West Bonnyville Business Park
AREA STRUCTURE PLAN

Prepared
by

AEGIS
"Achieving Potential"

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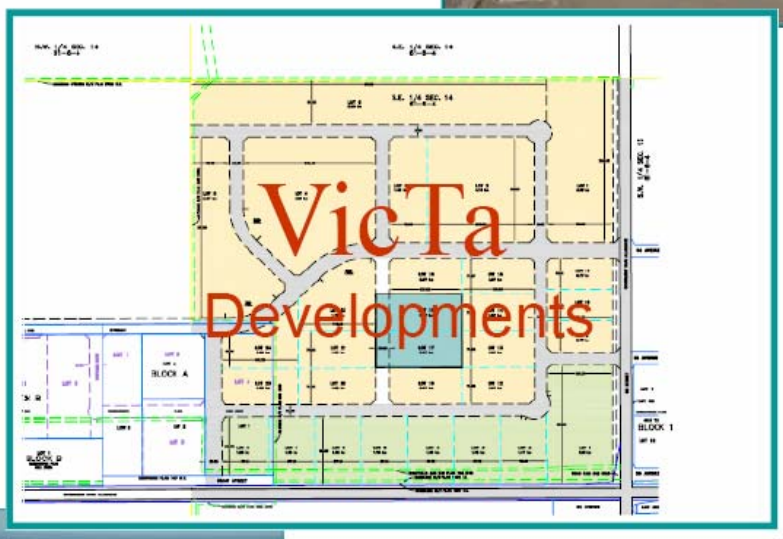

2005
Alberta Centennial

For

VicTa
Developments

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1.0 INTRODUCTION

1.1 Introduction

Victa Developments Ltd. is exploring the possibility of developing the SE¼ Sec. 14 Twp. 61 Rge. 6 W4M. The land is located in Bonnyville on the north side of Highway 28 (50th Avenue) immediately west of 66th Street. The civic address of the property is 6801 50th Avenue. The initial work involved in obtaining the necessary approvals to begin the development work involves the preparation of an Area Structure Plan.

An Area Structure Plan (ASP) is a statutory plan adopted by Mayor and Council by Bylaw. The Plan provides a broad framework or "structure" for future development within a plan area. An ASP provides general policy direction regarding how an area will develop over time and offers opinions related to the impact on adjacent and future development. More importantly, the plan reflects the Municipality's goals and objectives in relation to this development and adjacent and future developments. Issues including land use, transportation and servicing are addressed in the plan. This ASP also includes all of the available background information related to the property being considered for development.

Area structure plans are prepared to ensure that all stakeholders involved in the development of a parcel of land are aware of the considerations associated with the development. Stakeholders include but may not be limited to the land Owner, the Town of Bonnyville, adjacent land owners and service providers (power, natural gas and communications services). Stakeholders have varied and over lapping, vested interests in land. Consequently, the ASP must provide and categorize all the information that is available at the time that the plan is prepared. The information then becomes the basis of comments and opinions related to the suitability of land in relation to the proposed development.

1.2 Background Information

Background information includes the information that was available at the time that this report was written. The background information that was gathered for the preparation of this report included bylaws, guidelines and regulations, previous reports, and information of record.

Preparation of the report gave due consideration to provincial legislation and municipal bylaws including the following:

- Province of Alberta, Municipal Government Act (Chapter M-26)
- Town of Bonnyville, Municipal Development Plan (Bylaw 1261-05)
- Town of Bonnyville, Municipal Development Plan, 1997 (Bylaw No. 1135-97),
- Town of Bonnyville, Land Use Bylaw (Bylaw No. 1152-98),
- Millennium Subdivision Area Structure Plan (Bylaw 1263-05),

- Ringuette Area Structure Plan, December 2003 (Bylaw 1233-03), and
- Vincent Area Structure Plan (Bylaw 1244-04), June 2004

Guidelines and regulations that were taken into consideration included:

- Town of Bonnyville, Minimum Design Standards, and
- Town of Bonnyville, Guidelines to Land Development (February,1986)

The information included in these documents provides a guideline for the manner in which the developer must make application and for considerations related to the required capacity of services.

“Information of record”, specific to SE¼ Sec. 14 Twp. 61 Rge. 6 W4M, that was gathered for this report included Land Title’s information, water well information, and information pertaining to natural gas servicing and electrical power.

A number of Plans of Survey and Land Title documents were obtained including the following:

- Plan No. 635JY
- Plan No. 1457NY
- Plan No. 1861NY
- Plan No. 1998TR
- Plan No. 5702RS
- Plan No. 0324812
- Plan No. 0426695
- Plan No. 7922948
- Plan No. 9822708
- 062 026 615 Land Title Certificate
- 002 373 812 Land Title Certificate
- 022 180 407 Land Title Certificate
- 022 271 412 Land Title Certificate
- 032 353 431 Land Title Certificate
- 032 361 176 Land Title Certificate
- 032 361 176+2 Land Title Certificate
- 032 361 176+3 Land Title Certificate
- 032 437 660 Land Title Certificate

The information pertaining to Plans of Survey and Land Titles was purchased in a digital format.

Information pertaining to water wells was obtained from Telus Geomatics. The available water well drilling information included a location map for water wells and records for four (4) of the wells. The well ID records that were available included:

- Well ID: 0213569
- Well ID: 0213572
- Well ID: 0213574

The water well information is attached as Appendix "A".

Mr. Mark Harper from AltaGas Utilities provided a copy of Drawing No. W4-061-6-14-se indicating the location of natural gas lines on the property. The map is attached as Map 5A.

Mr. Varun Chhibbar, ATCO Electric was contacted by telephone (780-826-6758) for information pertaining to electrical services. The information that Mr. Chhibbar provided is included in the main body of this report.

The information that was gathered as outlined above became the basis for the preparation and organization of this Area Structure Plan.

1.3 Organization of the ASP for the SE¼ Sec. 14 Twp. 61 Rge. 6 W4M

Information included in this plan has been categorized as follows:

- Legal requirements associated with the preparation of an Area Structure Plan
- Standards and guidelines for development,
- Current site information
- Existing site characteristics,
- Goals and objectives of development,

The information outlined above provides a basis for the development of comments and opinions related to the following:

- Compatibility with adjacent land uses,
- Compatibility with future land uses,
- Development of a land use concept for the Plan Area,
- Surface storm water drainage,
- Sequencing of development through phasing, and
- Implementation of the Area Structure Plan.

A review of legal and regulatory requirements provides a starting point for the investigative work that must be carried out to acquire the remaining information.

2.0 Legal and Regulatory Considerations

2.1 Introduction

The "Municipal Government Act" together with Municipal Bylaws and Municipal Regulations provides a guideline for the preparation of Area Structure Plans.

The Municipal Bylaws that influence the preparation of the ASP include:

- the Municipal Development Plan – Bylaw 1261-05 and 1135-97
- the Land Use Bylaw No. 1152-98, and
- the Ringuette Area Structure Plan, Schedule "A" to Bylaw 1233-03

Documents published by the Town of Bonnyville that influence the preparation of the ASP include:

- Guidelines to Land Development, 1986, and
- Minimum Design Guidelines
- Outline Plan 80-0P-06

The document entitled "Guidelines to Land Development, 1986" provides much of the required information that ensures ASPs will reflect the goals and objectives of the municipality in regard to land development.

The document entitled "Minimum Design Standards" provides insight into the engineering standards developed by the town for land development.

The Municipal Government Act provides a general guideline for the development of an ASP.

2.2 Municipal Government Act

The Municipal Government Act, 2000 provides a framework for the development of ASPs and identifies the amount of land that must be provided as municipal reserve.

Section 633 outlines the requirements related to an Area Structure Plan as follows:

(1) For the purpose of providing a framework for subsequent subdivision and development of an area of land, a council may by bylaw adopt an area structure plan.

(2) An area structure plan

(a) must describe

(i) the sequence of development proposed for the area,
(ii) the land uses proposed for the area, either generally or with respect to specific parts of the area,

(iii) the density of population proposed for the area either generally or with respect to specific parts of the area, and
(iv) the general location of major transportation routes and public utilities, and

(b) may contain any other matters the council considers necessary.

Section 661 to 667 of the Alberta Municipal Government Act, 2000 identifies the requirements surrounding the dedication of land for roadways and municipal reserve. Section 661 states that:

> The owner of a parcel of land that is the subject of a proposed subdivision must provide, without compensation,
>
> (a) to the Crown in right of Alberta or a municipality, land for roads, public utilities and environmental reserve, and
>
> (b) subject to section 663, to the Crown in right of Alberta, a municipality, one or more school authorities, land for municipal reserve, school reserve, municipal; and school reserve, money in place of any or all of those reserves or a combination of reserves and money, as required by the subdivision authority pursuant to this Division.

The remaining sections go on to specify the manner in which the land will either be dedicated or cash in lieu will be paid.

The Municipal Government Act provides a framework for the preparation of the ASP and the requirements for the dedication of land for public utilities, roadways and municipal reserve. Municipal bylaws outline the Municipality's goals and objectives and provide zoning regulations and development guidelines.

2.3 Municipal Development Plan

The Municipal Development Plan provides direction related to the preparation of Area Structure Plans, and the community's goals and objectives for the "Industrial West" industrial development policy area. It is anticipated that the land being considered for development will involve highway commercial development and industrial development.

Section 2.1 of the "Municipal Development Plan" (MDP) clearly states that the preparation and adoption of ASP's is, in effect, implementation of the MDP.

The land being considered as part of the work included in this report is referred to as "Industrial West" in the MDP. The objectives and policies outlined for the development of industrial land, including Industrial West, by the MDP include the following:

10.6.2 Objectives

The Town's industrial land use objectives are to:

1. Encourage existing industrial uses to maintain and expand their operations;
2. Encourage complimentary industrial uses to locate in existing industrial areas;
3. Encourage a broad range of light, clean, and high tech developments. Educational, service commercial, institutional, and tourism based developments that reflect Bonnyville's economic development objectives are also encouraged;
4. Provide a high amenity base that will attract specific types of industrial and manufacturing uses;
5. Provide for industrial expansion in areas that reduce traffic and related impacts on the Town;
6. Maintain an adequate supply of industrial land within the Town boundaries in order to provide a balanced assessment and employment base; and
7. Discourage noxious heavy industrial developments within the Town boundaries.

10.6.3 General Industrial Policies

Industrial Land	(a) The Town shall develop an Industrial land ***Strategy*** strategy.
Industrial/Service Centre Strategy	(b) The Town shall develop an industrial/service centre strategy,
Promoting Bonnyville	(c) The Town and the Chamber of Commerce will continue to promote and market the Town and its potential for industry.
Industrial Economic Development Priorities	(d) The Town will work closely with various Town groups, including but not limited to, the Chamber of Commerce, tourism groups, agro-economic committees, and Community Futures, to act on the industrial economic development priorities established by the Town.
New Industrial Areas	(e) New industrial uses are encouraged to locate in industrial parks.
Non-Intensive Commercial	(f) Non-intensive commercial uses requiring extensive areas of land will be encouraged to locate in industrial areas.

Reduced Service Industrial Area

(g) The Town encourages the establishment of a large lot industrial area with a reduced level of municipal services, namely gravel roads, minimal street lighting, water supply cisterns, holding tanks for sanitary sewage, and storm drainage.

(h) Once municipal water and sewer becomes available to the Reduced Service Industrial Areas, connection to municipal service shall be required.

Industries Not Permitted

(i) New industries that create air pollution, negative environmental impacts or noxious odours will not be permitted to locate in Bonnyville.

Design Standards

(j) A high standard of building design, signage, and landscaping that demonstrates regard for Bonnyville's character is encouraged for industrial developments.

