## MUNICIPAL DISTRICT OF TABER IN THE PROVINCE OF ALBERTA

#### **BYLAW NO. 1798**

BEING a bylaw of the Municipal District of Taber in the Province of Alberta for the purpose of adopting Bylaw No. 1798 being the Area Structure Plan for Lot 3, Block 1, Plan 9611496.

WHEREAS the Council of the Municipal District of Taber has redesignated Lot 3, Block 1, Plan 9611496 located in the NW½ 8-9-16-W4M to the "Grouped Country Residential" land use district;

AND WHEREAS the purpose of proposed Bylaw No. 1798 is to establish standards and requirements regarding the development and subdivision of lands described as Lot 3, Block 1, Plan 9611496 in the NW½ 8-9-16-W4M;

AND WHEREAS the municipality wishes to provide for orderly growth and development to occur while minimizing land use conflicts;

AND WHEREAS the municipality may adopt an area structure plan pursuant to section 633 of the Municipal Government Act, RSA 2000, Chapter M-26, as amended, and provide for its consideration at a public hearing.

NOW THEREFORE, under the authority and subject to the provisions of the Municipal Government Act, RSA 2000, Chapter M-26, as amended, the Council of the Municipal District of Taber in the Province of Alberta, duly assembled does hereby adopt Bylaw No. 1798 being the Area Structure Plan for Lot 3, Block 1, Plan 9611496.

READ a first time this 14 day of	April 2009.
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READ a second time this 12 day of _	May , 2009.
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Reave Hank Van Beers	Muhicipal Administrator Derrick Krizsan
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#### Area Structure Plan: Block 1, Lot 3, Plan 9611496

#### Application for subdividing Block 1, Lot 3, Plan9611496

#### **Detailed Structure Plan**

The purpose of this subdivision is to create 3 lots varying in size from 4.96 to 6.4 acres more or less. The land is currently made up of one lot of 17.17 acres, more or less, consisting only of pasture land. The land is currently zoned Group Country Residential and is located approximately 4 miles south of Taber. This proposed development is similar to the existing developments in the immediate area.

**Detailed lot sizes:** Lot 4: 4.96 acres

Lot 5: 5.81 acres Lot 6: 6.4 acres

#### Road Network

- Lot 4 will be serviced by an approach at the North end of the lot, connecting to township road 9-2.
- Lot 5 will be serviced by an approach at the North end of the lot, connecting to township road 9-2.
- Lot 6 will be serviced by an approach at the North end of the lot, connecting to township road 9-2.
- Approaches will be constructed as per MD guidelines.

#### **Stormwater Management**

- The prevailing slope of all three proposed lots is generally southward.
- Property lines will be bermed or swaled to prevent cross lot drainage.
- For further details, refer to portions of Stormwater Management Plan prepared by due South Project Management Ltd. that pertain to this property.
- The attached report encompasses an area beyond the limits of this area structure plan for lot 3,block 1,plan 9611496. This in no way implies or authorizes approval of future subdivision on adjacent lands based on the information in the report.

#### **Geotechnical Report (Percolation tests conducted by EBA Engineering)**

Percolation Test	Location	Soil Texture Analysis (0.45m to 0.9m)	Percolation Test Result (min/cm)	Groundwater Levels (m)
Р3	4	SAND-trace to some silt, poorly graded, medium grained, damp, compact brown	5	Dry
P2	5	SAND-trace to some silt, poorly graded, medium grained, damp, compact brown	3	Dry
P1	6	SAND-trace to some silt, poorly graded, medium grained, damp, compact brown	4	Dry

• For further details, refer to portions of geo technical report completed by EBA Engineering that pertain to this property.

• The attached report encompasses an area beyond the limits of this area structure plan for lot 3,block 1,plan 9611496. This in no way implies or authorizes approval of future subdivision on adjacent lands based on the information in the report

#### • Lot Servicing

- All lots will be serviced with power, natural gas, and domestic water (raw/non-potable water) to the lot line.
- Power will be provided by overhead line by way of easement.
- Natural gas will be provided by buried line by way of an easement as per Atco's recommendations.
- Each lot will require potable water to be hauled into a cistern, at the expense of the lot owner.
- Domestic water (raw/non-potable) will be provided to each lot through a buried line by way of an easement. Provision of domestic water is subject to the landowner entering into a domestic water use agreement with the irrigation district.

#### **Affected Agencies**

- T.I.D. has reviewed the proposal and has responded with no objections, as per attached letter.
- S.M.R.I.D. has reviewed the proposal and has responded with attached letter.
- The CHR Public Health Inspector has reviewed the proposal, including the percolation tests, and has responded with attached letter.
- Horizon School Division has reviewed the proposal and no letter of response was received.
- ATCO Gas was contacted and no letter of response was received.

#### **Design Details**

- Any home, pre-built, manufactured or constructed on site must obtain a development permit from the M.D. of Taber.
- All non-residential buildings will be limited to personal use structures (example; garages, garden sheds, greenhouses, gazebos, vehicle storage buildings & pet animal shelters).

#### **Keeping of Animals**

- Horses will be allowed to a maximum of two per lot plus foals (up to 12 months old).
- No other animals, other than domestic pets will be allowed.

#### **Garbage Disposal**

- Garbage disposal will be by way of dumpster or hauling to the landfill, at the lot owner's expense.
- No burning barrels or burning of garbage in any way will be permitted.

#### **Home Occupations**

- Home occupation is a discretionary use and will be determined by the M.D. of Taber Land Use Bylaw.
- No commercial or industrial uses will be permitted.

#### Right to Farm

• It is a provision hereof that the owner of the lands may not hold liable any person in an action in nuisance resulting from agricultural operations. The owner of any agricultural operation is not to be prevented by injunction or other order of a court from carrying on the agricultural operation because it causes or creates a nuisance.

#### **Further subdivision of Land**

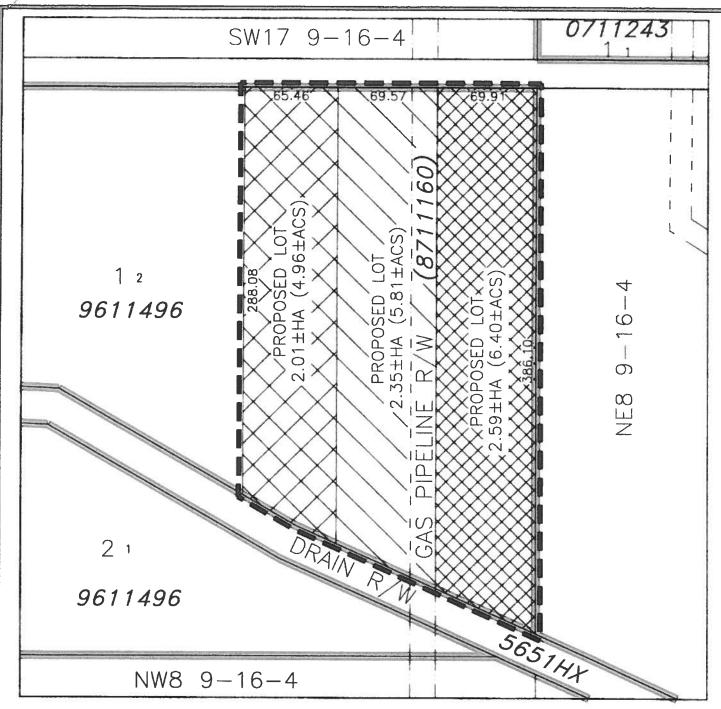
• It is a provision hereof that the owner of the lands may not further subdivide the land unless under the provisions of the Municipal District of Taber Land Use Bylaw.

#### **No Waiver**

 Failure by the Municipal District or any third party to enforce or require compliance with any provision hereof shall not render any such provision in any way unenforceable or invalid. No provision hereof shall be waived except in writing duly signed by the Municipal District of Taber.

N. 14 8-9-16 THEFT Figure 1 SITE PLAN AND TEST LOCATIONS 1200570 tes 00 120057 9 800 8 00tl 169 HVM #/N EBA Engineering Consultants IN. 600 150 N. Atl Williams - NO. 11 BONEHAZELOCKTON ST. MARY RWER IRROGATION LUSTRICT ERROR EDSTING FARMSTEAD MOUNE # # # @ **P11** SW 114 17-45 WEN TOWNSHIP ROAD 9-2 nw 14 8.9.18 year £ P12 GRIPES 12 ® CHICAGO T O ©F7 © EMIRES era Genera SHI CHOM BONNE NE 14 7-9-15 VAIN

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SUBDIVISION SKETCH LOT 3, BLOCK 1, PLAN 9611496 IN NW 1/4 SEC 8, TWP 9, RGE 16, W 4 M MUNICIPALITY; M. D. OF TABER **DATE; MAY 20, 2009** 

FILE; 2009-0-116





236 – 36 Street North Lethbridge, AB T1H 327 Tel.: (403) 394-7474 Fax: (403) 394-7404

www.duesouthproject.ca

July 22, 2008

File: 4070-001-00

Wadena Acres Box 4105 Taber, Alberta T1G 2C6

Dear Mr. Williams

RE: Wadena Acres

Stormwater Management Plan

due South Project Management is pleased to provide the stormwater management plan for the proposed development of 16 country residential lots covering 80 acres on the north half of the NW ¼ of Sec. 8, Twp 9, Rge 16 W4M.

#### Pre-Development Conditions:

The proposed site is located on agricultural lands that includes dry land and irrigated grasses and forages for the purpose of haying and grazing cattle. There are two established homes located in the existing homestead and a St. Mary River Irrigation District (SMRID) drain splits the site draining towards the south east corner of the site.

The general layout has the highest point of the site located in the northeast corner and the lowest point in the southeast corner of the development. The lands north of the drainage ditch are sandy clay soils used for dry land hay and grazing pasture which slope southerly towards the drain. The lands south of the drainage ditch have heavy clay soils that were used as irrigated hay land. The irrigation turnout is located at the high point in the southwest corner of the site and the land slopes northerly towards the drain.

Typical surface water runoff from this development into the SMRID drain would occur in the spring as a result of snowmelt while the ground is still frozen. Runoff from summer storms into the SMRID drain would be an unusual occurrence because surface water is typically trapped and/or absorbed into the soil. Water is vital to plant growth and the existing drainage of the site was designed to promote retention of soil moisture with positive drainage toward the drain to ensure standing water did not remain in the low areas for extended periods. The only significant runoff that would have reached the drain during the summer would have been when the landowner irrigating his hay on the south side of the drain.

#### **Stormwater Quantity:**

The concern with urbanization occurring in a rural area is that there are specific changes to the existing hydraulic regime of the area such as:

- An overall increase in annual volume of runoff
- A much faster rate of runoff from any given storm event
- Summer rainfall events that result in significant runoff from the urbanized areas, while little or no runoff comes from the rural portion of the basin.

