG		22.4	19.9	33.7	13.8	CL	0.0	20.6	79.4						
3.05	KB66	SPT		16.4													
4.57	KB67	BAG		22.6													
6.10	KB68	BAG		25.4													
6.71	KB69	BAG		35.1	16.4	51.9	37.3	CH	0.0	3.4	96.6						
7.62	KB70	BAG		24.7													
9.14	KB71	BAG		23.0													
10.67	KB72	BAG		25.1													
12.19	KB73	BAG		25.4													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

108

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB74	BAG		6.2													
1.52	KB75	BAG		5.4													
2.29	KB76	BAG		10.4													
3.05	KB77	BAG		30.7													
3.05	KB78	SY	230	23.9											N/A	N/A	
4.57	KB79	BAG		36.1													
4.57	KB80	SY	390	22.5											30	35	
6.10	KB81	BAG		25.8													

Clifton Associates Ltd.
engineering science technology

PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

109

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	KB82	BAG		12.8					0.0	25.4	36.2	38.5					
1.52	KB83	BAG		13.4													
2.29	KB84	BAG		22.9													
3.05	KB85	BAG		14.4													
4.57	KB86	BAG		11.7													
6.10	KB87	BAG		26.8													

Clifton Associates Ltd.
engineering science technology

PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

110

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN25	BAG		18.0					0.0	74.6	12.6	12.8					
1.52	MN26	BAG		23.7													
2.29	MN27	BAG		24.4													
3.05	MN28	BAG		26.4													
4.57	MN29	BAG		26.2													
6.10	MN30	BAG		36.1													
7.62	MN31	BAG		35.6													
9.14	MN32	BAG		34.8													
10.67	MN33	BAG		34.9													
12.19	MN34	BAG		33.5													
13.72	MN35	BAG		36.0													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

111

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN13	BAG		10.4													
1.52	MN14	BAG		25.1													
2.29	MN15	BAG		34.2													
3.05	MN16	BAG		32.1													
4.57	MN17	BAG		29.5													
6.10	MN18	BAG		31.8													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

112

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN19	BAG		8.4					0.0	32.3	50.4	17.2					
1.52	MN20	BAG		10.6													
2.29	MN21	BAG		15.5													
3.05	MN22	BAG		26.9													
4.57	MN23	BAG		37.3													
6.10	MN24	BAG		36.7													

Clifton Associates Ltd.
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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

113

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN36	BAG		15.5													
1.52	MN37	BAG		18.1													
2.29	MN38	BAG		29.8													
2.44	MN39A	SY	395	38.1											65	65	
3.05	MN39B	BAG		37.9													
4.57	MN40	BAG		32.4													
6.10	MN41	BAG		28.1													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

114

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN58	BAG		6.9									0.01				
1.52	MN59	BAG		22.8									0.14				
2.29	MN60	BAG		33.4													
3.05	MN61	BAG		34.4													
4.57	MN62	BAG		37.7													
6.10	MN63	BAG		32.8													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

115

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN1	BAG		19.9									0.74				
1.52	MN2	BAG		23.4									1.11				
2.29	MN3	BAG		29.5													
3.05	MN4	BAG		30.5													
4.57	MN5	BAG		33.4													
6.10	MN6	BAG		30.5													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

116

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN7	BAG		11.2													
1.52	MN8	BAG		5.6													
2.29	MN9	BAG		30.8													
3.05	MN10	BAG		28.6													
4.57	MN11	BAG		34.7													
6.10	MN12	BAG		40.2													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

117

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE				WATER CONTENT	CONSISTENCY				GRADATION				SULPHATE CONTENT	SHEAR STRENGTH			DRY DENSITY
DEPTH	NUMBER	TYPE	RECOVERY		PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY		COMPRESSION TEST	LAB VANE	POCKET PEN	
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN52	BAG		6.2													
1.52	MN53	BAG		30.5													
2.29	MN54	BAG		33.3													
3.05	MN55	BAG		31.5													
3.05	MN55A	SY	250	12.2											165	180	
4.57	MN56	BAG		34.0													
6.10	MN56	BAG		22.8													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