Screening

(k) Industrial developments shall be separated, screened and buffered from adjacent and uses and major transportation corridors. All outdoor storage areas of designated industrial parks shall be screened.

Existing Uses Encouraged

(l) Existing industrial operations are encouraged to expand their operations as they provide significant local employment opportunities.

Intensification

(m) Land use intensification of existing large industrial parcels is encouraged.

Relocation to Industrial Parks

(n) The Town encourages existing industrial uses to relocate from highway commercial areas to industrial parks.

Labour Intensive Industries

(o) Labour intensive industries are encouraged to locate in the existing industrial area in order for the labour force to be in proximity to the Downtown.

Limited Retailing

(p) retailing or wholesaling of products directly related to the site's principal industrial use shall be permitted.

The information outlined above provides an insight into the information that is included in the Municipal Development Plan (MDP). The Area Structure Plan must reflect the policies and objectives outlined in the Municipal Development Plan as much as possible. The Land Use Bylaw also has implications related to the preparation of the Area Structure Plan.

2.4 Land Use Bylaw

The purpose of the "Land Use Bylaw" is to divide the land within the jurisdiction of the Town of Bonnyville into Land Use Districts. The Land Use Districts given consideration for the development of SE¼ Sec. 14 Twp. 61 Rge. 6 W4M include C-3 Highway Commercial District, C-4 Shopping Centre District, M1 General Industrial District and M-3 Limited Services Industrial District.

Land use designations are subject to the development of a parcel of land for a specific business. Decisions related to specific types of zoning are made at the time that an application for a Subdivision or a Development Permit is lodged with the municipality. This report addresses considerations related to the four most likely land use designation zones that would satisfy the types of businesses interested in locating on this parcel of property.

Zoning considerations together with Guidelines for Land Development and Minimum Design Standards determine the parcel sizes and roadway widths that will be observed in the subdivision layouts.

2.5 Guidelines and Regulations

The Town of Bonnyville developed "Guidelines to Land Development" in 1986. The document provides guidance related to the procedures that must be observed to develop land within the corporate limits of the Town.

The document is divided into four sections of information as follows:

- Section A – Development Methodology
- Section B – Procedures for Development
- Section C – Suggested Outline for Development Agreement
- Section D – Minimum Design Standards

Sections B and D provide extremely useful information related to outline plans and the physical dimension of the elements that are included in an outline plan. The information is reflected in the majority of maps and diagrams included in this Area Structure Plan.

2.6 Summary

The information that has been gathered and reviewed for the preparation of this ASP provides reference material for all of the stakeholders involved with the development of SE¼ Sec. 14 Twp.61 Rge.6 W4M. The information also serves as a basis for the preparation of comments and opinions related to the suitability of this land for the development being proposed.

3.0 Current Site Information

3.1 Introduction

The area addressed by this Area Structure Plan is referred to as the "Plan Area" in the remainder of this report. Current site information pertaining to the plan area provides a comprehensive compendium of all of the background information of interest to all stakeholders. Information pertaining to the plan area included in this chapter has been categorized as follows:

- Information specific to the location of the plan area,
- Land ownership,
- Current land use and adjacent land use,
- Topography,
- Utilities and utility easements,
- Water well sites,
- Oil well and petrochemical sites,
- Geotechnical and Site Soils, and
- Other considerations related to development, and
- Summary

The information included in this chapter provides reference material for all of the stakeholders.

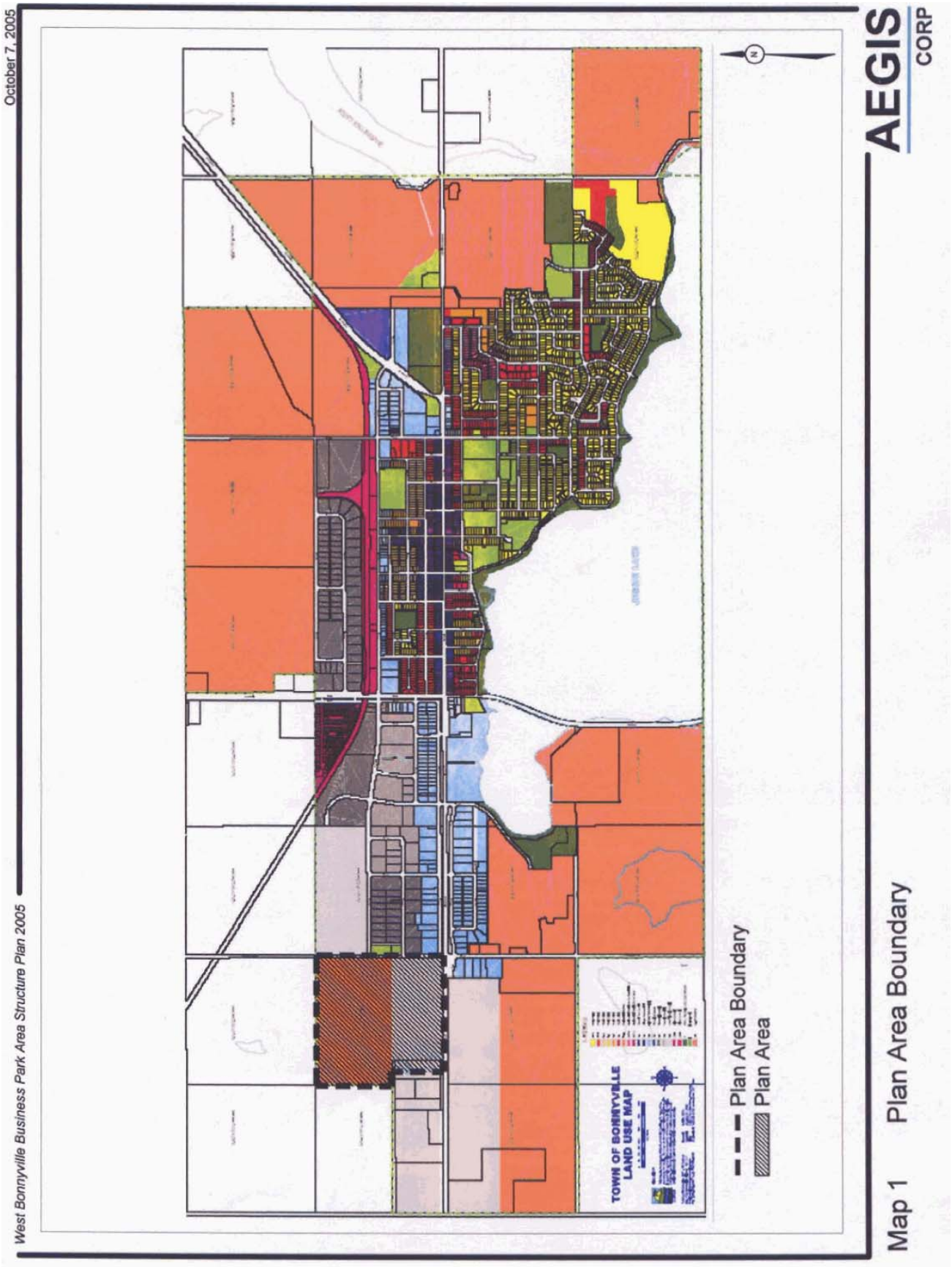
3.2 Plan Area

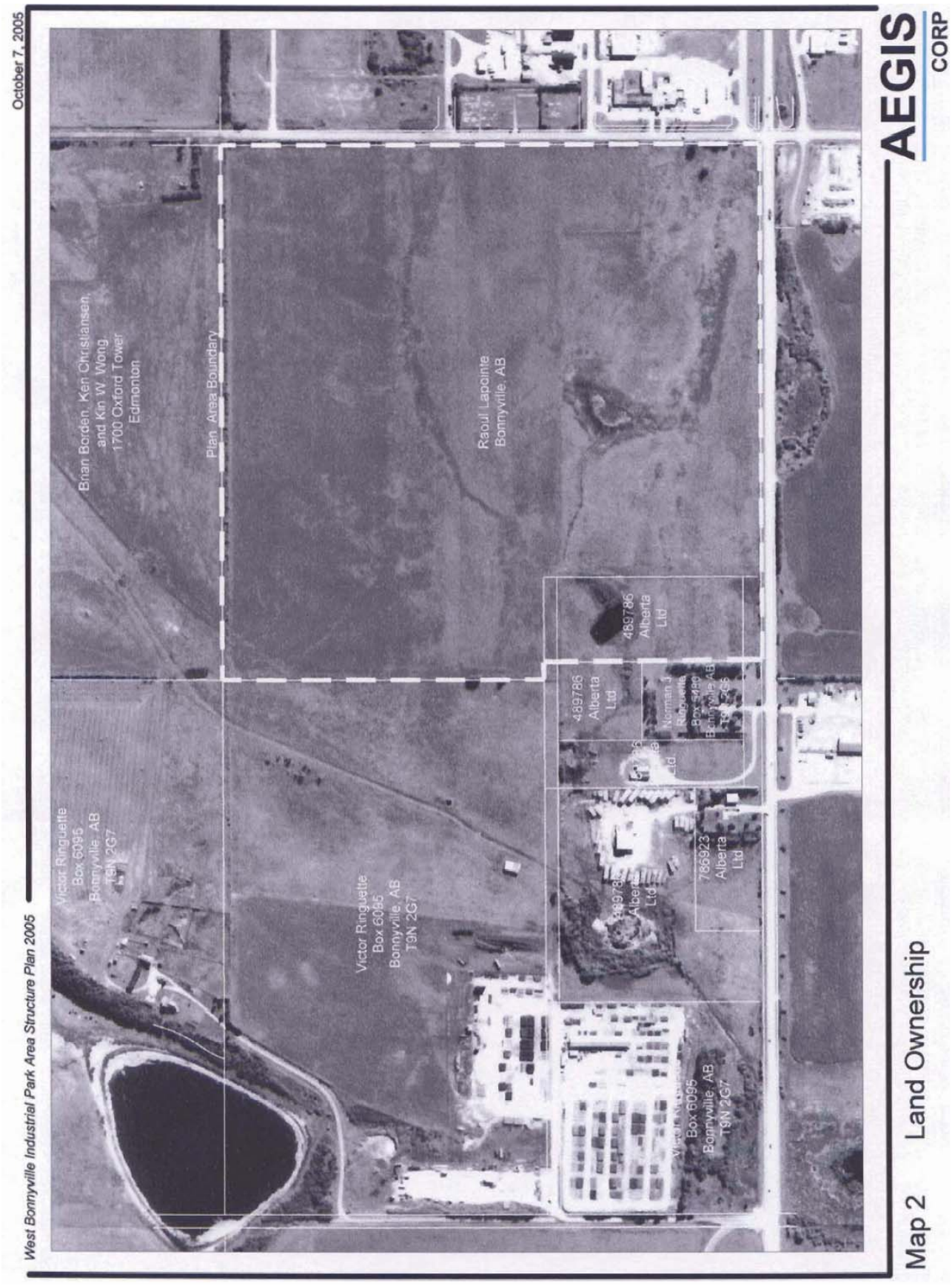
The plan area includes approximately 59.28 Ha (146.48ac) of the SE¼ Sec. 14 Twp. 61 Rge. 6 W4M. The land is located in the north west sector of the Town of Bonnyville and is bounded by Highway 28 (50th Avenue) to the south, 66th Street to the east, undeveloped land to the north, and unserviced industrial land to the west. The northern half of the westerly boundary of the plan area is also the westerly boundary of the SE¼ Sec. 14 Twp. 61 Rge. 6 W4M. The southern half of the westerly boundary is bordered by Block A, Lots 2 and 4 of registered plan 032 4812. The northern boundary of the plan area is the northern boundary of the SE¼ Sec. 14 Twp. 61 Rge. 6 W4M. and is also the northern corporate boundary of the Town of Bonnyville. Map 1 provides a diagram of the plan area.