These impacts are significant when you consider a typical residential subdivision with a high density of residential houses on small lots with concrete and asphalt surfaces. However the proposed subdivision consists of country residential lots that range in size from 2.9 acres to 6.5 acres. It is anticipated 5% to 10% of the lot will be developed with buildings, parking and driveway and the remaining lot will be unimproved. The increased runoff from the yard site during the summer storm events will be absorbed by the remaining unimproved lands within the lot.

#### **Stormwater Quality**

The two main contaminates that would be a concern for the SMRID drain would be sediment loading and nutrient enrichment. The most significant pollutant loading will occur in the spring with snowmelt since runoff from summer storms is a very rare occurrence.

The introduction of additional pollutants from post development of the site will be negligible when compared to the background concentrations from the agricultural land upstream on the SMRID drain or compared to the pollutant loading that would have occurred during irrigation.

Therefore the post development stormwater runoff quantity and quality will be consistent if not better then the pre development conditions and will have no negative impact on the SMRID drain or the downstream watercourse.

To minimize cross lot drainage the developer is recommended to construct either a berm or a swale ditch along the downstream edge of each property.

Should you have any questions or concerns you can contact the undersigned at your convenience.

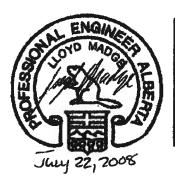
Yours truly,

due South Project Management Ltd.

Lloyd Madge, P.Eng. Project Engineer

LDM:mw

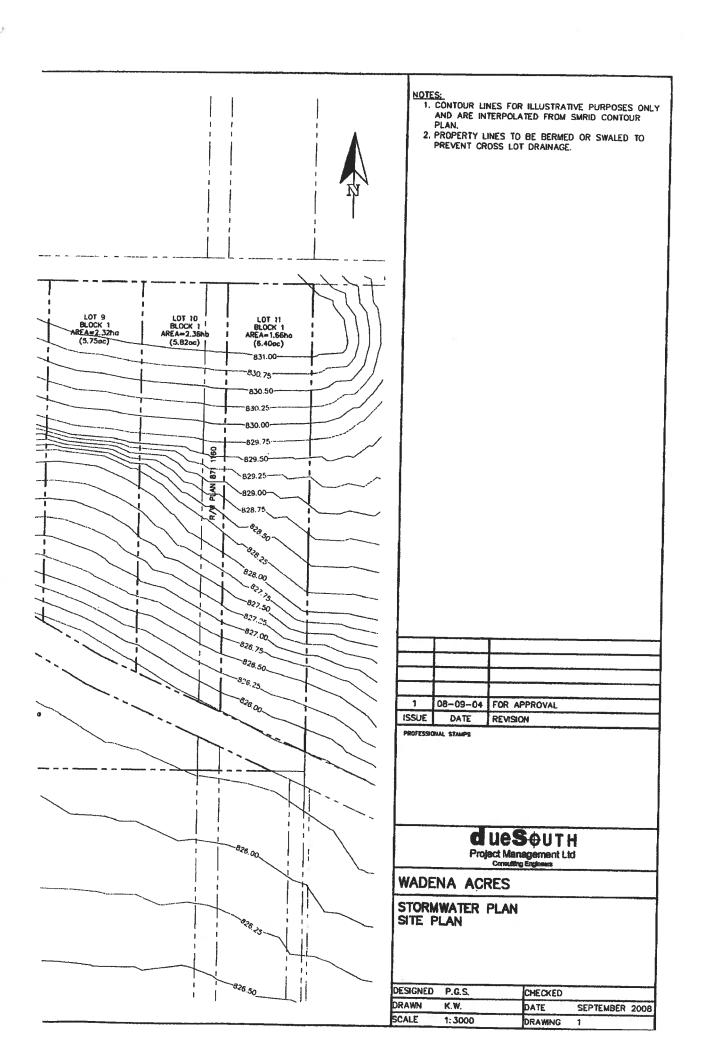
Enclosures (1)



PERMIT TO PRACTICE

NE SOUTH PROJECT MANAGEMENT LTD.
PERMET NUMBER: P 9222

The Association of Professional Engineers, Geologists and Geophysicists of Alberta





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Calgary Office 640 - 5 Avenue SW Calgary, Alberta, Canada T2P 3G4 Tel 403-297-8311 Fax 403-297-7336 www.ercb.ca, 6002 7 2 NdV

File No. 2008

## RECEIVED M.D. OF TABER

## REFERRAL REPLY FOR PROPOSED SUBDIVISION OR DEVELOPMENT REGARDING SOUR GAS WELLS OR PIPELINES

The Alberta Regulation 43/2002, Municipal Government Act, Subdivision and Development Regulation states that the Energy Resources Conservation Board (ERCB) must provide comments relevant to a proposed application that is within 1.5 kilometres of a sour gas facility.

Although the ERCB strives to maintain updated sour gas data related to the sour gas infrastructure, the conditions are not static and changes in level designation often occur and the ERCB may not be aware of these changes. We *strongly encourage* municipalities to undertake due diligence by confirming the most current sour gas data with the licencee.

The ERCB has reviewed and completed a search of ERCB regulated wells and pipelines in the vicinity of your referred subdivision or development application and our records indicate the following: (condition applicable if box is checked)

	A sour gas well (or wells) has (have) been identified within the search area of this application. The recommended setback distance is identified in this letter.
<b>X</b>	Other wells may exist within the area of this application. However, the ERCB has determined that these wells are either licensed as sweet wells or have an ERCB Level 1 sour designation and meet the recommended setback distance requirement of 100m.
	For a listing of ERCB wells in a specific area, contact the Information Services Group at the ERCB (403) 297-8311, Option #2.
	Sour gas pipeline(s), sour oil effluent pipeline(s) and/or sour salt water pipeline(s) containing greater than 10 moles of H <sub>2</sub> S gas per kilomole of natural gas has (have) been identified
ଛ <i>ପ</i> ଅ	within the search area of this application. The pipeline licence number, licensee and the recommended setback distance is identified in this letter. Pipeline information must be made available by the licensee upon request. Further, for oil effluent pipelines <i>Directive 26</i> requires that the licensee provides the level designation for these pipelines so that a setback determination can be made.
	Other pipelines may exist within the area of your referred application. However, the ERCB has determined that these pipelines licensed as sweet or have an ERCB Level 1 sour designation. For these types of pipelines, there is no regulated setback distance however, the right-of-way must be observed.
	The approximate locations of all pipelines in the area of application are shown on an enclosed copy of the ERCB's infrastructure map:
X	The approximate locations of abandoned wells in the area of application are shown on an enclosed conv of the FRCR's infrastructure man

#### Attachment

#### **ERCB Setback Distances**

A setback distance is the minimum distance that must be maintained between an energy facility and various surface developments for land use and public safety purposes. This distance may increase where sour gas is present. Sour gas is a natural gas that contains hydrogen sulphide (H<sub>2</sub>S).

Setback distances are dependant on the development density classification the ERCB assigns to your referral and the level assigned to a well or pipeline. The level of a well is determined by the licensed H<sub>2</sub>S release rate measured in cubic metres per second (m³/s). The level of a pipeline is determined by the licensed H<sub>2</sub>S release volume measured in cubic metres (m³). The development classification is a tool used by the ERCB to provide you with specific setback distance information for your referred application. The development density classifications; Permanent Dwelling, Unrestricted Country Development, Urban Centre and Public Facility are defined within Interim Directive (ID) 81-3 Minimum Distance Requirements Separating New Sour Gas Facilities From Residential and Other Developments and ID 97-6 Sour Well Licensing and Drilling Requirements, available on the ERCB's website. Setback distances corresponding to these development density classifications are found within these documents. If you feel your referred application has been incorrectly classified, please contact the person named on this letter.

#### Wells

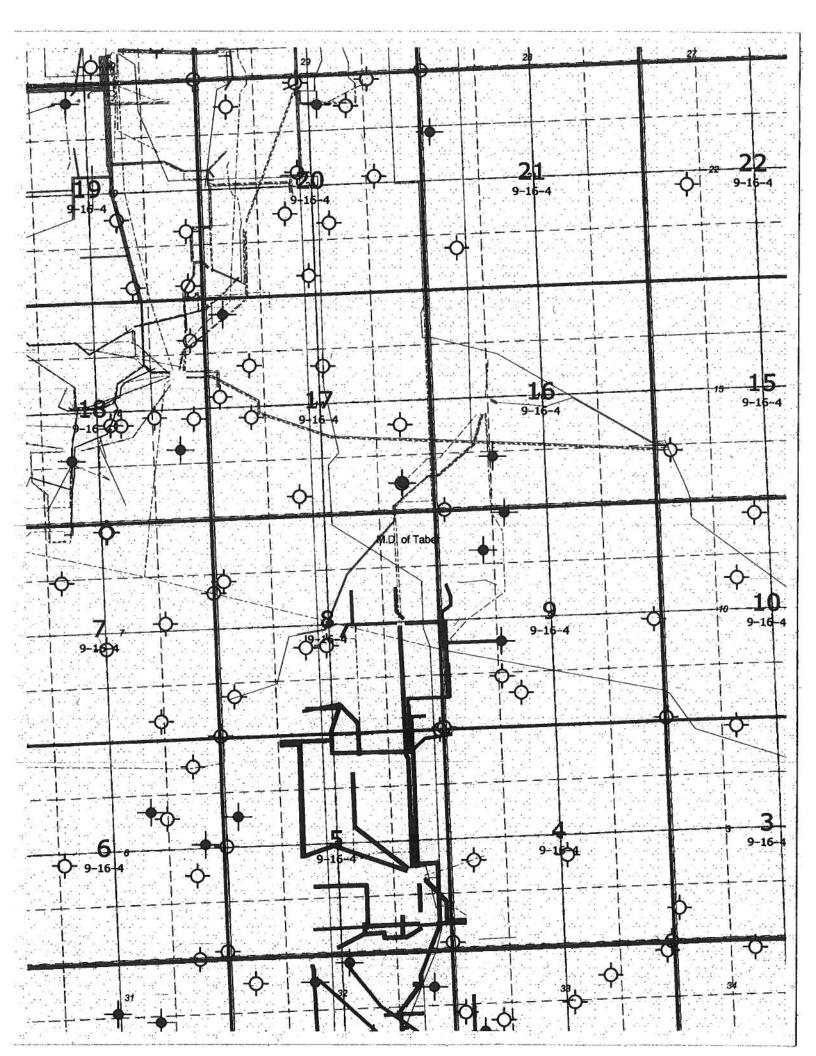
When any well licence is granted, the ERCB requires the licensee to maintain a minimum setback distance of 100 metres (m) from the wellhead to a surface improvement with a possible greater setback distance required if the well contains sour gas. Exceptions to this are surveyed roadways or road allowances that may be as close as 40 m. While the ERCB does not regulate land development, ERCB sour gas setback distances are reflected in the *Municipal Government Act (MGA) Subdivision and Development Regulation*. Both jurisdictions' regulations are intended to complement one another.