118

SUMMARY OF SAMPLING AND LABORATORY TEST DATA

SAMPLE					CONSISTENCY				GRADATION					SHEAR STRENGTH			
DEPTH	NUMBER	TYPE	RECOVERY	WATER CONTENT	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	USC	GRAVEL	SAND	SILT	CLAY	SULPHATE CONTENT	COMPRESSION TEST	LAB VANE	POCKET PEN	DRY DENSITY
meters			mm	%	%	%	%		%	%	%	%	%	kPa	kPa	kPa	kg/m^3
0.76	MN42	BAG		10.2													
1.52	MN43	BAG		9.4													
2.29	MN44	BAG		8.6													
2.74	MN44A	SY	220	2.8											N/A	N/A	
3.05	MN45	BAG		3.7													
4.57	MN46	BAG		23.9													
6.10	MN47	BAG		30.1													
7.62	MN48	BAG		28.0													
9.14	MN49	BAG		26.8													
10.67	MN50	BAG		33.4													
12.19	MN51	BAG		26.7													

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PROJECT Casa Grande Subdivision
LOCATION Grasswood, Saskatchewan
PROJECT NO. S1607

BORE HOLE NO.

119

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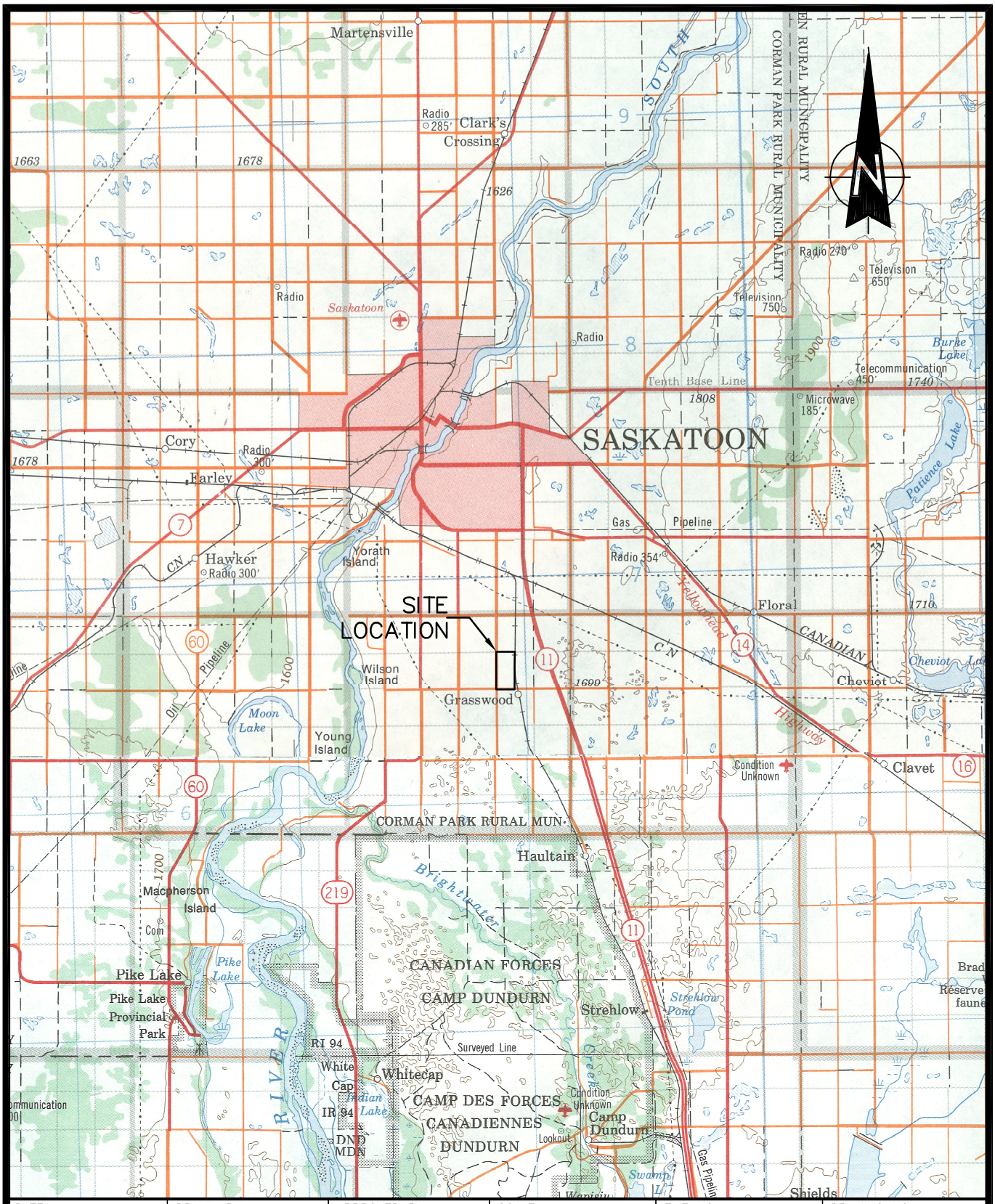
Drawings