3.3 Land Ownership

The SE¼ Sec. 14 Twp. 61 Rge. 6 W4M is owned by Mr. Victor Ringuette of Bonnyville, AB. Mr. Ringuette is the principal shareholder in VicTa Developments. VicTa Developments is the company that will assume responsibility for development of the plan area.

The names of the Owners of the land to the north and west of the plan area are shown on Map 2. It is possible that some of the titles may change between the time that the title search was conducted and the time that this report is published.


October 7, 2005
West Bonnyville Business Park Area Structure Plan 2005
AEGIS
CORP
Map 1 Plan Area Boundary
Plan Area Boundary
Plan Area
TOWN OF BONNYVILLE
LAND USE MAP



Map 2 Land Ownership

Consequently, some of the Owner's names may not be current at the time of development.

3.4 Current Land Use and Adjacent Land Use

Current and adjacent land use designations are shown on Map 3. The land north the plan area is zoned Urban Reserve and is presently being used for agricultural purposes. The southern portion of the SW ¼ Sec. 14 Twp. 61 Rge. 6 W4M, which is immediately west of the plan area is designated as Unserviced Industrial land and is being used for that purpose. The land south of the Highway 28 is designated as an Unserviced Industrial District and is being used mainly for agricultural purposes. The land situated immediately east of the Plan Area includes Highway Commercial, Institutional, General Industrial, and Unserviced Industrial land uses. The Plan Area and its adjacent land uses are also shown on the Town of Bonnyville Land Use Map (Schedule 'A' of Bylaw No. 1152-98).

3.5 Topography

Map 4 provides an insight into the topography of the plan area. The topography is well enough defined to allow identification of various land features including vegetation, natural storm drainage channels and ponds on the property.

There are no tree stands present in the plan area. Vegetation is mainly natural grasses and brush.

The Plan Area is relatively flat, with geodetic elevations ranging between 546.6m and 551.8m. The north portion of the Plan Area contains a natural drainage channel that drains surface runoff from the eastern edge of the plan area to the west. The south portion of the plan area includes one natural wet area occupying approximately 1.05 ha (2.6 ac). The southern portion also includes one man made storm water retention pond near the western boundary of the Plan Area.

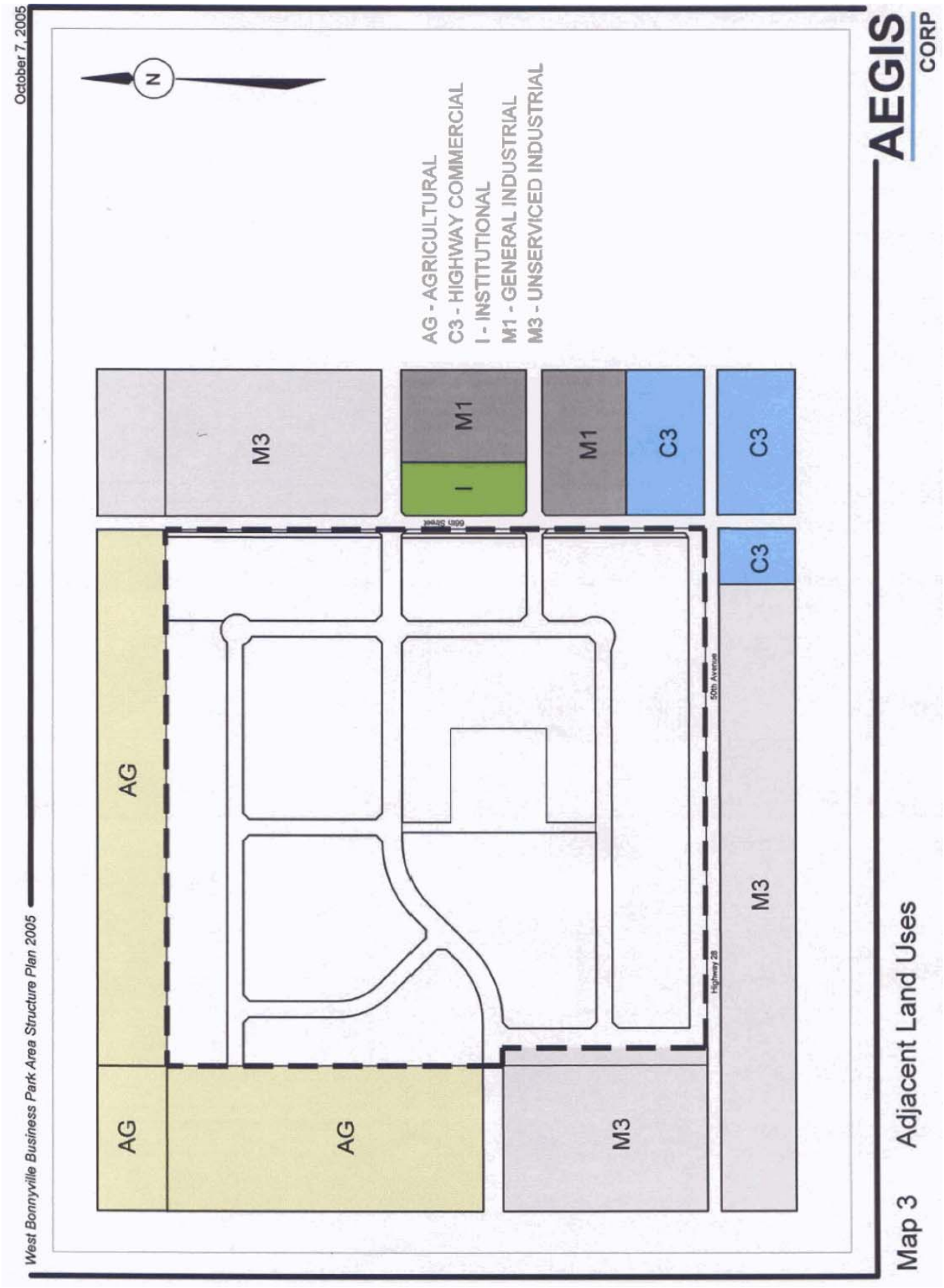
3.6 Utilities and Utility Agreements

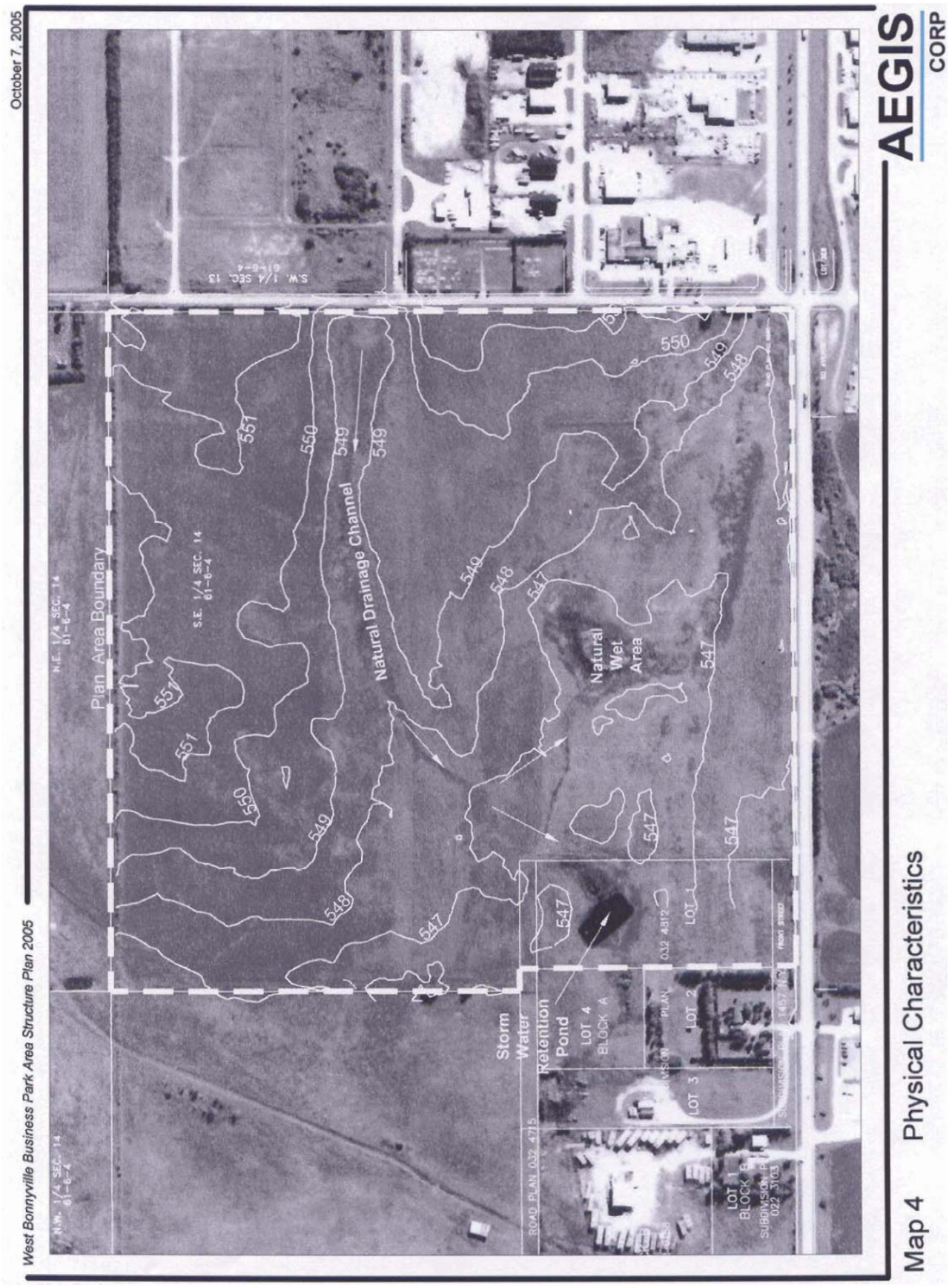
Map 5 indicates the type and approximate location of easements that are present in the plan area.

There are two natural gas right-of-ways as show on Map 5A traversing the plan area. AltaGas right of way plan 982 2708 runs north to south, parallel to the west boundary of the Plan Area. This gas line detours along the eastern periphery of Block A, Plan 032 4812. AltaGas right of way plan 792 2948 runs east to west, approximately 35m north of the Highway 28 road allowance.

There are two raw water supply lines crossing the southern portion of the Plan Area. Waterline right of ways 1998TR and 1861NY both run parallel to Highway 28. Waterline 1998TR is located approximately 17m north of Highway 28. Waterline 1861NY is located approximately 11m north of Highway 28.