#### **Abandoned Wells**

The ERCB recommends the applicant locate abandoned wells prior to the land use development planning phase and no structure be placed over top of an abandoned well. Setback recommendations for abandoned wells are explained in a document called *Advisory Land Use Planning Notes - Abandoned Oil and Gas Wells*. These notes have been prepared jointly by the ERCB and Alberta Municipal Affairs and can be viewed on the Municipal Affairs website at, <a href="http://www.municipalaffairs.gov.ab.ca/ms/AbandonedWellSites.cfm">http://www.municipalaffairs.gov.ab.ca/ms/AbandonedWellSites.cfm</a>. For a listing of ERCB abandoned wells in a specific area, contact the Information Services Group at the ERCB (403) 297-8190.

**Pipelines** 

When a pipeline licence is granted for a pipeline transmitting sour natural gas, sour oil effluent or sour salt water containing greater than 10 moles of H<sub>2</sub>S gas per kilomole of natural gas, the ERCB requirement for setback distances are stated within ID 81-3 and Directive 26 Setback Requirements for Oil Effluent Pipelines respectively. When licences are granted for pipelines transmitting other substances or for abandoned pipelines there is no regulated setback distance. However, land use and construction activity on the pipeline right-of-way is restricted by the right-of-way agreement. The



## Municipal District of Taker

**Administration Office** 

EPA Section

APR 0 9 2009



4900B - 50th Street TABER, ALBERTA, T1G 1T2 PHONE: (403) 223-3541 FAX: (403) 223-1799

April 7, 2009

### NOTICE OF PROPOSED AREA STRUCTURE PLAN

PP

Legal Description: Lot 3, Block 1, Plan 9611496 in NW 8-9-16-W4

Location: 4 miles south of the Town of Taber

Referral Agencies: Horizon School Division, Holy Spirit RC School Division, TELUS (Lethbridge), Chinook Health, FortisAlberta, AltaLink, Alberta Agriculture, Alberta Transportation, ERCB, ATCO Gas, St. Mary River Irrigation District, Taber Irrigation District,

The Municipal District of Taber is in receipt of an Area Structure Plan for the creation of 3 residential lots within Lot 3, Block 1, Plan 9611496 in NW 8-9-16-W4. The land is currently zoned Grouped Country Residential.

The Municipal District of Taber is requesting your comments on this proposed development to ensure your concerns, if any, are addressed by the developer.

Please submit your comments regarding this proposed development to the M.D. of Taber no later than May 4, 2009.

Sincerely,

Derrick Krizsan Municipal Administrator

/jjb

ART WILLIAMS

ISSUED FOR USE

SEPTIC DISPOSAL FIELD FEASIBILITY ASSESSMENT PROPOSED COUNTRY RESIDENTIAL SUBDIVISION PORTION OF NW 8-9-16-W4M M.D. OF TABER, ALBERTA

L12101391

August 2008



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#### 1.0 INTRODUCTION

This report presents the results of an assessment conducted by EBA Engineering Consultants Ltd. (EBA) of the feasibility of septic disposal fields for a proposed country residential subdivision to be located in the M.D. of Taber. The property proposed for subdivision is located within the north half of NW ¼ Sec 8-9-16 W4M near Taber, Alberta.

The proposed property is shown on Figure 1, inclusive of 16 country residential lots under consideration at this time. The lot sizes appear to range between approximately 2.6 to 4.2 acres, except for Lot 9, with 6.18 acres. It is noted that Lot 8, Block 1, is excluded from this evaluation. The property is bounded to the north by Township Road 9-2 and to the west by Range Road 16-6. The property is bounded to the east and south by farmstead properties. A St. Mary River Irrigation District Drainage channel is noted to run east-west across the middle area of the property, as shown on Figure 1.

It is understood from Mr. Williams that for approval of a rural residential subdivision application, the approving agencies have requested the following requirements be met:

- A percolation test in each lot to determine soil suitability for waste disposal system.
- A borehole in each lot to determine surface ground water conditions.
- Assessment of the potential cumulative effects of the septic systems within the subdivision and surrounding area, including potential impact on the water table.
- Engineering recommendations for residential foundation construction, based on soils and water table information.
- Engineering recommendations for proper compaction of fill materials and grading of building sites.

Authorization to proceed with this assessment was provided by Mr. Art Williams.

#### 2.0 FIELDWORK

In order to access the feasibility of septic disposal fields, EBA selected a total of 16 locations for the purpose of percolation testing (one per lot), as shown on Figure 1.

EBA staff Mr Mitch Van Orman, arranged for the fieldwork to be performed on July 14, 2008, using a drill rig contracted from Chilako Drilling Services Ltd of Coaldale, Alberta. The drill setup was equipped with a 200 mm diameter flight auger. The drilling program included 16 percolation testholes (200 mm diameter) drilled to depths of approximately 900 mm (PH001 through PH016). To determine ground water elevations a total of sixteen boreholes (BH001 through BH016) were also drilled at each lot location to a



depth of 3.0 m (with the borehole numbering matching that of the percolation test number in each case).

The soil conditions were visually classified at the time of drilling and disturbed grab samples were obtained at 600 mm interval from the 3.0 m boreholes. The soil samples were tested at EBA's Lethbridge laboratory for moisture content. The borehole logs including soil descriptions at each location are attached. An explanation of the terms and symbols used on the borehole logs is also included in Appendix B.

The soil conditions encountered included a surface covering of topsoil with a thickness of approximately 0.1 m. Underlying the topsoil, in borehole locations BH001 to BH004, sand was encountered to the borehole termination depths of 3.0 m. The sand was described as medium grained, trace to some silt, poorly graded, damp, compact, and dark brown. Underlying the topsoil in borehole locations BH005, BH006, and BH008, gravel was encountered to depths of approximately 1.7 m to 2.4 m. The gravel was described as containing some sand, well graded, sizes to 20 mm, sub-angular and round, damp, compact and grey brown. Underlying the gravel in the boreholes BH005, BH006 and BH008, clay till was encountered, which was silty, some sand, trace gravel, very moist, stiff, medium plastic and brown with coal and oxide specks.

Excepting the above, at the other borehole locations, layers of clay or clay till were encountered underlying the topsoil throughout the rest of the property, typically extending to depths of 1.1 m to in excess of 3 m below ground surface. The layers were described as silty, with some sand to sandy, moist, stiff to very stiff in consistency, medium plastic and brown. The deeper soils included sand and gravel layers at BH009, BH011 and BH012.

Groundwater levels at the borehole locations. These values are shown on the table below.

The percolation test at each location included half filling the percolation testhole with water and allowing the testhole to saturate for a period of 24 hours. On July 15, 2008, the percolation holes (P1 through P16) were refilled with water to approximately 0.45 m below existing ground surface and maintained for 2 hours. The subsidence of the water was measured versus time (every 30 minutes). The following table provides the water levels and percolation test results.



Percolation Test	Location	Soil Texture Analysis (0.45 m to 0.9 m)	Percolation Test Result (min/cm)	Groundwate Levels (m)
P1	Lot 12 Block 1	SAND – trace to some silt, poorly graded, medium grained, damp, compact, brown	4	Dry
P2	Lot 11 Block 1	SAND - trace to some silt, poorly graded, medium grained, damp, compact, brown	3	Dry
P3	Lot 10 Block 1	SAND – trace to some silt, poorly graded, medium grained, damp, compact, brown	5	= Dry
P4	Lot 9 Block 1	SAND – trace to some silt, poorly graded, medium grained, damp, compact, brown	4	Dry
P5	Lot 7 Block1	GRAVEL – some sand, well graded, sizes to 20mm, sub-angular, damp, compact, brown	3	1.8
P6	Lot 6 Block 1	GRAVEL – some sand, well graded, sizes to 20mm, sub-angular, damp, compact, brown	6	1.7
P7	Lot 5 Block 1	SAND -silty, trace gravel, poorly graded, medium grained, moist, compact, brown	8	1.5
P8	Lot 4 Block 1	GRAVEL - some sand, well graded, sizes to 20mm, sub-angular, damp, compact, brown	5	1.4
<b>P</b> 9	Lot 9 Block 2	CLAY - silty, some sand, moist, very stiff, medium plastic, light brown,	50	1,6
P10	Lot 8 Block 2	CLAY - silty, some sand, moist, very stiff, medium plastic, light brown,	90	2.2
P11	Lot 7 Block 2	CLAY - silty, some sand, moist, very stiff, medium plastic, light brown,	50	2,0
P12	Lot 6 Block 2	CLAY - silty, some sand, moist, very stiff, medium plastic, light brown,	30	2.2
P13	Lot 5 Block 2	CLAY - silty, some sand, moist, very stiff, medium plastic, light brown,	10	2.3
P14	Lot 4 Block 2	CLAY (TILL) - silty, some sand, moist, very stiff, medium plastic, brown with grey mottling, coal and oxides	16	2.1
P15	Lot 3 Block 2	CLAY (TILL) - silty, some sand, moist, very stiff, medium plastic, brown with grey mottling, coal and oxides	21	2.4
P16	Lot 2 Block 2	CLAY (TILL) - silty, some sand, moist, very stiff, medium plastic, brown with grey mottling, coal and oxides	22	2.3



#### 3.0 SEPTIC DISPOSAL FIELDS

The Safety Codes Council's, Alberta Private Sewage Systems Standard of Practice 1999, states that a subsurface effluent disposal system that uses the absorption of effluent into the soil for treatment and disposal, should absorb the effluent into the soil at a rate of:

- not faster than 5 minutes per 2.5 cm (2 minutes/cm); and
- not slower than 60 minutes per 2.5 cm (24 minutes/cm),

as determined by a percolation test. In addition, the natural separation between the point of effluent infiltration into the soil and the groundwater should be a minimum of 1.5 m.

The percolation test results generally ranged between 3 and 22 minutes/cm for most of the lots, which would comply with these guidelines. It is noted however, that at test locations PH009, PH010, PH011 and PH012, the test results were outside of the Safety Code Council's guidelines, i.e. test in these locations were slower than the minimum rate of 24 minutes/cm, attributed to the medium plastic clay soils.

It is also noted that groundwater exists at some of the locations, but is typically below 1.5 m below ground surface. The exceptions include PH007 and PH008, with groundwater levels of 1.5 m and 1.4 m below ground surface.

These results indicate that the near surface soils for design and construction of septic disposal fields generally satisfy the requirements of the Safety Code Council's guidelines. However, several notes are presented, as follows.