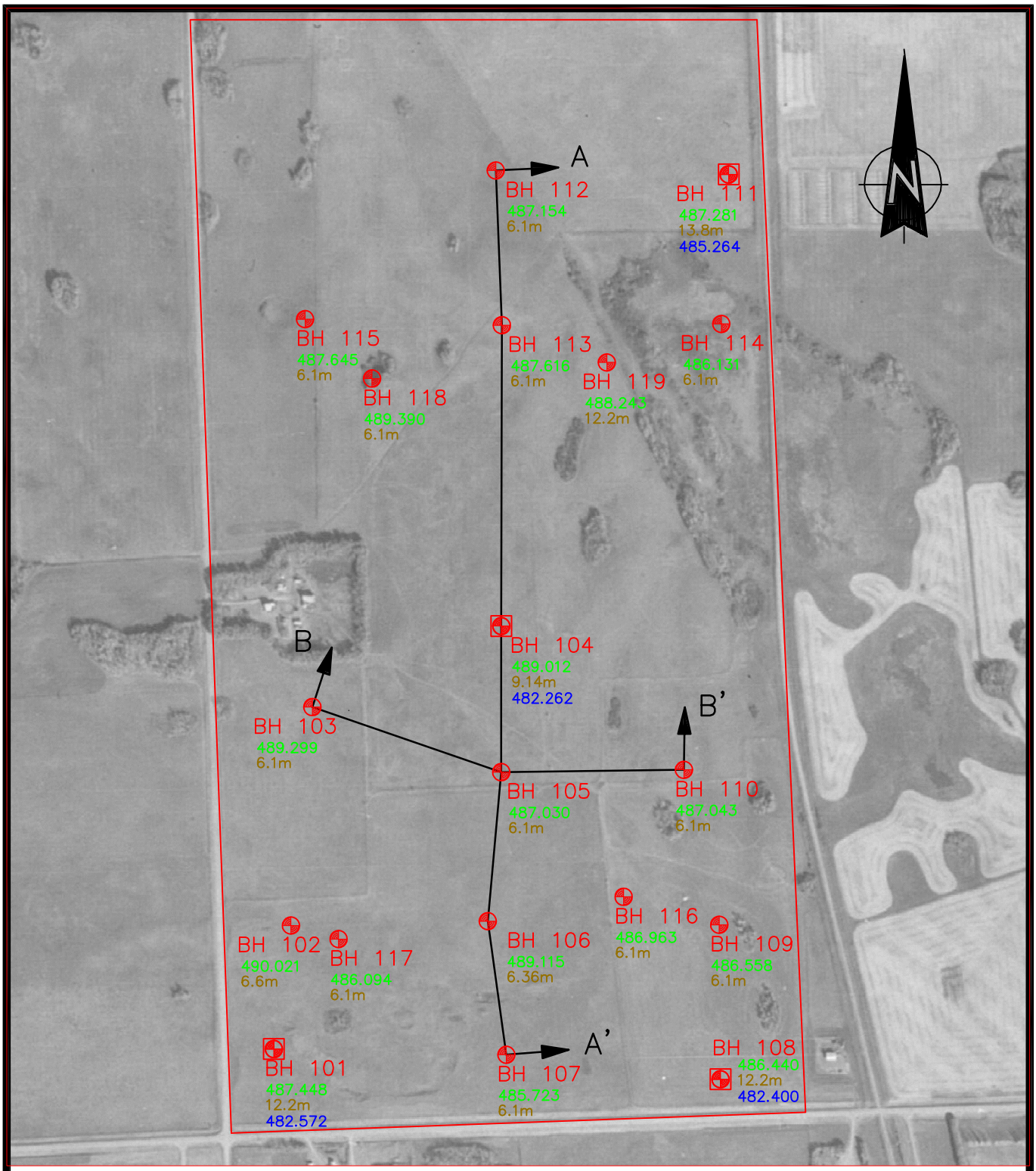
DATE	DRAWN BY	APPROVED BY	SCALE	FILE NO.	DRAWING NO.
14/03/08	LLT		NTS	S1607001	S1607–01