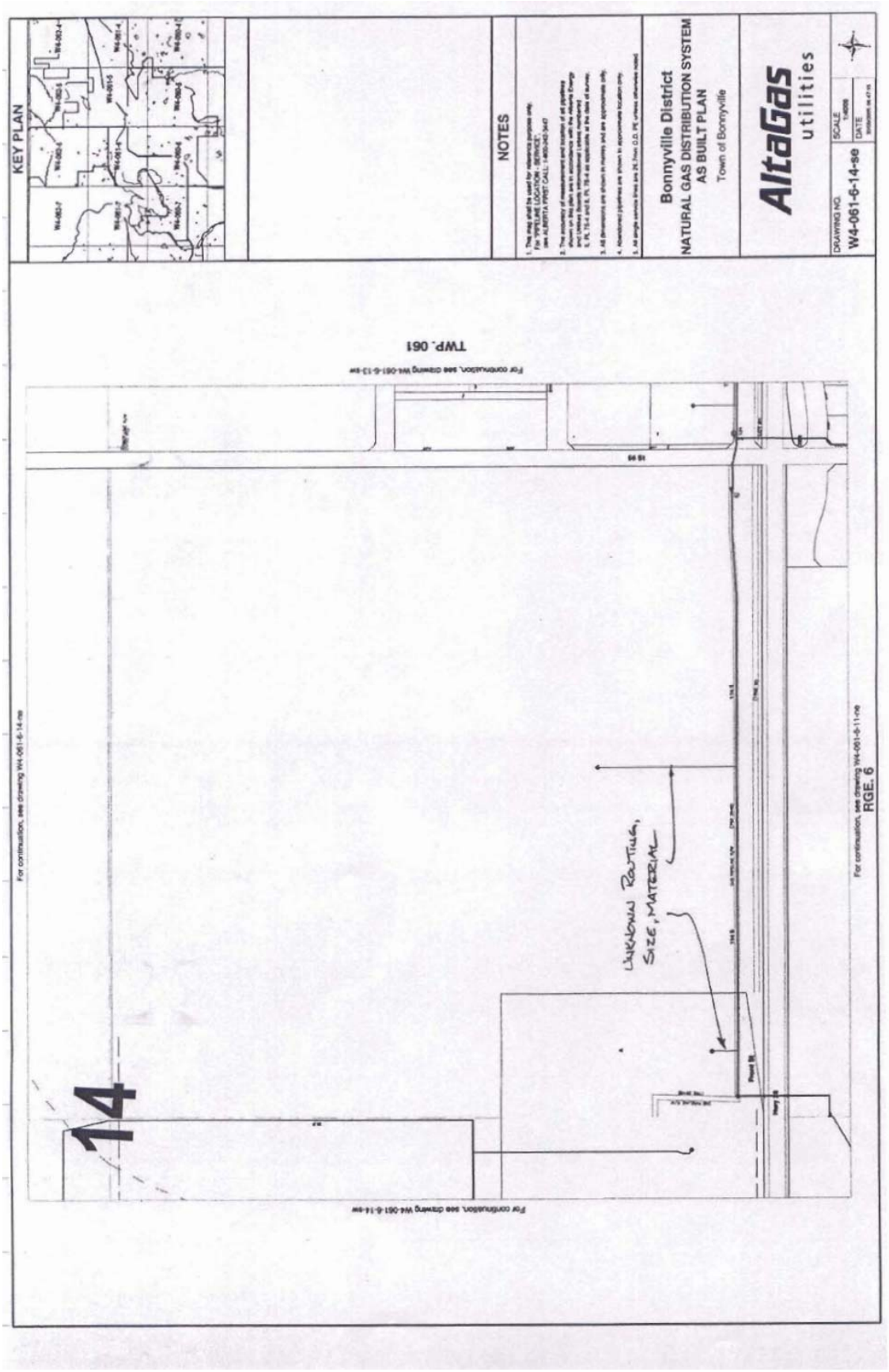
An ATCO Electric transmission power line right-of-way No. 5702 RS traverses the site along the northern boundary of the Plan Area. Map 5 illustrates the existing underground infrastructure in the Plan Area.


October 7, 2005
West Bonnyville Business Park Area Structure Plan 2005
N
AG - AGRICULTURAL
C3 - HIGHWAY COMMERCIAL
I - INSTITUTIONAL
M1 - GENERAL INDUSTRIAL
M3 - UNSERVICED INDUSTRIAL
AG
AG
AG
M3
M3
M1
I
M1
C3
C3
C3
M3
60th Street
50th Avenue
Highway 28
AEGIS
CORP
Map 3 Adjacent Land Uses



Map 4 Physical Characteristics

Map 5 Existing Infrastructure



Map 5A AltaGas Utility Right of Ways

3.7 Water Well Sites

Information pertaining to water wells is attached as Appendix A. Three wells were drilled. The lack of information of the water well reports indicates that the wells were not developed to the point of producing water. It is probable that water was not present in the drilled holes at the time of drilling.

3.8 Oil Well, Petrochemical Sites and Mineral Agreements

Information pertaining to oil well, petrochemical sites and mineral agreements was obtained from Abacus Datagraphics Ltd. The information is included as Appendix B. The information included in Appendix B makes reference to Crown Mineral Agreements. The rights afforded to the agreement holder are subject to the surface rights of the land owner.

There are no restrictions related to construction on this property as a result of the minerals agreements.

3.9 Geotechnical and Site Soils Conditions

A very thorough geotechnical report was prepared in the early summer of 2005 by AMEC Earth and Environmental. The report, which is attached as Appendix "C", concludes that the soils in the plan area will support development with little or no difficulty.
More specifically the report states:

"The subsurface conditions at this site are considered to be suitable for the proposed development since the native soil deposits at shallow depths have adequate bearing characteristics. It is expected that future industrial buildings will impose light to moderate structural loads. As such, the subsurface conditions are suites to strip and spread footing foundations, as well as pile foundations.

The soil conditions at the site are also well suited for installation of underground utilities, construction of slab-on-grade floors, and construction of asphalt surfaced roadways."

Twenty-four test holes were drilled on proposed roadways in the plan area. Consequently, it is reasonable to assume that the plan area soils are not a cause for concern.

3.10 Considerations Related to Development

Concern has been expressed regarding access to Lot 4, Block A, Subdivision Plan 032 4815 immediately west of the south westerly boundary of the plan area. Access will be provided from a proposed north/south road that will be constructed adjacent to the east boundary of Lots 2 and 4. VicTa Developments is prepared to allow a caveat or an easement to be registered ensuring that the parcel will be developed as a dedicated roadway.

All other concerns that are raised after this ASP has been reviewed by stakeholders will also be addressed.

3.11 Summary

The current site information provided in this section of the report is as complete as was possible. Stakeholders will find the Appendices to be useful reference material when reviewing the considerations related to development of this property. The information provides a basis for the development of a land use strategy for the property and supporting data for the Owner's objectives.

4.0 Land Use Strategy and Developers Objectives

4.1 Introduction

It is the intent of the proposed land use strategy to satisfy as many of the objectives related to the development of the plan area as possible. The Municipal Development Plan outlines objectives in the "General Industrial Policies". VictTa Developments has chosen goals and objectives that are consistent with Mayor and Council's vision for development in this part of the Community as outlined in the Municipal Development Plan. The land use strategy developed for this property includes highway commercial, general industrial development and municipal reserve.

4.2 Land Use Strategy

The southerly boundary of the plan area is adjacent to Highway 28 (50th Avenue) and the easterly boundary is adjacent to 66th Street (Road Allowance).
These roadways are both high traffic corridors in the Town. It is proposed that the land in the plan area adjacent to Highway 28 and the land adjacent to 66th Street north towards 52nd Avenue be designated as highway commercial property as shown on Map 6. There are obvious advantages associated with that proposal including compliance with the goals and objectives of Mayor and Council.

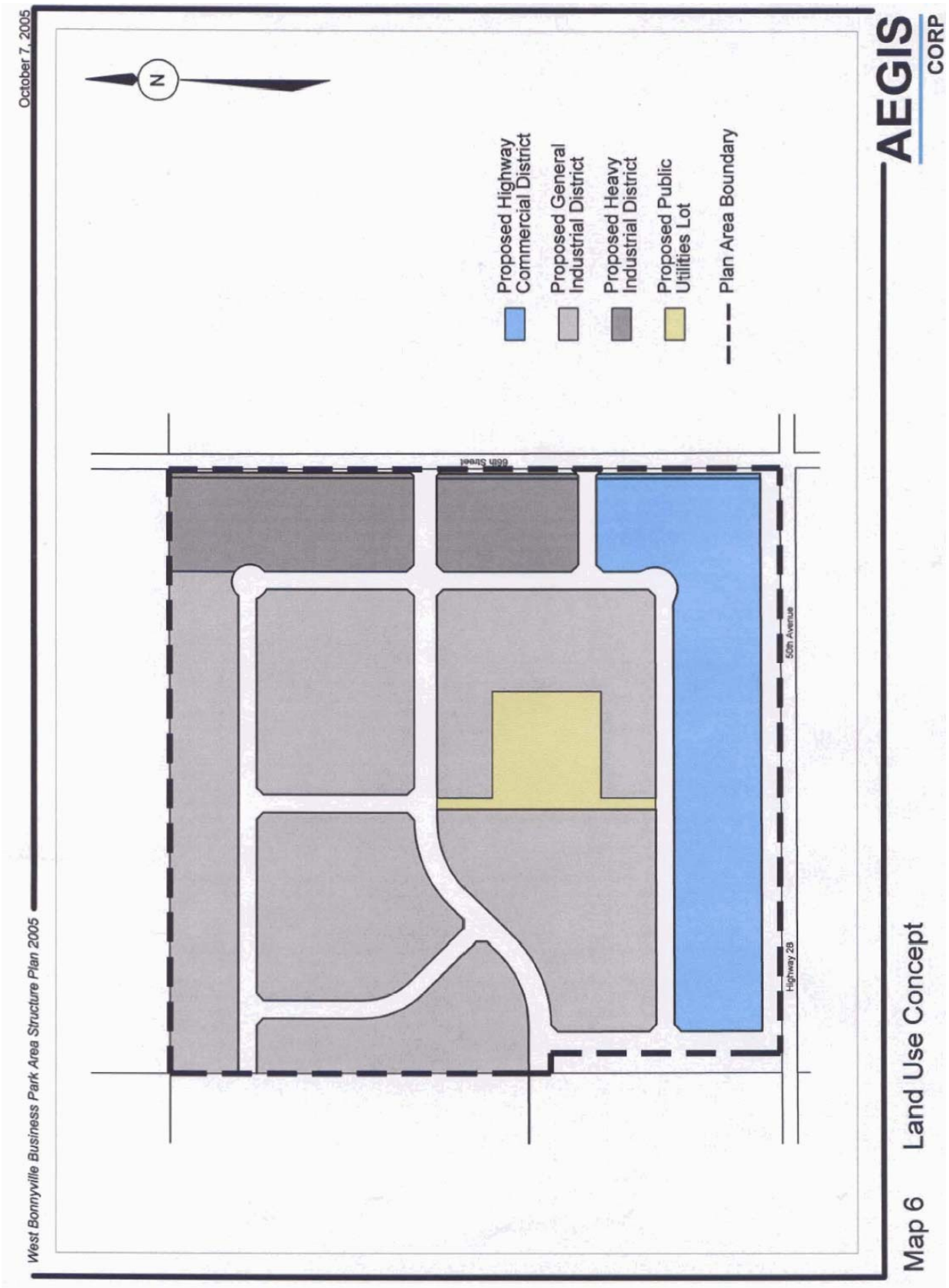
An important advantage that is not as obvious is that highway commercial development along the roadways will screen roadway traffic against the visual aesthetic of a general industrial designation that is planned for the remainder of the property.

The goals and objectives set by Mayor and Council are consistent with this proposal.

4.3 Highway Commercial Districts Goals and Objectives

Highway Commercial Districts are intended to provide for vehicle oriented businesses requiring highway visibility and a large site area. Uses that are or will become obnoxious by way of noise, odour, dust or fumes are not allowed in a highway commercial district.

Highway 28 is the major transportation corridor running east to west through Bonnyville. Development along the west entrance to the Town on Highway 28 is an extension of the existing development along the remainder of Highway


October 7, 2005
West Bonnyville Business Park Area Structure Plan 2005
N
Proposed Highway Commercial District
Proposed General Industrial District
Proposed Heavy Industrial District
Proposed Public Utilities Lot
Plan Area Boundary
66th Street
50th Avenue
Highway 28
AEGIS CORP
Map 6 Land Use Concept

28. Commercial development along the highway will screen the proposed General Industrial District.

The objectives of highway commercial development along these roadways (Highway 28 and 66th St.) are as follows:

- To provide an extended range of commodities available to consumers in Bonnyville and throughout the regional trade area,
- To appropriately screen the proposed General Industrial District north of Highway 28 and west of 66th St.,
- To improve the appearance of the entrance of Highway 28 to the Town of Bonnyville,
- To encourage a variety of vehicle orientated and big box commercial business operations to locate in this section of the plan area.