For the case of PH009, PH010, PH011 and PH012, where isolated areas of slower percolation rates than that recommended by the guidelines are encountered, this may require re-location of the proposed septic disposal field to more acceptable areas. Alternatively, other means of establishing a disposal field, such as construction of a septic field mound or other such industry acceptable measures should be considered for these specific lots. Another option would be to raise these specific lots by a minimum of 0.9 m, with fill soils comprising sand or gravel soils obtained from other areas of the property (essentially, mounding the entire property). It is expected that the percolation test results within the granular fill soils would meet the Safety Code Council's guidelines, pending confirmation of percolation rates, following placement of the fill.

The results also show that for PH007 and PH008, because of existing groundwater conditions at 1.4 m to 1.5 m below ground surface, a partial or fully mounded system may be required to satisfy the Safety Codes Council's requirement for a natural separation between the point of effluent infiltration into the soil and the groundwater should be a minimum of 1.5 m. Alternatively, these specific lots should be raised in grade a minimum amount of 0.3 m, so that the installed septic field will be a minimum of 1.5 m above the groundwater table.

Based on the results of this assessment, the use of septic disposal fields for the country residential developments is considered feasible, with the above development modifications



to be considered for specific lots. However, it is noted that the specific site selection of the proposed fields needs careful consideration by the septic field installer to satisfy the requirements of the Regulations Having Jurisdiction (Municipality, AENV, Alberta Labour). This requirement is in accordance with the provincial regulations, which state that two percolation tests are required within the final footprint of the field by the installer. Following the site-specific testing, the septic disposal field should be designed and sized accordingly by the disposal field designer. It is further recommended that the design footprint of the residences be determined once the final disposal field is selected, to ensure the appropriate gravity flow or pumping requirements are satisfied.

During installation of the weeping trenches, the installer should pay close attention to the soil conditions, to define the extent of any sand pockets or any areas of slower percolation rates (higher plastic clay zones). These should be immediately reported to the disposal field designer for review prior to completion of the septic disposal field.

The information provided herein is intended to be a preliminary assessment of the feasibility of septic disposal fields for this residential development as per the provincial regulations. Site specific municipal regulations or siting requirement guidelines with respect to the local health unit, if applicable, have not been addressed.

With regards to the cumulative effects of the septic systems within the subdivision and surrounding area, it is understood that the M.D. of Taber has established the requirement that rural residential lot must not be less than 2 acres. Since all of the lots exceed this minimum required size established by the M.D. of Taber, the potential for cumulative effects of septic disposal fields within the subdivision is minimal. Also if the Safety Codes Council's requirement for a natural separation between the point of effluent infiltration into the soil and the groundwater (i.e., a minimum of 1.5 m) is met, it is considered that the potential for impact on the groundwater table would be negligible.

## 4.0 SUBDIVISION DEVELOPMENT RECOMMENDATIONS

#### 4.1 LOT GRADING

In general terms, the lot grading should be designed and carried out to the current Engineering Standards of the Municipality. The particulars for this development are discussed in this section.

Following organic stripping, all lots should be initially graded for drainage at a minimum gradient of 2.0%. The existing surficial site soils comprising clay, clay till, sand or gravel are suitable for use as 'landscape fill' materials or for use as 'general engineered fill' materials for lot grading, as defined in Appendix C.

The moisture content of the site soil materials at surface generally appears to be variable with respect to the anticipated optimum moisture content for these soils. It is anticipated therefore, that moisture conditioning will be required at the site for proper compaction.



The earthwork contractor should, however, make his own estimate of the requirements and should consider such factors as weather and construction procedures.

General engineered fill materials for lot grading should be moisture conditioned to within a range of -1% of optimum to +2% of the optimum moisture content prior to compaction and compacted to a minimum of 98% of SPD.

Further recommendations regarding backfill materials and compaction are contained in Appendix C.

#### 4.2 ROAD SUBGRADE PREPARATION

Within all paved areas, the upper 300 mm of native soils or prepared general engineered fill subgrade should be scarified and uniformly moisture conditioned to between minus 1% of optimum and 2% over optimum moisture content. The subgrade should then be uniformly compacted to a minimum of 98% of SPD.

Backfill to raise these areas to subgrade level should be general engineered fill materials, as defined in Appendix C, moisture conditioned and compacted as noted above. The subgrade should be prepared and graded to allow drainage to the road shoulders and ditches. Proof-rolling of the prepared surface is recommended to identify localized soft areas and for an indication of overall subgrade support characteristics.

It is imperative that positive surface drainage be provided to prevent ponding of water within or adjacent to the pavement structure. Surrounding landscaping should be such that runoff water is prevented from ponding beside paved areas in order to avoid softening and premature failure of the pavement surface.

If localized areas of soft subgrade soils are encountered, provisions may be required to subcut each small area and replace with engineered fill, or alternatively, with granular (pit-run) fill with the use of a geogrid or geotextile fabric to strengthen the subgrade support characteristics. Further design information can be provided following initial proof-rolling of the subgrade soils.

#### 4.3 EXCAVATIONS AND TRENCH BACKFILL

Excavations should be carried out in accordance with the Alberta Occupational Health and Safety Regulations.

For this project, the depth of excavations are anticipated to be shallow to moderate for such components as foundations, service trenches, and tie-ins (<3.0 m). Excavations which are to be deeper than 1.5 m should have the sides shored and braced or the slopes should be cut back not steeper than 1.0 horizontal to 1.0 vertical for periods up to one month. Where excavations are open for longer than one month or in granular soils, the slopes may have to be cut back flatter than 1.0 horizontal to 1.0 vertical. This should be reviewed on site by experienced personnel.





It is considered that varying amounts of groundwater seepage will occur in isolated areas, where the excavation exceeds the groundwater level below the existing ground surface. Therefore, although dewatering of most excavations should not be necessary, dewatering should be expected in some areas, particularly in wet, granular soils. In these localized areas, any seepage should be directed towards a sump for removal from the excavation.

Temporary surcharge loads, such as spill piles, should not be allowed within a distance from an unsupported excavation face equal to the depth of excavation. Mobile equipment should be kept back at least 2.0 m. All excavations should be checked regularly for signs of sloughing, especially after rainfall periods. Small earth falls from the sideslopes are a potential danger to workmen and must be guarded against.

The moisture content of the soils encountered across the site is generally variable with respect to the estimated Standard Proctor optimum moisture content for the materials. It is expected that such soils would be satisfactory as trench backfill material, however, may require moisture conditioning prior to compaction.

Trenches must be backfilled in such a way as to minimize the potential differential settlement and/or frost heave movements. A minimum density of 95% of SPD is recommended for all trench backfill, at a moisture content of between -1% and +2% of optimum. The exception is that the top 600 mm of all trenches should be compacted to 98% of SPD. The compacted thickness of each lift of backfill shall not exceed 150 mm. The upper 1.5 m of service trenches should be cut back at a maximum slope of 1.0 horizontal to 1.0 vertical to avoid an abrupt transition between backfill and in situ soil.

It should be noted that the ultimate performance of the trench backfill is directly related to the uniformity of the backfill compaction. In order to achieve this uniformity, the lift thickness and compaction criteria must be strictly enforced.

For frost protection, pipes buried with less than 2.1 m of soil cover (above top of pipe) should be protected with insulation to avoid frost effects that might cause damage to or breakage of the pipes. Rigid insulation placed under areas subject to vehicular wheel loadings should be provided with a minimum thickness of 600 mm of compacted granular base.

General recommendations regarding construction excavation, backfill materials and compaction are contained in Appendix C.

#### 4.4 CONCRETE TYPE

As per CSA and EBA's experience in this area, the potential degree of sulphate attack on concrete may be considered to be severe (Class S-2). Accordingly, the use of Sulphate Resistant Portland cement at a maximum water/cementing materials (W/CM) ratio 0.45 is recommended for foundation concrete and all concrete exposed to soil and/or groundwater. If available, a proven flyash should be used as a supplemental cementing material. Based on EBA's experience with Alberta aggregates, a W/CM ratio of 0.45 normally corresponds to a 28-day compressive strength of 28 MPa or greater



(32 MPa at 56-days). Stricter recommendations may be required due to structural or other considerations, or for exposure to de-icing chemicals.

Air entrainment of 4 to 6% by volume is recommended for all concrete exposed to freezing temperatures, native soils and/or groundwater. This should be increased to 5 to 7% for exterior flatwork.

#### 4.5 PAVEMENTS

The following design for asphalt concrete surfaced pavement is provided for this development. Car and light-truck usage only has been assumed for the access road, with occasional to rare delivery truck, garbage disposal truck, and fire truck traffic. Note that this structure is equivalent to a City of Lethbridge local pavement structure.

DESIG	EN PAVEMENT SECTION
MATERIAL TYPE	LIGHT-DUTY (mm)
Surface Course Asphalt Concrete (Type III)"	75
Granular Base Course*	200

<sup>\*</sup> Current City of Lethbridge Transportation Engineering Standards (or equivalent)

The above recommended pavement layer thicknesses generally refer to average values and recognize typical construction variability. As constructed layer thicknesses should satisfy the thickness tolerances identified in the City of Lethbridge Engineering Standards for granular materials and asphalt concrete (or equivalent for the Municipality).

Subgrade support for pavements generally consists of stiff, moist, silty clay soils or compact sand or gravel soils. It should be recognized that the consistency of these materials, groundwater, site drainage, weather conditions, or other factors could impact the constructed subgrade support characteristics.

The upper 300 mm of soils should be scarified, uniformly moisture conditioned to between minus 1% of optimum and 1% over optimum moisture content and uniformly recompacted to a minimum of 98% of SPD. Backfill to bring these areas to subgrade level should be general engineered fill materials, as defined in this report. The subgrade should be prepared and graded to allow drainage to the shoulders and ditches. Proof-rolling of the prepared surface is recommended to identify localised soft areas and for an indication of overall subgrade support characteristics.

It is imperative that positive surface drainage be provided to prevent ponding of water. Recommended minimum grades of 1.0% should be used in hard surfaced areas. Surrounding landscaping should be such that runoff water is prevented from ponding beside paved areas in order to avoid softening and premature failure of the pavement surface.



All asphalt paving lifts should be compacted to a minimum of Marshall design density, as per current City of Lethbridge Transportation Detailed Engineering Standards. Note that the Municipality may have somewhat different requirements, however, the Lethbridge Standards are used most frequently by most contractors in southern Alberta. Additional recommended guidelines for design and construction of pavement structure are presented in Appendix C of this report.

If a granular pavement section is to be considered, it may be comprised of pit-run gravel with a minimum thickness of 300 mm. However, since the local pit-run gravel may be relatively coarse (large, rounded particles) and sandy, it will be difficult to blade smooth during regular maintenance. It is recommended that a surfacing layer of crushed gravel (granular base course) be placed within a nominal thickness of 50 mm, as this layer will be easier to maintain. All granular layers should be compacted to 100% of SPD. Recommendations for maintenance of gravel pavement are provided in Appendix C, "Gravel Yards and Pavements".