Clifton Associates Ltd.
engineering science technology

CLIENT: NEIL KETILSON

PROJECT: CASA GRANDE SUBDIVISION

TITLE: SITE LOCATION PLAN



BORE HOLE LOCATION
PIEZOMETER

492.70 SURFACE ELEVATION
9m DEPTH OF BOREHOLE
489.76 GROUNDWATER ELEVATION

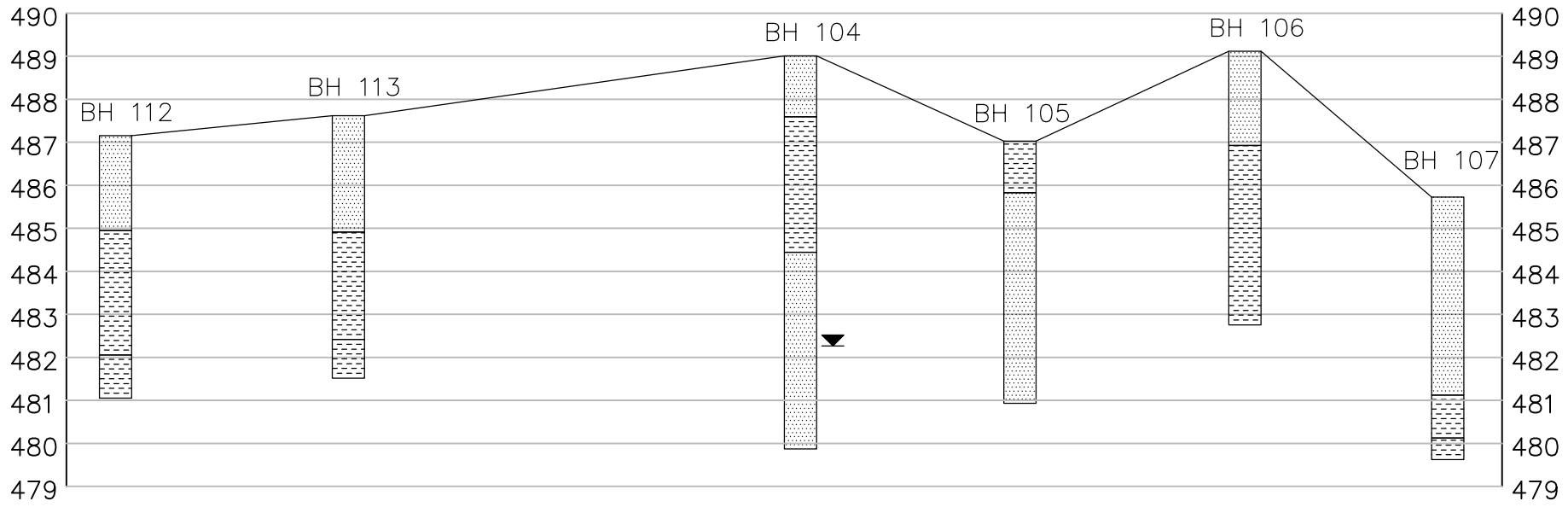
DATE	DRAWN BY	APPROVED BY	SCALE	FILE NO.	DRAWING NO.
25/03/08	LLT		1:10,000	S1607001	S1607-02