4.4 General Industrial Districts Goals and Objectives

General Industrial districts are intended to provide for warehousing and storage, and light and medium industrial and manufacturing uses which are not expected to have negative impacts beyond the boundaries of the site. General industrial districts, generally speaking, do not involve the handling of hazardous materials.

The Municipal Development Plan, 1997 suggests that 2.43 gross hectares of industrial land is required for each population increase of 100 persons. The population in Bonnyville increased by 610 persons (10.67% or approximately 2.2 % per year) between 1996 and 2001. The population in 2001 was 5709 persons (Municipal Development Plan). The proposed strategy for the plan area includes approximately 38.0 ha of industrial land. The industrial land will be completely developed in approximately ten (10) years if the population growth rate continues at 2.2%.

The proposed General Industrial land use within the Plan Area is compatible with surrounding land uses, and complies with the Town of Bonnyville Municipal Development Plan Bylaw 1261-05.

The objectives of general industrial development are as follows:

- To ensure an adequate supply of industrial land is available in Bonnyville,
- To provide numerous lots of various sizes to accommodate unpredictable requests for Industrial land,
- To extend the Town's existing infrastructure into the plan area,
- To encourage future industrial business operations to locate in the Plan Area,
- To encourage existing industrial business operations to relocate from Highway Commercial areas to the Plan Area,
- To ensure industrial developments are appropriately screened from Highway 28 and 66th Street, and from incompatible land uses,
- To provide an adequate transportation network for the transportation of industrial goods,

- To ensure compatibility between the Plan Area and the Municipal Development Plan.

The Owner's objectives related to the development of the land are consistent with the objectives outlined above. Objectives for the development of municipal reserve within the plan area are not as clearly defined.

4.5 Municipal Reserve

The Municipal Government Act provides for the dedication of land for municipal reserve or for the payment of cash-in-lieu of dedicating land. Dedication of land or payment of cash is usually decided on the basis of an agreement between the land owner (developer) and the Subdivision Authority. Consideration can also be given to both dedication of land and payment of cash to satisfy the municipal reserve requirement.

Consideration should be given to dedicating land adjacent to the proposed storm sewer retention pond as municipal reserve. The remaining requirement for dedication of municipal reserve could be contributed in cash.

4.6 Summary

The land use strategy developed for the plan area incorporates the goals and objectives of Mayor and Council as outlined in the Municipal Development Plan for the "Industrial West", highway commercial development, general industrial development and municipal reserve dedication. The integration of infrastructure requirements into the overall land use strategy determines the develop ability of the plan area.

5.0 Infrastructure Requirements

5.1 Introduction

Comments pertaining to infrastructure requirements often benefit the Town and the Developer when identifying the considerations and possible costs associated with a development. Planning for storm water management, transportation, sanitary sewer systems, and water distribution at this early stage of the development process provides insight into the challenges that may arise when designing for the provision of these services. Telecommunications, gas, and electrical utilities are also required in modern developments. Storm water management is often referred to as the most important of the services and most forgotten when developing a subdivision.

5.2 Storm Water Management and Earthwork

The Town of Bonnyville Municipal Servicing Report proposed that the Town be divided into four major drainage areas for the purpose of addressing storm water flow concerns. The area included in the Area Structure Plan is referred to as the West Drainage Area. The eastern portion of the west drainage area contributes storm drainage to Jesse Lake. The western portion of the west drainage area contributes drainage to Moose Lake through natural drainage channels and man

made ditches. The development proposed by this ASP is in the western portion of the drainage area. The Town of Bonnyville Municipal Servicing Report suggests that consideration should be given to upgrading this system as development occurs.

Storm water management requirements are as outlined by the email included in Appendix D, as follows:

> "The north western portion (20 ha) of the partially developed existing Commercial/Industrial area to the east of the plan area drains through a 450 mm culvert crossing under 66th Street, 40 m North of the intersection between 66th Street and 54th Avenue. This existing Commercial/Industrial area will contribute a flow of 0.14 m³/s through the culvert to the proposed area. The applicant, through the ASP, must demonstrate how this flow will be accommodated through the ASP lands.
>
> The minor system will convey runoff from rainfall events less than or equal to 1 in 5 year storm event without any surface ponding or excessive surface flow. The Major system will consist of surface flood paths, roadways, roadway culverts, watercourse and storm water management facilities designed to carry runoff from events up to and including 1 in 100 year storm event. From a storm water management perspective, the applicant is required to provide the following information:
>
> - a calculation of the pre-development flow rate on site;
> - engineering proof that storm water discharge from on-site storm water management facilities will not exceed the pre-development flow rate;
> - identification of the overland drainage route (e.g. ditch system or pond) and how it will drain to a drainage facility and/or off site; and
> - demonstration that the development will result in no negative downstream impacts."

Map 8 entitled "Proposed Storm Water Drainage" indicates the overland route that is proposed to accommodate the additional flows from the north western portion (20 ha) of the partially developed existing Commercial/Industrial area to the east of the plan area. Map 8 also provides an indication of the overland flow routes which will provide minor and major systems to accommodate runoff from events up to and including 1 in 100 year storm events.

The remainder of the information pertaining to the instruction is included in Appendix D. Appendix H includes the following information:

- a copy of the instruction received from the Town,

- copies of National Topographical Maps that demonstrate that adjacent land does not and will not contribute overland flow to the proposed development,
- a map indicating proposed elevations directing storm water to the proposed storage pond,
- storm water management model calculations for 1 in 5 year rainfall events for undeveloped and developed land,
- storm water management model calculations for a 1 in 100 year rainfall event for undeveloped and developed land,
- preliminary calculations to indicate the size of the retention pond,
- a map indicating off-site storm water drainage channels that will provide overland flow routes for drainage away from the proposed development, and
- excerpts from the *Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems* outlining Best Management Practices (BMP's) for removal of pollutants from storm water.

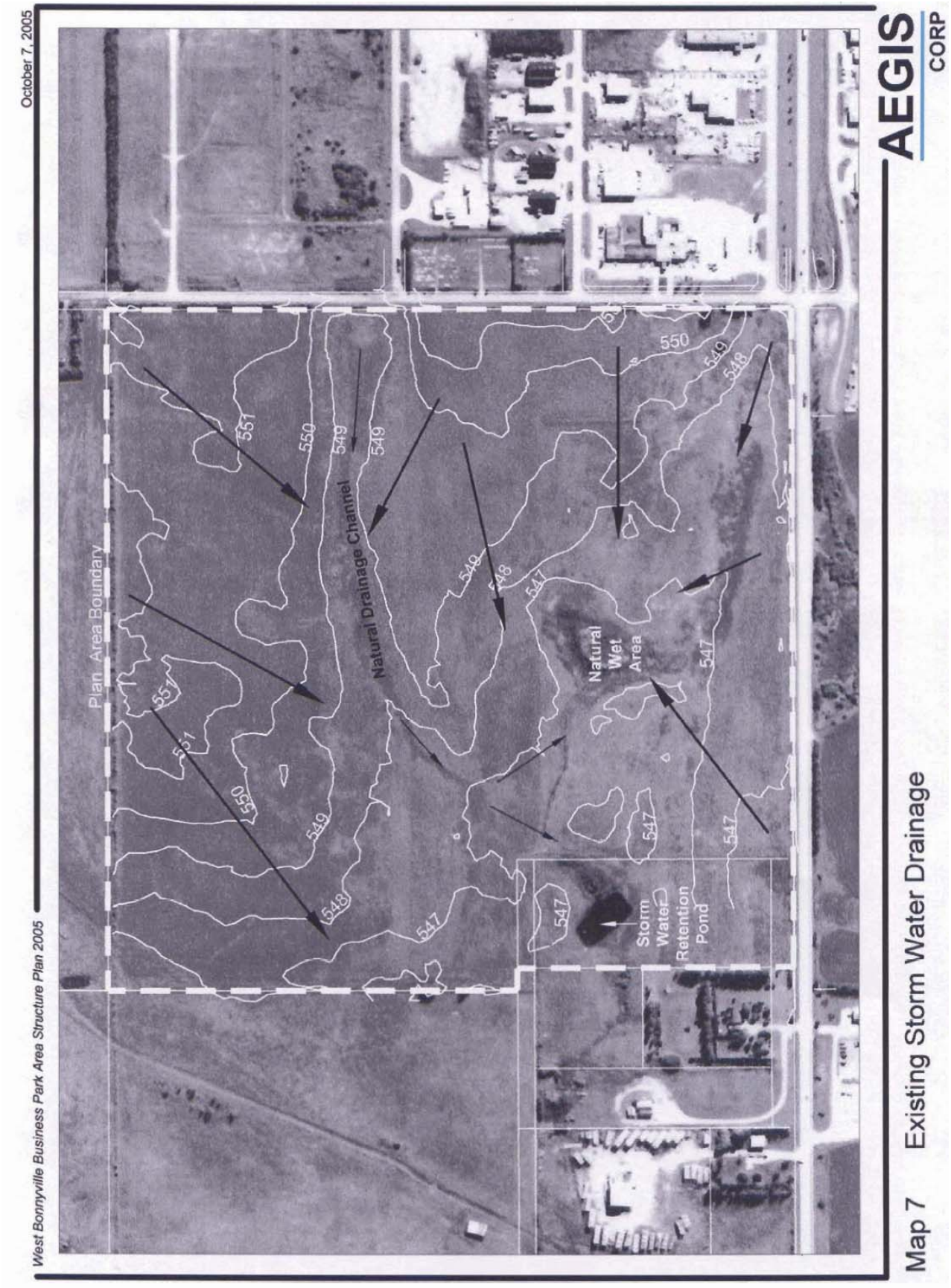
The incorporation of a storm water retention pond provides maximum mitigation of negative downstream impacts. Water will be pumped from the pond into the existing off site storm water receiving channels at the predevelopment flow rates. The proposed pumps will be designed to ensure that the predevelopment flow rates are maintained. This approach ensures that the proposed development will not contribute additional runoff to existing channels. thereby ensuring that there will be no erosion due to post development flows.

The *Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems* outlining Best Management Practices (BMP's) for removal of pollutants from storm water state that, "Wet ponds have been cited as providing the most reliable end-of-pipe BMP in terms of water quality treatment."