#### 4.6 RECOMMENDATIONS FOR FOUNDATIONS

Based on our understanding of the proposed residential buildings configuration, shallow foundations should be constructed a minimum of 1.4 m below the final design exterior ground surface (frost protection requirement) or deeper, if a basement is to be considered. At this depth the foundation subgrade soil should consist of stiff to very stiff, damp to moist, medium plastic clay, sand or gravel. At this depth, the foundation subgrade soil should rest on native soils only.

The net allowable static bearing pressure for the design of strip and spread footings at this depth may be taken as 75 kPa, on native, undisturbed soils. The factor of safety used from ultimate bearing capacity was 3.0. Footing dimensions should be in accordance with the minimum requirements of the Alberta Building Code 1997 (Section 9.15.3 Footings).

It is recommended that a smooth edge-trimming bucket or Grade-All be used for final excavation to the foundation subgrade elevation to minimize disturbance of the founding soils. The foundation concrete should be placed immediately following excavation to ensure the bearing soil (medium plastic clay) does not dry out below the plastic limit. A mud slab is recommended immediately after excavation to footing level within granular soils, in order to prevent disturbance of the granular foundation subgrade.

The foundation soils are prone to volume changes (both heave and settlement) with varying moisture content. Therefore, a permanent weeping tile system is also recommended around the outside perimeter of the structure at the foundation elevation to maintain a consistent moisture profile of the founding soils. This will reduce the potential of differential movement (heave or settlement) of the foundations.

Settlement of footings designed and constructed in accordance with the above recommendations should be well within the normally tolerated values of 25 mm total and 15 mm differential.



#### 4.7 BELOW GRADE WALLS

All below grade walls should be designed to resist lateral earth pressures in an "at-rest" condition. This condition assumes a triangular pressure distribution and may be calculated using the following expression.

$$P_o = K_o (\gamma H + q)$$

Where:

P. lateral earth pressure "at-rest" condition (no wall movement occurs at a given depth)

Ko = co-efficient of earth pressure "at-rest" condition (use 0.5 for cohesive backfill and 0.45 for sand and gravel backfill)

bulk unit weight of backfill soil (use 19 or 21 kN/m³ for cohesive or granular backfill, respectively)

H = depth below final grade (m)

q = surcharge pressure at ground level (kPa)

Considering the groundwater levels, hydrostatic pressures may not need to be considered in the wall design, provided a below grade weeping tile system is installed at the lowest wall elevation and appropriately tied into the on-site drainage system.

Backfill around concrete walls should not commence before the concrete has reached a minimum two-thirds of its 28-day strength and the walls should be laterally braced. Only hand operated compaction equipment should be employed within 600 mm of the concrete walls. Caution should be used when compacting backfill to avoid high lateral loads caused by excessive compactive effort. A compaction standard of 95% of Standard Proctor maximum dry density (SPD) is recommended. To avoid differential wall pressures, the backfill should be brought up evenly around the walls.

#### 4.8 FROST PROTECTION

For protection against frost action, perimeter footings in heated structures should be extended to such depths as to provide a minimum soil cover of 1.4 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

Pipes buried with less than 2 m of soil cover should be protected with insulation to avoid frost effects that might cause damage to or breakage of the pipes. Rigid insulation placed under areas subject to vehicular wheel loadings should be provided with a minimum thickness of 600 mm of compacted granular base.



#### 5.0 DESIGN AND CONSTRUCTION GUIDELINES

Recommended general design and construction guidelines are provided in Appendix C, under the following headings.

- Shallow Foundations
- Construction Excavations
- Backfill Materials and Compaction
- · Proof-Rolling
- · Pavements
- · Gravel Pavement

These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the works although they may prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix C, the main text should govern.

#### 6.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings in 16 geotechnical boreholes and 16 percolation test locations. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, EBA should be notified and given the opportunity to review our current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction.

This report has been prepared for the exclusive use of Mr. Art Williams, for specific application to the development described in Section 1.0. It has been prepared in accordance with generally accepted soil engineering practices. No warranty is either expressed or implied.

For further limitations, reference should be made to the General Conditions in Appendix A of this report.



#### 7.0 CLOSURE

We trust this report satisfies your present requirements. Should you require additional information, please contact our office.

Respectfully submitted, EBA Engineering Consultants Ltd.

Prepared by:

John Christensen Senior Technologist

/sdt

Reviewed by:



J.A. (Jim) Ryan, P.Eng. Project Director

PERMIT TO PRACTICE EBA ENGINEERING CONSULTANTS LTD.

Signature

The Association of Professional Engineers, Geologists and Geophysicists of Alberta







# **APPENDIX**

APPENDIX A GEOTECHNICAL REPORT - GENERAL CONDITIONS\*



### GEOTECHNICAL REPORT - GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

#### 1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

## 2.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

#### 3.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

## 4.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/sock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

## 5.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

#### 6.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

## 7.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

#### INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

#### 9.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

#### 10.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

#### BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

#### 12.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the client's expense upon written request, otherwise samples will be discarded.

#### 13.0 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

#### 14.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

#### 15.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

The Client recognizes and agrees that electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.





R. two defended Page 1 SITE PLAN AND TEST LOCATIONS Consentents (M. COO Ess. Consentents LM. COO Ess. OF SERVING Sec. X 100 100.00 A N. Ari Williams COLUMN CO 6 Hebbe P.F. ®P\$ PROGRAMM TESTOCHMON ST. MAKY ROVER IPROBATION DUSTRICT DROWN EXISTING FAVORESTEAD PAVORESTEAD E H TOWNSHIP HOAD 9-2 SW 14 17.8-16 WAL NAV 14 89-18 WALL SHEAT OF WAY GENERAL **₽12** CONTROL OF STREET 6,73 4,834096 M ©.77 © 04/000 & Estable eritore Gerifore PANCE HOVD IRE 死 447年時期3

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# **APPENDIX**

APPENDIX B BOREHOLE AND PERCOLATION TESTHOLE LOGS\*



#### TERMS USED ON BOREHOLE LOGS

#### TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51mm O.D. spllt spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): includes (1) inorganic and organic slits and clays, (2) gravelly, sandy, or slity clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

ESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (kPa)
Very Soft	Less Than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater Than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

#### **GENERAL DESCRIPTIVE TERMS**

	and the same and the same and a same a sa
Slickensided Fissured	<ul> <li>having inclined planes of weakness that are slick and glossy in appearance.</li> <li>containing shrinkage cracks, frequently filled with fine sand or slit; usually more or less vertical.</li> </ul>
Laminated Interbedded Calcareous	<ul> <li>composed of thin layers of varying colour and texture.</li> <li>composed of alternate layers of different soil types.</li> <li>containing appreciable quantities of calcium carbonate.</li> </ul>
Well Graded	<ul> <li>having wide range in grain sizes and substantial amounts of intermediate particle sizes.</li> </ul>
Poorly graded	<ul> <li>predominantly of one grain size, or having a range of sizes with some intermediate size missing.</li> </ul>



## MODIFIED UNIFIED SOIL CLASSIFICATION †

MA	OR DIVI	SIONS	GROUP SYMBOLS	1.3	TYPICAL NAMES				CLASSIFICA	TION CRI	TERIA		
	action ve	CLEAN	아 GW Well-graded gravels and gravels and mixtures, little or no fines		on symbols	$\begin{array}{ccc} & C_0 = D_w/D_w & Greater than 4 \\ & & & \\ & $							
<b>*</b>	GRAVELS one of coarse for or o	ರಜ್ಞ	GP	Po	orly graded gravels as ad mixtures, little or no	nd gravel- o fines		GW, GP, SW, SP GM, GC, SM, SC Bordering Chestification requiring use of dust symbols	Not meeting both	n criteria fo	GW		
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	GRAVELS WITH FINES	<b>G</b> M	Silt	y gravels. v <b>el-s</b> and-silt mixtures		e of fines	GW, GP, GW, GC, Bordering requiring	Arterburg limits plot delow "A" line		plotting hatched	Atterburg limits plotting in halched area are	
<b>VAINED S</b> on No	20%	GRA	GC	Cle græ	yey gravels, vel-sand-clay mixture	8	of percentag		Atterburg limits p or plasticity inde	olot above " x greater th	A" fine an 7	borderi classific requirin dual sy	cations g use of
ARSE-GR 50% retail	Se e se e	CLEAN	sw		il-graded sands and ç ds,iitlie or no fines	pravelly	Classification on basis of percentage of fines	200 sleve 5. 200 sleve 8 sleva	$C_{ij} = D_{ij}/D_{ij}$ $C_{ij} = \frac{(D_{ij})^2}{D_{ij} \times D_{ij}}$	Greater t		3	
CO More than	SANDS n 50% of coa asses No. 4 s	Sec	SP		orly graded sands and ds, little or no fines	l gravelly	Classificat	Less than 5% Pass No. 200 sleve More than 12% Pass No. 200 sleve 5% to 12% Pass No. 200 sleve	Not meeting both criteria for SW				
	SANDS More than 50% of coarse fraction passes No. 4 sieve	SANDS WITH FINES	SM	Silty	/ sands, sand-slit mix	tures		Less than I More than 5% to 12%	Atterburg limits plot below "A" line or plasticity index less than 4 hatched area are borderline		in danea ere		
	<u> </u>	28 2 11	sc	Cia	ey sands, sand-clay	mixtures			Atterburg limits plot above "A" line or plasticity index greater than 7 dual symbols			cations ig use of	
FINE-GRAINED SOILS 50% or more passes No. 200 steve*	AYS		ML Inorganic slits, very fine sands, rock flour, slity or clayey fine sands				PLAST	CITY CHA	<b>IRT</b>				
	SILTS AND CLAYS Liquid Amit 50% or less		CL.	plas	inorganic clays of fow to medium plasticity, gravelly clays, sandy clays, silly clays, lean clays			soils and	or classification of fine-grained its and fine fraction of coarse-street soils.				
			OL.	Orga of lo	Organic sitts and organic sitty clays of low plasticity		Y IN	10 1	Soils passing 428 µm Equation of 'A' line: P1 = 0.73 (LL - 20)				
INE-GRAI more pass	AYS	%0;	МН	diate	ganic silts, micaceous or omaceous fine sands or , elastic silts			20	CI CI	+	MH	16 OH	_
50% or	SILTS AND CLAYS	greater than 50%	СН		ganic clays of high licity, fat clays			10 10 N	20 50 40		60	70 80	90
	SILT	gre	ОН		inic clays of medium gh plasticity			ad N		ī	••		
IGHLY C	RGANIC	SOILS	PΤ	Peat, muck and other highly organic soils 1:			*Ba	sed on the material passing the 3 in. (75 mm) sieve STM Designation D 2487, for identification procedure see					
		·	SOIL C	OMPO	DNENTS				0\	/ERSIZE N	RATERI	AL	
FRAC	MOITS		SIEVE SIZE		DEFINING R PERCENTAGE E MINOR COM	Y WEIGH	TOF		Rounded or subrounded  COBBLES 75 mm to 200 mm				
		PASS	ING RETAI	NED	PERCENTAGE	DESCRI	PTO	R	BOULDERS	> 200 mm			Tax
GRAVEL coarse fine		75 m 19 m			>35 %	*end			Not rounded  ROCK FRAGMENTS >75 mm				
SAND coarse medium fins		4.75 2.00 425	mm   425 µ	m	21 to 35 % 10 to 20 % >0 to 10 %	"y-adjec "som: "trac	B*	1	ROCKS	<del></del>	> 0.76	cubic m	etre in vol
SiLT (non plastic) or CLAY (plastic)		ion plastic) 75 µm as above but					1				4		