Clifton Associates Ltd.
engineering science technology

CLIENT: NEIL KETILSON

PROJECT: CASA GRANDE SUBDIVISION

TITLE: BORE HOLE LOCATION PLAN



SCALE
VERTICAL: 1:375,000
HORIZONTAL: 1:7,500

LEGEND:

CLAY

SILT

SAND

DRAWING REVISIONS			
6			
5			
4			
3			
2			
1			
NO	DD/MM/YY	DESCRIPTION	BY

Clifton Associates Ltd.
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CLIENT

NEIL KETILSON

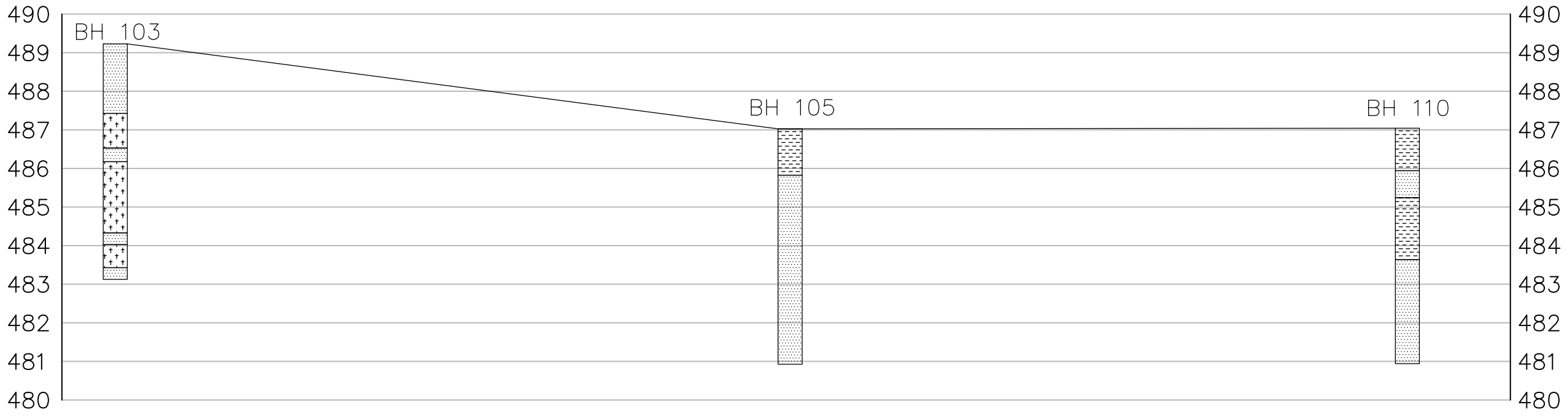
PROJECT TITLE

CASA GRANDE SUBDIVISION

DRAWING TITLE

CROSS SECTION A–A'
(NORTH–SOUTH)

PROJECT NO.		FILE NO.
S1607		S1607001
DATE	SCALE	DWG. NO.
20/03/08	AS SHOWN	S1607–03
DRAWN	CHECKED	
LLT		



SCALE
VERTICAL: 1:50,000
HORIZONTAL: 1:2,500

LEGEND:

CLAY

SILT

SAND

DRAWING REVISIONS			
6			
5			
4			
3			
2			
1			
NO	DD/MM/YY	DESCRIPTION	BY

Clifton Associates Ltd.
engineering science technology

CLIENT
NEIL KETILSON

PROJECT TITLE
CASA GRANDE SUBDIVISION

DRAWING TITLE
CROSS SECTION B–B'
(WEST–EAST)

PROJECT NO. S1607		**FILE NO.** S1607001	
DATE 20/03/08	**SCALE** AS SHOWN	**DWG. NO.** S1607–04	
DRAWN LLT	**CHECKED**		

Clifton Associates Ltd.
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Appendix A

ANALYTICAL REPORT

CLIFTON ASSOCIATES LTD

ATTN: KIM BONNEAU

2120 AIRPORT DR.

SASKATOON SK S7L 6M6

Reported On: 27-FEB-08 03:23 PM

Lab Work Order #: **L605119** **Date Received:** **26-FEB-08**

Project P.O. #:
Job Reference: S1607
Legal Site Desc:
CofC Numbers: C061070

Other Information:

Comments:

NICK PIDSKALNY
General Manager, Saskatoon

For any questions about this report please contact your Account Manager:

RAECHELLE KREESE

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L605119-1 BH 101								
Sampled By: NOT PROVIDED on 25-FEB-08 @ 15:00								
Matrix: WATER								
Routine Water Analysis								
Alkalinity, Total								
Alkalinity, Total (as CaCO3)	287		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Bicarbonate (HCO3)	350		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Hydroxide (OH)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Carbonate (CO3)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Chloride (Cl)	90		1	mg/L	26-FEB-08	26-FEB-08	BFE	R634984
ICP Cations								
Calcium (Ca)	148		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Potassium (K)	4.2		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Magnesium (Mg)	73.4		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sodium (Na)	21		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sulfate (SO4)	263		4	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Ion Balance Calculation								
Ion Balance	104			%		27-FEB-08		
TDS (Calculated)	783			mg/L		27-FEB-08		
Hardness (as CaCO3)	672			mg/L		27-FEB-08		
Nitrate, Nitrite and Nitrate+Nitrite-N								
Nitrate-N	2.5		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrite-N	0.08		0.05	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrate+Nitrite-N	2.6		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
pH and Conductivity								
pH	7.5		0.1	pH	26-FEB-08	26-FEB-08	CMF	R635197
Conductivity (EC)	1220		10	uS/cm	26-FEB-08	26-FEB-08	CMF	R635197
L605119-2 BH 108								
Sampled By: NOT PROVIDED on 25-FEB-08 @ 15:30								
Matrix: WATER								
Routine Water Analysis								
Alkalinity, Total								
Alkalinity, Total (as CaCO3)	308		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Bicarbonate (HCO3)	376		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Hydroxide (OH)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Carbonate (CO3)	<5		5	mg/L	26-FEB-08	26-FEB-08	ANT	R635110
Chloride (Cl)	6		1	mg/L	26-FEB-08	26-FEB-08	BFE	R634984
ICP Cations								
Calcium (Ca)	91		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Potassium (K)	3.2		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Magnesium (Mg)	24.3		0.1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sodium (Na)	15		1	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Sulfate (SO4)	42		4	mg/L	27-FEB-08	27-FEB-08	DAD	R635292
Ion Balance Calculation								
Ion Balance	101			%		27-FEB-08		
TDS (Calculated)	367			mg/L		27-FEB-08		
Hardness (as CaCO3)	327			mg/L		27-FEB-08		
Nitrate, Nitrite and Nitrate+Nitrite-N								
Nitrate-N	<0.1		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrite-N	<0.05		0.05	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
Nitrate+Nitrite-N	0.1		0.1	mg/L	26-FEB-08	26-FEB-08	BFE	R635054
pH and Conductivity								
pH	7.3		0.1	pH	26-FEB-08	26-FEB-08	CMF	R635197
Conductivity (EC)	640		10	uS/cm	26-FEB-08	26-FEB-08	CMF	R635197

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L605119-2 BH 108 Sampled By: NOT PROVIDED on 25-FEB-08 @ 15:30 Matrix: WATER **Routine Water Analysis**								

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Preparation Method Reference(Based On)	Analytical Method Reference(Based On)
ALK-TOT-SK	Water	Alkalinity, Total		APHA 2320 B-Auto-Pot. Titration

Alkalinity is determined by a titration of an aliquot with standardized acid solution to a pH of 4.5. Total alkalinity, bicarbonate, carbonate(if present) and hydroxide(if present) also reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 2320B.