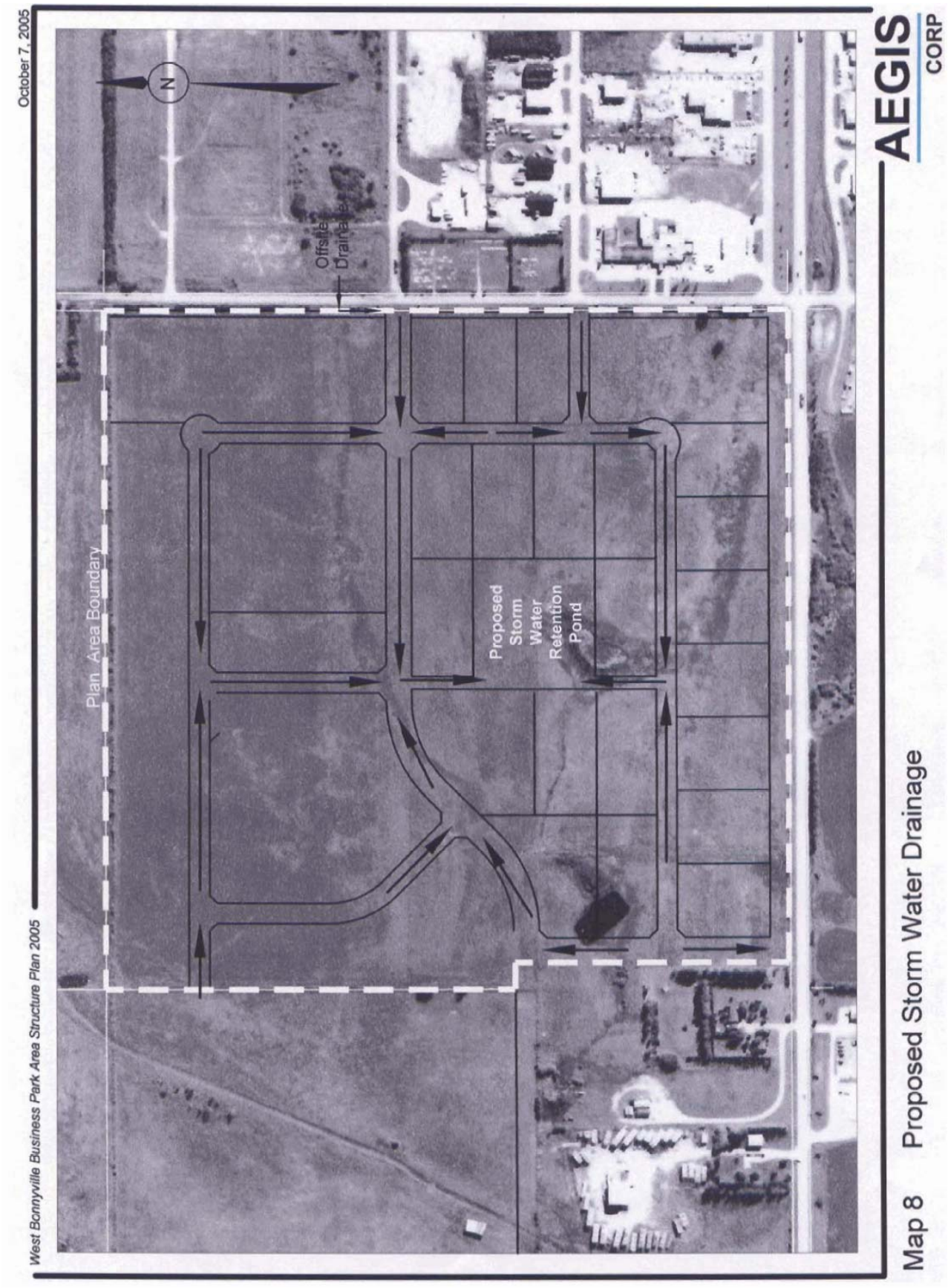
Storm water management will continue to be addressed to the satisfaction of the Town of Bonnyville as part of the work undertaken to complete the detailed engineering design of a storm water management system. These systems will be designed in compliance with *Storm Water Management Guidelines for the*

Province of Alberta and *The Town of Bonnyville Design Guidelines.* Compliance with these guidelines will ensure that storm water management
systems are designed in accordance with best management practices. The control of storm water flow on site is dependent upon the elevations that are constructed on site. The construction of these elevations is accomplished by adjusting the existing topography of the site.

Existing topography is not always conducive to ensuring that storm water will flow away from buildings and roadways in the development area. Map 7 indicates the existing topography and storm water drainage patterns in the plan



Map 7 Existing Storm Water Drainage


October 7, 2005
N
Offsite Drainage
Plan Area Boundary
Proposed Storm Water Retention Pond
West Bonnyville Business Park Area Structure Plan 2005
AEGIS CORP
Map 8 Proposed Storm Water Drainage

area. Normally, adjustments must be made to the existing topography to ensure that flooding is prevented and storm water does not pond on building sites and roadways.

The preferred method of storm drainage flow management within a subdivision is surface drainage as opposed to an underground storm drainage piping system. Surface drainage involves accommodating the flow of storm drainage along the surface of roadways. The elevations of the roadways are adjusted to cause storm water to flow to a storm water inlet or catch basin or to a pond. Elevations of roadways and building lots are created to accommodate storm flow by moving earth to create the desired grades.

The Town of Bonnyville has established minimum design standards related to storm drainage on roadways. Road gradients must maintain a minimum gradient of 0.5% to ensure adequate surface drainage. Catch basins are usually installed at 250 m to 350 m intervals to ensure that the flow of water on the surface of the roadways does not become too deep. The furthest points away from the pond in the proposed street layout for the plan area are approximately 650 m distant from the storm drainage pond. Consequently, catch basins and the associated underground piping will have to be installed in addition to adjusting the elevations of the existing ground surface to manage the flow of storm water. The adjustments to the existing ground surface involve moving earth to accommodate storm water drainage. The procedure is referred to as earthwork.

Preliminary earthwork calculations to accommodate storm water flows suggest that surface drainage that incorporates catch basins and underground piping is possible providing a storm water retention pond is constructed. Surface runoff will flow from the outer boundaries of the plan area to a retention pond near the center of the plan area. Catch basins and underground piping are required because the distance from the pond to the furthest point away from the pond exceeds 350 m.

Preliminary calculations indicate that approximately 390,000 cu. m. of earth will have to be moved to create acceptable surface drainage and a storm water retention pond. The size of the storm water pond, based on this preliminary overview, will be approximately 7,350 sq. m. if the pond is two (2) metres deep. Water levels in the pond will most probably have to be maintained by pumping excess water from the pond to the north ditch along Highway 28. The cursory review undertaken to reach this conclusion assumes that the roadways will function as storm water conduits.

5.3 Roadways and Transportation

Roadways are categorized as external or perimeter roadways and internal roadways. External roadways provide present and future access to the development at the intersections of the internal and external roadways. All roadways will be built according to a rural cross-section design.

The Plan Area is bounded on the south by Highway 28 (50th St.) and on the east by 66th Street. These two roadways are designated as Truck and Dangerous Goods routes. Highway 28 will provide high level controlled limited access. 66th St. provides access to an industrial collector roadway. Improvements are planned

for the intersection at Highway 28 and 66th Street. These roadways will provide a high level of service to the proposed development.

It is proposed that the internal road network include an industrial collector street and several local streets as shown on Map 9. The collector street is a continuance of 54th Avenue and runs east to west through the plan area as shown on Map 9A. Provision has also been made to ensure that the collector street can also cross the quarter section (SE¼ Sec. 14 Twp. 61 Rge. 6 W4M) to the west as outlined in the Ringuette Area Structure Plan Bylaw No. 1233-03. The internal roadways proposed for this plan area are consistent with the roadways planned for the "Ringuette Area Structure Plan" with the exception of the proposed roadways in a small area in the south east section of the "Ringuette Area Structure Plan". Provision for the widths of the roadways (Collector street) has been assigned in accordance with the design standards outlined by the Town of Bonnyville.

The Town of Bonnyville Minimum Design Standards require a 30m right-of-way and 13 m roadway surface for industrial and collector streets and a 24 m right-of-way and 11 m roadway surface for industrial local streets. These right-of-way and roadway widths are required for the safe transportation of large trucks and equipment.

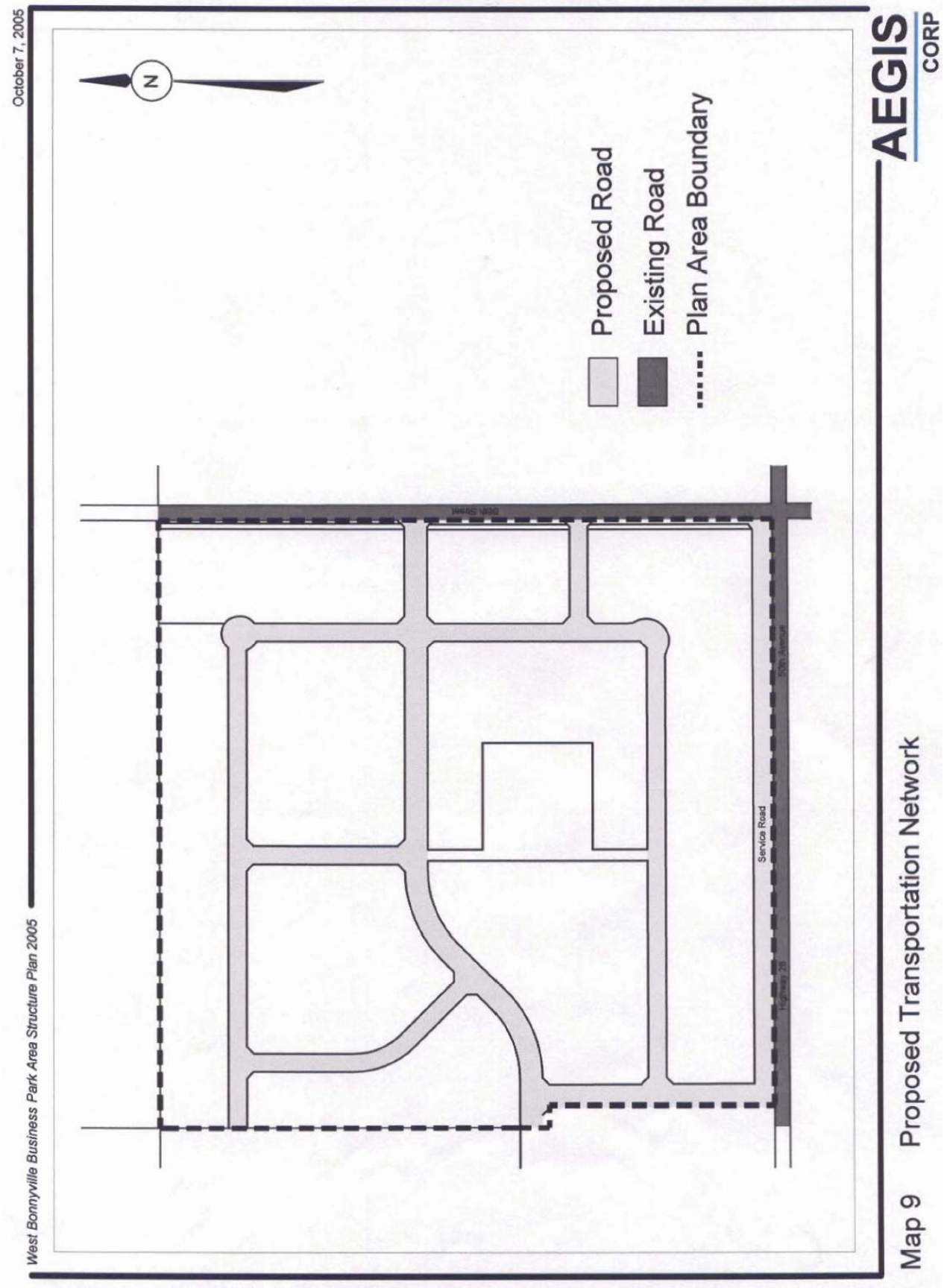
Frontage streets or service roads will be constructed adjacent to the west side of 66th Street and north of Highway 28 to provide access to the proposed commercial lots that cannot be accessed from these roadways.