	JECT: RURAL RESIDENTIAL SUBDIVI				-					PRO	ECT NO	BOREH	OLEN
	ATION: NW1/4 SEC. 8-9-16 W4M	DRILL METH						AUGER			L121013	391 - 08BH0	01
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BACK	KFILL TYPE BENTONITE PE	GRAVEL SLOUG				OUT			0	DF	RILL (	CUTI	ING		SAI	ND		TIME	
Depth (m)	SOIL		SAMPLE TYPE	SAMPLE NUMBER	E CONTENT								21	0	40	ETRA 60	80		Denth (#)
D P	DESCRIPTION	JN	SAMP	AWIPLE	PO I DI	PLAS		M.			QUID	-	5(	20CH	(ET F	NED ( 150 EN. (	kPa)		Č
0	TOPSOIL - clay, silty, sandy, damp, dark brow CtAY - silty, sandy, very molst, stiff, medium p organics, white precipitales	n, roots, organics lastic, light brown, trace	-11			-	0	40	6		80	+	10	NO 4	200	300	400		
-	organos, anne prospitates																		
			<b>E</b>	21.	3		B												
1																			
O7716/08	CLAY (TILL) - sity, some sand, very moist, stif coal and oxide specks	, medium plastic, brown,	6	2 20		•			3		.5								¥.
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	End of Borehole @ 3.0m  Some Seepage or Sloughing on Committee				-											******			1
	Some Seepage or Sloughing on Committee Standpipe Installed to 3.0m indicated Water Level Measured July 16, 2008					· · · · · · · · · · · · · · · · · · ·													
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-		SEC. 8-9-16 W		CLIENT: N		-			75.4	A 1 1/	)ED	-	PF	-		BOR		
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DMUK	FILL I IPE	B DEMIONIE	PEA GRAVE	L IIII SI		100		ROUT			$\mathcal{U}$	KILL	CUTI	INGS	<b>∷</b> \$/	MD		7
					18	田	EN I		-939	10000 F	M 5							
Depth (m)			SOIL		Σ	15	ğ						1	STAN	DARD PE	NETRATIC	N (N)	4
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	CLAY (TILL) -	silty, some sand, ve oxide specks	ry moist, stiff, mediur	n plastic, brow	vn,	B3	20.6	1	9									
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		L RESIDENTIAL 4 SEC. 8-9-16 W		CLIENT: MR.					07"	14 4	100	-	_	P						HOL	
	SOUTH OF		114(	PROJECT EN		-	_			M Al	JUE	:K	+			.12	1013	91 -	U8B	H009	<u> </u>
	LE TYPE	DISTURBED	NO RECO	The second second second	GIIII	CEN.	-	A-CA			П	П	UELD	V T	IDE	'n	0.0	255			_
	FILL TYPE		PEA GRAV		Ct.I								HELB				~	ORE			
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					TYPE	SAMPLE NUMBER	MOISTURE CONTENT														
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ta			CRIPTION		出	E E	W.	-						٦	•	UNC	40 ONF	60 INEC	(kPa	1	1
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					S	SA	2		20	40	6	0	80		1	00 00	200	300	. (KP8 ) 4(	10	
- 0	TOPSOIL - C	lay, siity, sandy, dam sandy, moist, very st	ip, dark brown, roots	s, organics					:											;	Γ
-	mottling	g, trace organics, whi	iii, meulom piasuc, t lte precipitates	oank brown with gre	7				i						:	: :	:				l
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97/16/08	SAND - silly, t	trace clay, trace grav , wet, compact, brow	el, poorly graded, fi	ne to medium									: :					}**! !			1
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Г	CLAY (TILL) -	sitty, some sand, ve oxide specks	ry moist, stiff, medic	ım plastic, brown,	麵	B4				<u>l.i</u> .		:	: :				:				
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	Some Seepag	e or Sloughing on C	conmoletion						_			Ē					4				Ì
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		RESIDENTIAL		CLIENT: MR.	-				- 16				PRO	JE(	TNC	) B(	REHO	)LE I
-	THE PARTY NAMED IN COLUMN	SEC. 8-9-16 W	4M	DRILL METH						1 AU	GER			L1	21013	91 - 1	08BH0	10
	SOUTH OF T			PROJECT EN	IGIN	EER:	-				-							
	E TYPE	DISTURBED		RY X SPT		y2	1	-CASI	NG			SHELB	TUBE		C	ORE		22
BACKF	ILL TYPE	BENTONITE	PEA GRAVE	L SLOU	GH	NU VA	1	ROUT	T			DRILL (	UTTIN	GS	: S	AND	in in	
					٦.,,	TE	-	T			17.7		T		4.5			7
=					SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	-										
Depth (m)			SOIL			19	8	1					51	AND 20	ARD PI	NETR/	TION (N	
8		DESC	RIPTION		12	Щ	뿥							- UN	CONF	INED	80 (kPa)	1
n					A	F	ST	PLAS	STIC	M.	C.	riguid	_	50	100	150	200 (kPa)▲	4
	<b>*</b> 25250			124	S	SA	8		20	40	60	80	1 '	100	200	300	400	
0	TOPSOIL - CE	y, silly, sandy, dam	p, dark brown, roots,	organics					1		WI.			1				1
	Mottling	ancy, moist, very sti	ff, medium plastic, da	ink brown with gre	y					- 15								
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	200mm grav	el seam with free w	ater @ 1.5m							****			11:	:			i.	-
_	CLAV (PILL)	46.7						1										
	CLAY (TILL) - ( with light	sity, some sand, ver hown and arev mo	ry moist, stiff, medium tiling, coat and oxide	n plastic, brown	2000									÷				
	***************************************	nonn and grey mo	must post dita ovide	epours		B3	18.9	•										
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<b>►</b>  116,008  <b>►</b>								1										
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	End of Bo	rehole @ 3.0m		\$2 - 11 - 24   12 - 12   12   12   12   12   12   12	П				: :: :				1			•		1
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	Slotted PVC St	e or Sloughing on C andpipe installed to r Level Measured J	3.0m		11											T I		
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	and rate of 3 days	or a population of the first			_ = L.2	- t [7]	V 1	viii [		ZIAN.			160	WIP!	L- 1   10°	1114	/LEDIN	

	JECT: RURAL RESIDENTI		1 0	LIENT: MR.	ART	WIL	LIAM	3			/I. u V 100		PRO	JECT	NO.	BOF	REHO	LE NO
	ATION: NW1/4 SEC. 8-9-16	W4M	1	RILL METHO	DD; 1	50n	nm SC	LID	STE	M AU	GER			$\overline{}$			BH01	
-	SOUTH OF TABER, AB			ROJECT EN														
	PLE TYPE DISTURBE	D NO REC	OVER	Y X SPT				A-CA	SING		M	SHELBY	TUBE	T	COF	ξE	100000000	
BACK	KFILL TYPE 💹 BENTONIT	E PEA GR	AVEL	III SLOUC	3H			GRO	JT		N	DRILL C	UTTIN	GS				
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Depth (m)		2011			SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	-					ST	ANDAR	DEN	TOAT	ON (N)	_
#		SOIL			щ	Z	1 2	<b>L</b>					1	20	40	60	80	Depth (#)
ದಿ	UE	SCRIPTION			M	문	1 %	PL	ASTIC	M.	C i	LIQUID		UNCO	ONFIN IOO	IED (kl 150	200	1 6
					S	A	SS	1	$\vdash$	77	87-5		A	<b>POCH</b>	ŒT PI	EN. (ki	Pa)A	1 -
0	TOPSOIL - clay, sitty, sandy,	damp, dark brown, ro	ots, on	ganics		S	-	+-	20	40	60	80	+ :	100_2	00	300	400	+-
- 1	CLAY - slity, sandy, moist, ver mottling	y stiff, medium plasti	c, dark	brown with grey														1
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H	GRAVEL - some sand, well gra	arted sizes to 20mm	cubon	order and saved												: :		
- 1	damp, compact, grey bro	Wn	, outrail	Aner sun totilo		82	6.7	•										
1																		1
1	CAMP twee to come and to								***				1	*··!··				1
- 1	SAND - trace to some soit, trace grained, free water, comp	e gravel, poorly grad eact, brown	led, fine	e to medium														
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3  -	End of Borehole @ 3.0m	TOTAL				B5	18.8	ļ <u>i</u>	8				ļ		Ϋ́			
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	No Seepage or Sloughing on C Slotted PVC Standpipe Installe	conmpletion												0				1
- 1	Indicated Water Level Measure	d July 16,				1					; ;	5						-
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00	EBA Enginee	ring Con	suli	tants L	td.	R	EVIEV	VED	BY:	JAR		1111	COM	PLET	E: 7/	14/20	800	
en una	AL L12101391 ART WILLIAMS SUBDIVISIO	NI GO I EDA GINT NOMYRO				D	RAWII	YG N	IO: E	111			Page	1 of	1			- 1953