CL-SK	Water	Chloride (Cl)		APHA 4500 CL-E

Chloride in the extract is determined colorimetrically at 660 nm by complexation with mercury (II) thiocynate. In the colorimetric method, chloride (Cl-) displaces thiocyanate which, in the presence of ferric iron, forms a highly colored ferric thiocyanate complex.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500Cl-E.

ETL-ROUTINE-ICP-SK	Water	ICP Cations		APHA 3120 B-ICP-OES

These ions are determined directly y ICP-OES.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 3120B.

IONBALANCE-SK	Water	Ion Balance Calculation		APHA 1030E
N2/N3-SK	Water	Nitrate, Nitrite and Nitrate+Nitrite-N		APHA 4500 NO3F

Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl)ethylenediamine dihydrochloride. The resulting water-soluble dye has a magenta color, which is measured at 520nm. Original nitrite can also be determined by removing the cadmium column and following the same procedure. Nitrate-N, Nitrite-N and NO3+NO2-N are reported.

Reference
Greenberg, Arnold E., Cleseri, Lenore S., Eaton, Andrew D., Standard Methods For The Examination of Water and Wastewater, 18th Edition, 1992, Method 4500NO3-F.

PH/EC-SK	Water	pH and Conductivity		APHA 4500-H, 2510

** Laboratory Methods employed follow in-house procedures, which are generally based on nationally or internationally accepted methodologies.

Chain of Custody numbers:

C061070

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
SK	ALS LABORATORY GROUP - SASKATOON, SASKATCHEWAN, CANADA		

Reference Information

GLOSSARY OF REPORT TERMS
Surr - A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior but not normally detected in environmental samples. Prior to sample processing, samples are fortified with one or more surrogate compounds.
The reported surrogate recovery value provides a measure of method efficiency. The Laboratory control limits are determined under column heading D.L.
mg/kg (units) - unit of concentration based on mass, parts per million.
mg/L (units) - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
UNLESS OTHERWISE STATED, SAMPLES ARE NOT CORRECTED FOR CLIENT FIELD BLANKS.
Although test results are generated under strict QA/QC protocols, any unsigned test reports, faxes, or emails are considered preliminary.

ALS Laboratory Group has an extensive QA/QC program where all analytical data reported is analyzed using approved referenced procedures followed by checks and reviews by senior managers and quality assurance personnel. However, since the results are obtained from chemical measurements and thus cannot be guaranteed, ALS Laboratory Group assumes no liability for the use or interpretation of the results.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

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Lab Work Order # (lab use only)	SAMPLER (Initials):	

Sample #	SAMPLE IDENTIFICATION (This description will appear on the report)	DATE	TIME	SAMPLE TYPE	REJ	HAZARDOUS ?	HIGHLY CONTAMINATED ?	NUMBER OF CONTAINERS
	BH 101	Feb 25/08	3:00pm	H2O	X			1
	BH 108	"	3:30	"	X			1

GUIDELINES / REGULATIONS

SPECIAL INSTRUCTIONS / HAZARDOUS DETAILS

Failure to complete all portions of this form may delay analysis. Please fill in this form *LEGIBLY*.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the reverse page of the white report copy.

RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	SAMPLE CONDITION (lab use only)
Kath Nagel	Feb 26/08		26-Feb-08	TEMPERATURE 8°C / SAMPLES RECEIVED IN GOOD CONDITION ? (YES) NO (If no provide details)
RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	

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