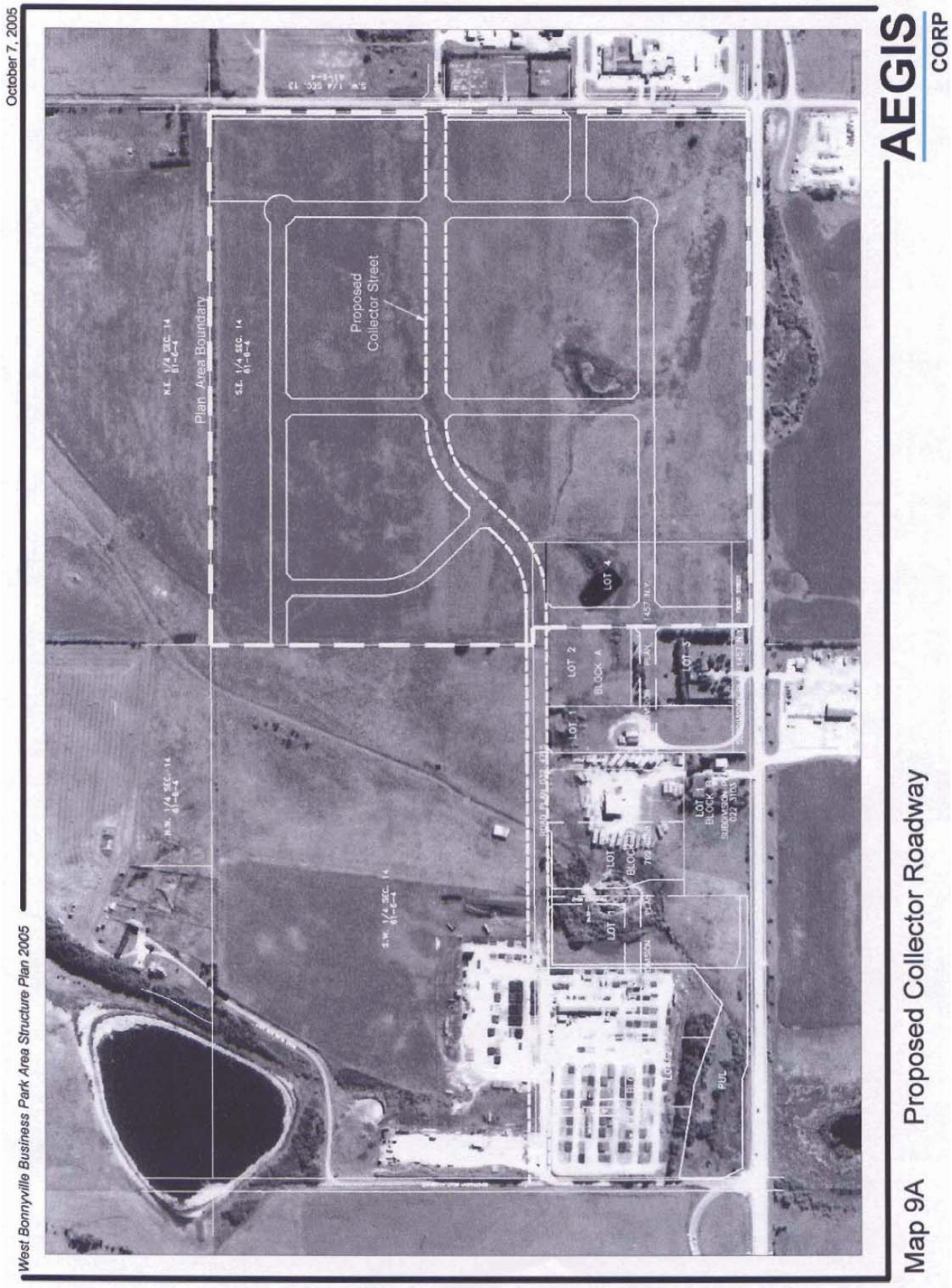
The proposed road network as illustrated in Map 9 provides access to all lots as well as safe and efficient traffic flow through the plan area. The road network also provides a corridor for the installation of underground services including water mains.

5.4 Water Distribution

Water distribution piping is usually installed under the roadway surface. Existing treated water distribution mains have been installed to the east side of 66th St.. These water mains can be extended to provide treated water to the plan area. The capacity of the water mains will satisfy design requirements for servicing the proposed development. Proposed water mains must be looped to ensure adequate fire flow rates can be achieved.

The Town of Bonnyville Minimum Design Standards stipulate that water systems must be designed to be consistent with both the Town's minimum


October 7, 2005
N
Proposed Road
Existing Road
Plan Area Boundary
Service Road
Highway 28
AEGIS
CORP
West Bonnyville Business Park Area Structure Plan 2005
Map 9 Proposed Transportation Network


October 7, 2005
West Bonnyville Business Park Area Structure Plan 2005
Plan Area Boundary
Proposed Collector Street
AEGIS CORP
Map 9A Proposed Collector Roadway

Design Standards and the Insurance Bureau of Canada's recommended standards for fire flow. Commercial districts require a flow rate of 190 litres/second (2500 igpm). General Industrial districts require a flow rate of 230 litres/second (3000 igpm). The minimum water main size required for Commercial and Industrial districts is 250mm diameter.

The proposed water distribution system will be connected to the existing water main at two (2) locations:

- the existing 250mm diameter water main located on the east side of the intersection between 66th Street and 52nd Avenue and

- the existing 200mm diameter water main located on the east side of the intersection between 66th Street and 54th Avenue

In order to be consistent with the Town of Bonnyville Municipal Servicing Report of January 1979, the proposed water distribution system will be extended to the north east through a utility right-of-way for future connection on 66th Street. The water mains on the west and north side of the proposed water distribution system will be 300mm diameter.

The proposed water distribution system for the plan area is shown on Map 10.

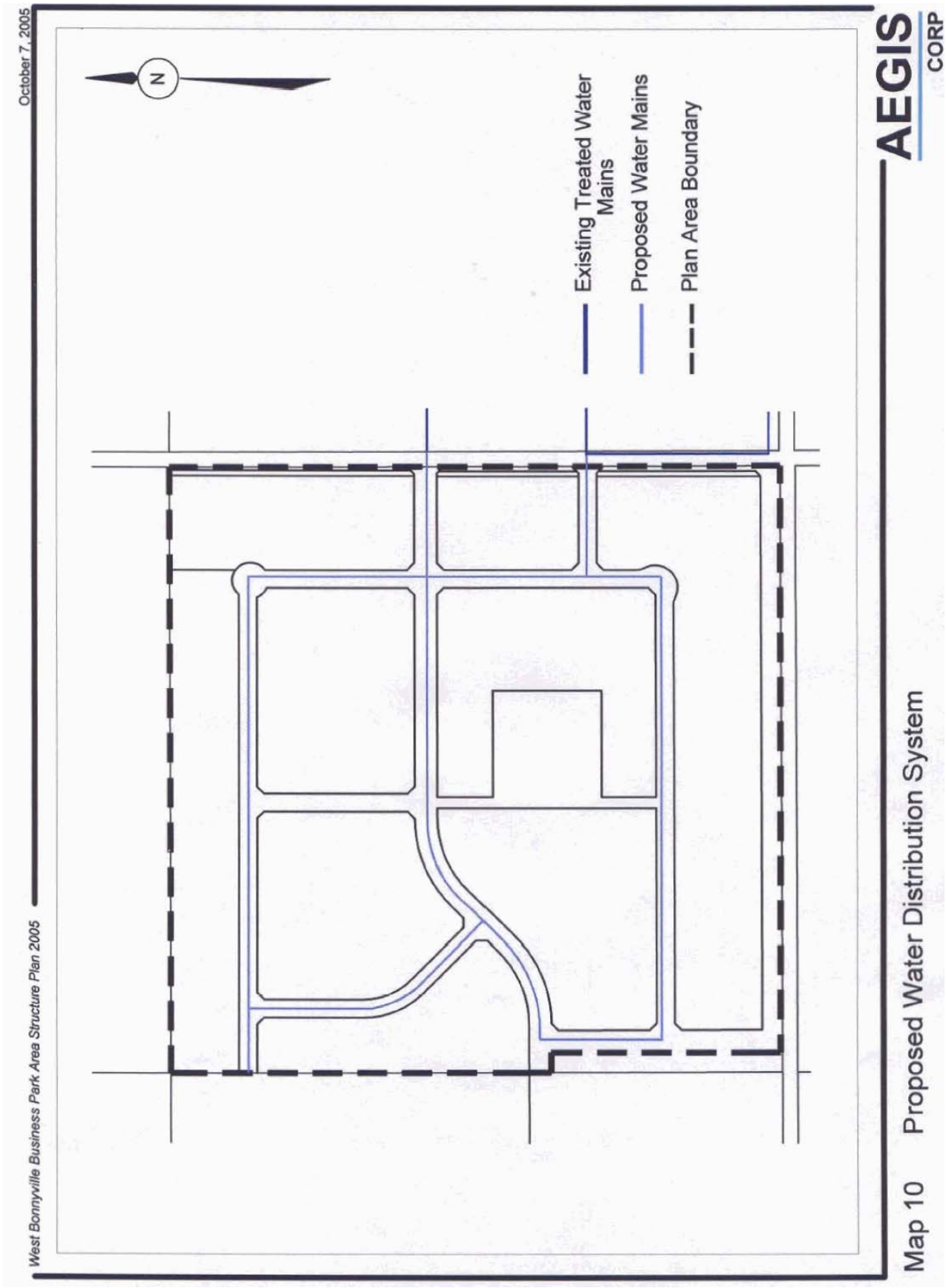
The installation of water mains is always undertaken in conjunction with the installation of sanitary sewerage mains.

5.5 Sanitary Sewage Collection

Sanitary sewage collection piping is also installed under the roadway surface. The existing sanitary sewer main installed on 52nd Avenue to the east side of 66th St. is a 200 mm diameter pipe. This connection offers adequate capacity to accept flows from the proposed development but does not have adequate depth to allow gravity flow of the sewage. The design elevations of the proposed development dictate that a collection point for sanitary sewage must be constructed in the area of the storm retention pond as shown on Map 11.

A lift station located as shown will require that a sanitary sewage force be installed from the lift station to the existing sanitary sewage main on 52nd Ave. The force main must be capable of satisfying the Town's Minimum Design Standards for flow volumes.

The Town of Bonnyville Minimum Design Standards stipulate that sewage piping must have a design capacity of 6,800 litres per gross hectare per day for industrial development, and 22,500 litres per gross hectare per day for commercial development. The piping must also be designed to accommodate