		L RESIDENTIAL : 4 SEC. 8-9-16 W		N V IOIOIY	-		MR. A	_				STI	ENA.	١١٥	FD							ORE 08BI	
		TABER, AB					TEN						-141	~~~	<b>₩</b> [7	-	-		L 12	1013	51-	UODI	10
	E TYPE	DISTURBED	7	NO RECOV				~ 11 V			-CA		2	Г	m:	SHELL	DV.	TUBE		11 0	ORE		
	ILL TYPE			PEA GRAV			SLOUG	H			SRO							TTING	201				
		144		, ,		ши		T	O.		T	71			71,	JUILL	-	THAC	201	·] 3/	AIAD		
e								SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	<u></u>												
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ebl		DESC	RIF	PTION				교	凹	星					LH		*****	•	UN	CONF	INED	80 (kPa)	•
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0	TOPSOIL - C	lay, silly, sandy, dam	o dork	brown santa		i.		10,	8	₹	_	20	4	0	60	80		-	00	200	300	40	
	CLAY (TILL)	- silly, sandy, moist, s	diff. lov	v to medium	, organ	hrow	coal	-				:											:
	and ox	de specks			,,		,,					:					:						:
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•	SAND - silty, p	poorly graded, fine gr	ained.	moist, compa	act, bro	wn	············				ļ								}}			·	
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g	CLAY (TILL) - oxide sp	silty, sandy, moist, st	ff, low	medium plas	tic, bro	Wa, c	oal and				1 :	:								:			:
7716/08	oxide sp	e~vg										:											:
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	End of B	orehole @ 3.0m						П				···		···				•		-			•
	Some Seepad	e or Sloughing on Co	nmole	ition																			:
	Slotted PVC S	e or Sloughing on Co tandpipe Installed to or Level Maasured Ju	3.0m	1								:											:
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	IECT: RURAL RES			_	ENT: MR				-	11.7				PRC	JEC	T NO	BC	REHO	LE NO
-	TION: NW1/4 SEC		M	_	LL METH		_				UA N	GER			L12	21013	91 - 0	8BH01	13
	SOUTH OF TABE		-		JECT E	-	EER:	-		-						20000	ittiggete o		
	- Invest	STURBED	NO RECOV	-				- because/	-CAS	-				Y TUBI			DRE		AMERICAN SE
ACK	FILL TYPE BI	ENTONITE	PEA GRAVE	EL	SLO	UGH	T &	_	ROU	T		23	RILL (	CUTTIN	IGS	SA	ND		
Depth (m)			SOIL CRIPTION			SAMPLE TYPE		MOISTURE CONTENT	PLA				ionio	+	20 ♦ UN 50 • PC	40 ICONF 100 ICKET	60 INED ( 150 PEN. (	200 kPaj≜	
0	TOPSOIL - clay, silt	y, sandy, dam	p, dark brown, roots,	organ	ics	+	S	2	1	20	40	60	80	+-	100	200	300	400	+-
A	CLAY (TILL) - silty, s coal and oxide	Offic Sand Vec	ff, medium plastic, lig y moist, stiff, mediur				<b>B</b> 1	17.9											
	200mm medium g	rained sand se	eam @ 1.5m				B2	15.1	•								,		
							B3	18.7									11		
Boote							B4												¥
	End of Borehol	a @ 3.0m					<b>B</b> 5	19.5		9									-
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		RESIDENTIAL SEC. 8-9-16 W		CLIENT: MR. DRILL METH	-			-	TAA A	UGEE	,	PRO			-	REHOL	-
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		RESIDENTIAL SEC. 8-9-16 W	SUBDIVISION	CLIENT:						OT:		4146			PR		CT NO			
CITY: SOUT			T178	DRILL ME							EM.	AUG	ER	_		L1	21013	91 - 1	U8BH	015
SAMPLE TY		DISTURBED	7 NO 2500	PROJEC		INE	EK:						117				4			
BACKFILL T			NO RECOV				- K	_	-CA		3			SHELB				ORE	110	
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						쒼	SAMPLE NUMBER	MOISTURE CONTENT												
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gde			CRIPTION			님	Z Z	HE WE		Vηι		- 11			+	20 <b>♦</b> U	40 NCONF	60 INED	(kPa)	-
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Depth (m)			SOIL CRIPTION		SAMPLE TYPE		MOISTURE CONTENT	PLA	STIC	M.C		alupi	1	20 40 UNCON 50 100	ENETRATION (N 60 80 FINED (KPa) 150 200
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3	End of B	orehole @ 3.0m				<b>B</b> 5	17.7								
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LOCA	TION: NW1/4	SEC. 8-9-16 W	/4M		MR. ART				ST	EM.	AUC	3ER	11 2	+	1110	_			08PI	
CITY:	SOUTH OF	TABER, AB			T ENGINE									10			TA		00.	100
SAMP	LE TYPE	DISTURBED	NO RECOV						SIN	G		M	SHE	LBY	TUB	= [		ORE		
BACK	ILL TYPE	BENTONITE	PEA GRAV		SLOUGH	-						_	_					AND	-	
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2						SAMPLE TYPE	MOISTURE CONTENT	L												
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BACK	ILL TYPE	BENTONITE	PEA GRAVE	L [	∭ St	OUGH	_	[i] (	RO	UT			77	DRII	T CI	JTTIN	es[		SAND			_
							W	MOISTURE CONTENT														1
Depth (m)			SOIL				TYPE	Š	Г				12			35	TAND	ARDF	ENET	RATIC	H (N)	
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PRO	JECT: RURAL RESIDENTIAL	CLIENT: MR. ART	WIL	LIAMS	3		-30.74			PF	ROJI	ECTN	10.	BOI	REHO	LE NO.	
LOC	ATION: NW1/4 SEC. 8-9-16 W	4M	DRILL METHOD: 1	50m	m SO	LID	STEN	UA N	GER			-	_	_		3PH00	-
CITY	SOUTH OF TABER, AB		PROJECT ENGINE	ER:	JIM F	AYA	V				A	Stelling.		-102-111	WASSE		1-2000
	PLE TYPE DISTURBED		VERY 🔀 SPT		目	V-CAS	SING			SHELI	BY TL	BE		COR	Œ		
BACH	KFILL TYPE BENTONITE	PEA GRAV	ÆL SLOUGH			GROL	Л		Z	DRILL	CUT	TING	s	SAN	D		
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Depth (m)		COII		SAMPLE TYPE	MOISTURE CONTENT	-		-				STA	NDARD	PENI	TRAT	ION (N)	
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	CLAY - silty, sandy, damp, stiff, lo	w plastic, brown, tra	nce organics	1													1 0
	SAND - trace to some slit, poorly			k									ı				-
	brown					l		,,,,,,,	<b>.</b>	<u>.</u>					<u>.i.j.</u>		
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TECHNI	CALL 12101391 ART WILLIAMS SURDIVISION I		-	-	-		-			-1-		- 41		-			

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PROJ	ECT: RURAL RESIDENTIAL SUBDIVISION	CLIENT: MR. ART	NILI	JAMS				- 10	o An	PRO	EC.	TNO	- BO	REHOL	E NO.
	TION: NW1/4 SEC. 8-9-16 W4M	DRILL METHOD: 1:				TEN	AU	GER			L12	1013	)1 - Of	8PH004	E
	SOUTH OF TABER, AB	PROJECT ENGINE	ER:								81				
-		ERY SPT			CASI				SHELB'			CC			
BACK	FILL TYPE BENTONITE PEA GRAVI	EL IIII SLOUGH	_	<u>.</u> 0	ROUT			77	DRILL (	CUTTING	GS[	SA	ND		
			PE	MOISTURE CONTENT											
E	SOIL		≥	S S S						ST	ANDA 20	RD PE	NETRAT	R(N) HON	€
Depth (m)	DESCRIPTION		PLE	JRE				Y.	2.00	1	UN	CONF	60 NED (	Pa	Depth (ft)
0			SAMPLE TYPE	USIC			M	,	LIQUID	<b>A</b>	SO POI	CKET	150` PEN. (#	kPa <b>)</b> ▲	
0	TOPSOIL - clay, slity, sandy, damp, dark brown, roots	organics	+	₹		20	40	60	80		100	200	300	400	
	SAND - trace to some sill, poorly graded, medium gra-		k												[ ]
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# **APPENDIX**

APPENDIX C DESIGN AND CONSTRUCTION GUIDELINES\*



#### SHALLOW FOUNDATIONS

Design and construction of shallow foundations should comply with relevant Building Code requirements.

The term 'shallow foundations' includes strip and spread footings, mat slab and raft foundations.

Minimum footing dimensions in plan should be 0.45 m and 0.9 m for strip and square footings respectively.

No loose, disturbed or sloughed material should be allowed to remain in open foundation excavations. Hand cleaning should be undertaken to prepare an acceptable bearing surface. Recompaction of disturbed or loosened bearing surface may be required.

Foundation excavations and bearing surfaces should be protected from rain, snow, freezing temperatures, excessive drying and the ingress of free water before, during and after footing construction.

Footing excavations should be carried down into the designated bearing stratum.

After the bearing surface is approved, a mud slab should be poured to protect the soil and provide a working surface for construction, should immediate foundation construction not be intended.

All constructed foundations should be placed on unfrozen soils, which should be at all times protected from frost penetration.

All foundation excavations and bearing surfaces should be inspected by a qualified geotechnical engineer to check that the recommendations contained in this report have been followed.

Where over-excavation has been carried out through a weak or unsuitable stratum to reach into a suitable bearing stratum or where a foundation pad is to be placed above stripped natural ground surface such over-excavation may be backfilled to subgrade elevation utilizing either structural fill or lean-mix concrete. These materials are defined under the separate heading 'Backfill Materials and Compaction'.





## CONSTRUCTION EXCAVATIONS

Construction should be in accordance with good practice and comply with the requirements of the responsible regulatory agencies.

All excavations greater than 1.5 m deep should be sloped or shored for worker protection.

Shallow excavations up to about 3 m depth may use temporary sideslopes of 1H:1V. A flatter slope of 2H:1V should be used if groundwater is encountered. Localized sloughing can be expected from these slopes.

Deep excavations or trenches may require temporary support if space limitations or economic considerations preclude the use of sloped excavations.

For excavations greater than 3 m depth, temporary support should be designed by a qualified geotechnical engineer. The design and proposed installation and construction procedures should be submitted to EBA for review.

The construction of a temporary support system should be monitored. Detailed records should be taken of installation methods, materials, in situ conditions and the movement of the system. If anchors are used, they should be load tested. EBA can provide further information on monitoring and testing procedures if required.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down, at 45 degrees from the horizontal from the base of foundations of adjacent structures intersects the extent of the proposed excavation, these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless the excavation support system has been designed to accommodate such surcharge.



### **BACKFILL MATERIALS AND COMPACTION**

Maximum density as used in this section means Standard Proctor Maximum Dry Density (ASTM Test Method D698) unless specifically noted otherwise. Optimum moisture content is as defined in this test.

"Landscape fill" material may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90 percent of maximum density.

"General engineered fill" materials should comprise clean, inorganic granular or clay soils. "Select engineered fill" materials should comprise clean, well-graded granular soils or inorganic low plastic clay soils. Engineered fill materials should be placed in layers of 150 mm compacted thickness and should be compacted to 98 percent of maximum density.

Granular soils used for select engineered fills should consist of relatively clean, well graded, sand or mixture of sand and gravel (maximum size 75 mm).

Low plastic clay with the following range of Atterberg limits is generally considered suitable for use as select engineered fill.

Liquid Limit	= 20  to  40%
Plastic Limit	= 10 to 20%
Plasticity Index	= 10 to 30%

Clay fill materials should be compacted at or slightly above the optimum moisture content.

"Structural fill" materials should comprise clean, well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 100 percent of maximum density.

Backfill adjacent to and above footings, abutment walls, basement walls, grade beams and pile caps or below highway, street or parking lot pavement sections and base courses should comprise "general engineered fill" materials as defined above.

Backfill below slabs-on-grade or where increased volumetric stability is desired should comprise "select engineered fill" materials as defined above.

Backfill supporting structural loads should comprise "structural fill" materials as defined above.

Exterior backfill adjacent to footings, foundation walls, grade beams and pile caps and within 300 mm of final grade should comprise inorganic clay "general engineered" fill as defined above. Such backfill should provide a relatively impervious surface layer to reduce seepage into the subsoil.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction,



careful observation of the foundation wall for deflection should be carried out continuously. Where deflections are apparent, the compactive effort should be reduced accordingly.

In order to reduce potential compaction induced stresses, only hand held compaction equipment should be used in the compaction of fill within 500 mm of retaining walls or basement walls.

Backfill materials should not be placed in a frozen state, or placed on a frozen subgrade. All lumps of materials should be broken down during placement.

Where the maximum-sized particles in any backfill material exceed 50 percent of the minimum dimension of the cross-section to be backfilled, such particles should be removed and placed at other more suitable locations on-site or screened off prior to delivery to site.

Bonding should be provided between backfill lifts, if the previous lift has become desiccated. For fine-grained materials the previous lift should be scarified to the base of the desiccated layer, properly moisture-conditioned and recompacted and bonded thoroughly to the succeeding lift. For granular materials, the surface of the previous lift should be scarified to about a 75 mm depth followed by proper moisture-conditioning and recompaction.

Suggested specifications for various backfill types are presented below.

"Pit-Run gravel" and fill sand shall be reasonably well graded and should conform to the following gradings:

SIEVE SIZE	PIT RUN GRAVEL (A.T. D6-C80)	FILL SAND
80.0 mm	100	
50 mm	55-100	YEAR HAVE
25 mm	38 – 100	100
16 mm	32 – 85	IMET
5.0 mm	20 – 65	75 – 100
630 µm		45 – 80
315 µm	6-30	M= 1.
80 µm	2 – 10	2 - 10

The Pit-Run gravel should be free of any form of coating and any gravel or sand containing clay, loam or other deleterious materials should be rejected. No oversize material should be tolerated. The percent of material passing the 80  $\mu$ m sieve should not exceed 2/3 of the material passing the 315  $\mu$ m sieve.

20 mm and 40 mm crushed gravel should be hard, clean, well graded, crushed aggregate, free of organics, coal, clay lumps, coatings of clay, silt and other deleterious materials. The aggregates should conform to the following Alberta Transportation gradation requirements when tested in accordance with ASTM C136:





SIEVE SIZE	20 mm CRUSH (A.T. D2-C20)	40 mm CRUSH (A.T. D2-C40)
40 mm	XII CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACTOR OF THE CONTRACT	100
25 mm	4 - 10 1000 - 10 1000 200	70 – 94
20 mm	100	are all our photosocial come
16 mm	84 – 94	55 – 85
10 mm	63 – 86	44 – 74
5.0 mm	40 – 67	32 – 62
1.25 mm	20 – 43	17 – 43
630 µm	14 – 34	12 – 34
315 µm	9 – 26	8 – 26
160 µm	5 – 18	5 – 18
80 µm	2 – 10	2 – 10

A minimum of 60 percent of the material retained on the 5 mm sieve for the 20 mm crushed gravel should have at least two freshly crushed faces. Not less than 50 percent of the material retained on the 5 mm sieve for the 40 mm crushed gravel should have at least two freshly crushed faces.

The 20 mm granular course should be compacted in lifts not exceeding 150 mm to 100 percent of Standard Proctor maximum dry density.

"Coarse gravel" for bedding and drainage should conform to the following grading:

SIEVE SIZE	28 mm GRAVEL	20 mm GRAVE
40 mm	100	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
28 mm	95 - 100	100
20 mm	B-	85 - 100
14 mm	25 - 60	60 - 90
10 mm		25 – 60
5 mm	0 - 10	0-10
2.5 mm	0 - 5	0-5

"Coarse sand" for bedding and drainage should conform to the following grading:

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SIEVE SIZE	PERCENT PASSING
(Square Openings)	(By Weight)
10 mm	100
5 mm	95 - 100
2.5 mm	80 - 100
1.25 mm	50 - 90
630 µm	25 - 65
315 μm	10 - 35
160 μm	2 - 10
80 μm	0-4

<sup>&</sup>quot;Lean-mix concrete" should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.



#### PROOF-ROLLING

Proof-rolling is a method of detecting soft areas in an 'as-excavated' subgrade for fill, pavement, floor or foundations or detecting non-uniformity of compacted embankment. The intent is to detect soft areas or areas of low shear strength not otherwise revealed by means of testholes, density testing, or visual examination of the site surface and to check that any fill placed or subgrade meets the necessary design strength requirements.

Proof-rolling should be observed by qualified geotechnical personnel.

Proof-rolling is generally accomplished by the use of a heavy (15 to 60 tonne) rubber-tired roller having 4 wheels abreast on independent axles with high contact wheel pressures (inflation pressures ranging from 550 kPa (80 psi) up to 1030 kPa (150 psi).

A heavily loaded tandem axle gravel truck may be used in lieu of the equipment described in the paragraph above. The truck should be loaded to approximately 10 tonnes per axle and a minimum tire pressure of 550 kPa (80 psi).

Ground speed - maximum 8 km/hr recommended 4 km/hr.

The recommended procedure is two complete coverages with the proof-rolling equipment in one direction and a second series of two coverages made at right angles to the first series; one 'coverage' means that every point of the proof-rolled surface has been subjected to the tire pressure of a loaded wheel. Less rigorous procedures may be acceptable under certain conditions subject to the approval of an engineer.

Any areas of soft, rutted, or displaced materials detected should be either recompacted with additional fill or the existing material removed and replaced with general engineered fill, or properly moisture conditioned as necessary.

The surface of the grade under the action of the proof-roller should be observed, noting; visible deflection and rebound of the surface, formation of a crack pattern in the compacted surface or shear failure in the surface of granular soils as ridging between wheel tracks.

If any part of an area indicates significantly more distress than other parts, the cause should be investigated, by, for example, shallow auger holes.

In the case of granular subgrades, distress will generally consist of either compression due to insufficient compaction or shearing under the tires. In the first case, rolling should be continued until no further compression occurs. In the second case, the tire pressure should be reduced to a point where the subgrade can carry the load without significant deflection and subsequently gradually increased to its specified pressure as the subgrade increases in shear strength under this compaction.



Proof-Roll dos

## **PAVEMENTS**

The following recommended procedures for pavements have been based on the use of the area generally by cars with some light truck traffic, as is normal for parking lot areas and access roadways. Recommendations for occasional heavy truck access areas are also presented. These recommendations are intended as minimums only for subgrades having a California Bearing Ratio (CBR) value of 2 or higher, under saturated conditions.

Maximum density as used in this section means Standard Proctor Maximum Dry Density (ASTM Test Method D698) unless specifically noted otherwise.

The subgrade should be graded to drain towards catch basin locations. All loose, soft or organic material should be removed from beneath pavement areas. The subgrade should be scarified to a depth of not less than 150 mm below the surface and recompacted. In areas where general engineered fill is placed to achieve design grades, the subgrade should be compacted to 98 percent of maximum density and proof-rolled prior to placing fill. The upper 150 mm of subgrade (and/or general engineered fill) under pavement sections should be compacted to not less than 100 percent of maximum density.

Proof-rolling of the entire surface area under pavement sections should be carried out to detect any local soft spots. Soft spots detected as a result of proof-rolling should be excavated and backfilled with 'general engineered fill'. Recommended procedures for proof-rolling are presented under a separate section in Appendix C. General engineered fill is defined under the section entitled "Backfill Materials and Compaction" in Appendix C.

The parking area and roadways base course should comprise a layer of compacted cement stabilized aggregate or crushed gravel of nominal size equal to 20 mm placed on top of the compacted subgrade. The base course should have a compacted thickness of not less than 100 mm. The base course should be compacted to not less than 100 percent of maximum density.

The surface of the final lift of base course must have an asphalt prime coat of SS-1, or its equivalent, applied prior to the placement of asphaltic concrete.

The asphalt thickness is dependent on asphalt mix specifications and should be reviewed when details of the mix are available. Minimum surface lift thickness in multiple-lift construction should be not less than 50 mm.

Preparation of the subgrade should be carried out within restricted areas. This is to avoid loosening of the prepared areas by site traffic before compaction of the subgrade and placement of the granular material have been completed. Protection of the prepared subgrade against precipitation and frost should be undertaken.

Observation of compaction and asphalt laying operations should be carried out by staff of EBA Engineering Consultants Ltd.

Where there is risk of gasoline or diesel oil spillage, such as in the vicinity of pump islands, concrete pavements are preferred to asphalt.



#### MAINTENANCE OF GRAVELLED YARDS

Gravel surfaced yards are susceptible to rapid deterioration if not properly maintained. For most gravel surfaced roads and yards this will involve grading at least three times yearly, twice in the spring and once in late summer or fall, with occasional touch up in problem areas. No noticeable rutting should be allowed to persist in spring time when frost is coming out of the ground. High wheel loads from forklifts, poor surface drainage and/or a high water table and clay subgrade soils can all result in a need for increased maintenance.

Ruts should not be allowed to exceed 25 mm in 1.2 m (1" in 4). Areas that rut should be repaired as soon as possible. If not repaired promptly, the rutted areas will hold water, which reduces the ability of the gravel to bridge over soft areas and can lead to softening of the subgrade. Rutting will get progressively worse and more costly and difficult to repair.

In rutted areas, 20 mm crushed gravel should be placed to fill low spots. The high areas should not be graded off to fill in low areas. This creates areas of reduced gravel thickness in the high spots, which will eventually lead to future punchouts and/or soft spots.

The overloading of forklifts can lead to excessively high stresses under the front axle. This should be avoided. High wheel loads from an overloaded forklift could exceed the allowable stresses for the gravel thickness, especially in rutted areas where ponded water can lead to softening.

Excessive regrading will also negatively impact performance. Gravel surfacing tends to form a crust with traffic. This crust provides improved stability and helps shed water. Excessive regrading can breakup this crust and reduce the ability of the gravel surfacing to shed water. There is also a tendency to pull gravel from high spots to fill minor ruts. As noted above, this can cause problems with the reduced gravel thicknesses in areas that initially perform well.