October 7, 2005
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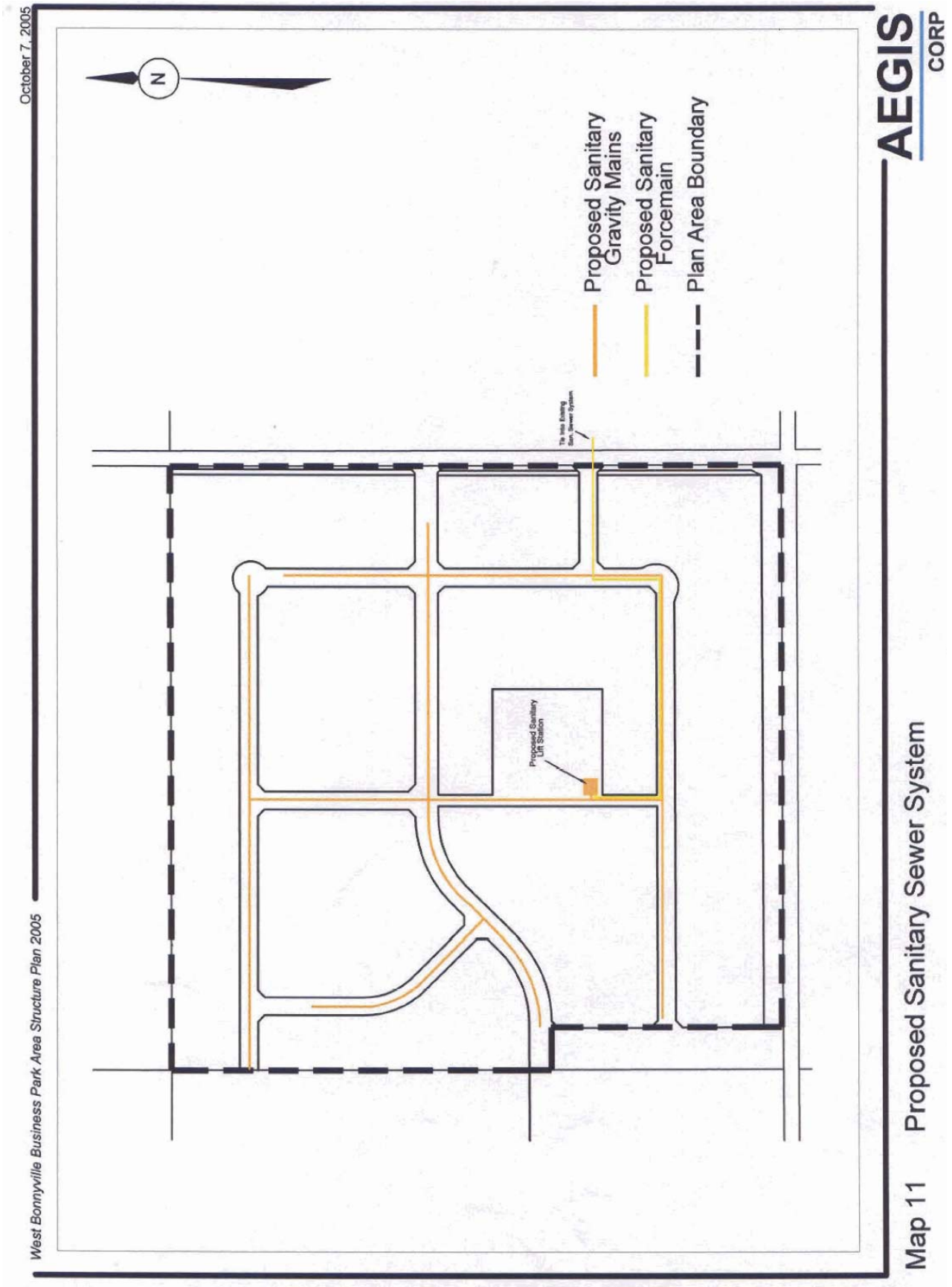
Existing Treated Water Mains
Proposed Water Mains
Plan Area Boundary
AEGIS CORP
West Bonnyville Business Park Area Structure Plan 2005
Map 10 Proposed Water Distribution System


October 7, 2005
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Proposed Sanitary Gravity Mains
Proposed Sanitary Forcemain
Plan Area Boundary
To Into Existing San. Sewer System
Proposed Sanitary Lift Station
West Bonnyville Business Park Area Structure Plan 2005
AEGIS CORP
Map 11 Proposed Sanitary Sewer System

a peak hourly flow rate of 3.5 times the average hourly flow rate. Collection piping and the force main must be designed to satisfy these requirements.

The remaining underground or shallow utilities include electrical, natural gas and communications installations.

5.6 Electrical Services

Electrical energy can be delivered either by overhead or underground wires. Electrical distribution services can be installed in easement in the back of the lots but are usually in easement adjacent to the front lot lines. The developer shall be responsible for obtaining relevant approvals and paying for electrical infrastructure associated with the development of the site.

There is an existing transmission power line right-of-way along the northern boundary of the plan area. It is doubtful that the service provider can connect to that power line.

Electrical utility distribution and servicing is coordinated by ATCO Electric at the request of the Developer.

5.7 Natural Gas Services

Natural gas distribution and servicing is also designed and coordinated by the gas company (AltaGas) upon request from the Developer.

There are two gas pipelines that traverse the plan area. AltaGas will decide if either of the lines can contribute to distribution or servicing in the proposed development. The developer shall be responsible for obtaining relevant approvals and paying for natural gas infrastructure associated with the development of the site.

5.8 Communication Services

Communications services include telephone, internet and cable services. The service providers for these services are Telus and Northern Cablevision. These services are installed under the same conditions that electrical and natural gas services are installed. The developer shall be responsible for obtaining relevant approvals and paying for communications infrastructure associated with the development of the site.

5.9 Summary

All of the preliminary work undertaken to evaluate the development of the plan area has indicated that the plan area can be serviced with a minimum of challenges and difficulties. But, it must be emphasized that the work undertaken to date has been preliminary in nature. Consequently, the comments offered in regard to infrastructure requirements may have to be adjusted to reflect the results of more thorough detailed engineering design work.

Construction and installation of the various components of the infrastructure is extremely expensive. Also, there is no guarantee that the subdivided land will sell in a timely manner. It was suggested earlier in this document that the industrial land alone may require as long as ten years to sell. The only available procedure that can be implemented to reduce the amount of the initial investment is to explore the possibility of constructing the subdivision in phases.

6.0 Phasing of the Development

6.1 Introduction

Phasing the development of a subdivision reduces the amount of capital investment that is required at the outset of the work. Phasing allows a section of the subdivision to be developed and sold. The sale of the initial lots generates cash flow to begin construction of a second phase. This approach allows land to be developed with a minimal amount of capital at the outset. The ASP designates the approved layout of the subdivision by bylaw and, as such, cannot be changed over the course of the development without an amendment to the bylaw. The phasing of the subdivision can be adjusted to develop only the lots that can be sold in a specified time frame such as a year or two years.

The phasing proposed for this subdivision is a suggestion only. The actual phasing of the development of the subdivision will be determined by the lot sales and the economy. Map 12 indicates a suggested phasing for this development. More importantly, the map introduces the concept of phasing in regard to the plan area.

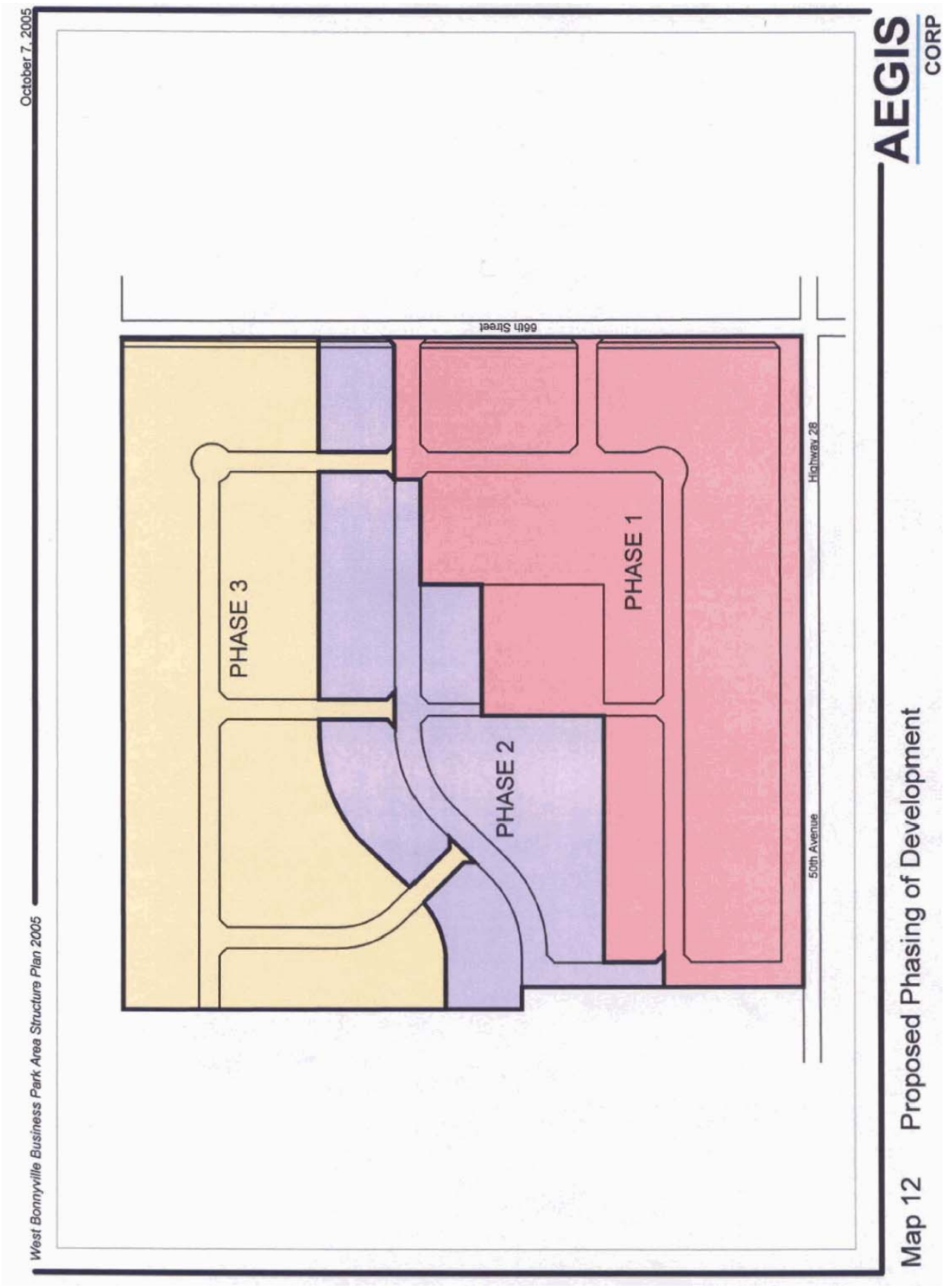
Three phases have been proposed for the plan area. The phases have been developed on the basis of a logical progression of development and the economical, efficient extension of services.

6.2 Phase 1

Phase 1 includes the development of a parcel of highway commercial property north of Highway 28 and east of 66th St. (Map 12 Proposed Phasing of Development) This area has been selected as Phase 1 on the basis that it is the most visible and probably the most saleable portion of the development.

This phase will be developed, initially as a block of land. Lots will then be subdivided from the phase as the lots are sold. That approach allows a specific purchaser to purchase a lot size that is suitable to his development. Water and sewer can be installed at the time of the sale of a parcel The roads will be constructed as illustrated on Map 12 (Phase 1). The construction of the service road will be included in Phase 1.

The water system will need to be extended from the intersection of 52nd Avenue and 66th Street, and the intersection of 54th Avenue and 66th Street. The proposed water system will be looped as shown on Map 10 Proposed Water


October 7, 2005
West Bonnyville Business Park Area Structure Plan 2005
AEGIS
CORP
Map 12 Proposed Phasing of Development
65th Street
Highway 28
50th Avenue
PHASE 1
PHASE 2
PHASE 3

Distribution System. The proposed storm water retention pond and sanitary lift station will be developed as part of Phase 1. The development of Phase 2 can begin after 80% of the land designated as Phase 1 has been sold.

6.3 Phase 2

Phase 2 involves the development of both general and heavy industrial parcels. The water system has already been installed as part of Phase 1 (See Map 10 Proposed Water Distribution System.

54th Avenue will be extended as part of this phase of the development. See Map 12 Proposed Phasing of Development. Sanitary sewer infrastructure can be extended north of the lift station. The remaining roadways and services will be constructed as part of Phase 3.

6.4 Phase 3

Phase 3 involves the development of the remaining parcels of property. This stage of development will require the completion of the water and sanitary sewer infrastructure and the roadways.

6.5 Summary

The suggested phasing identifies a logical south to north sequence for development of the plan area. The proposed phasing of development will allow development costs to be partially financed by the sale of lots in previous phases of development.

Implementation of the Area Structure Plan through phasing aids in ensuring that the developer has adequate funds to complete the entire subdivision.

7.0 Implementation

7.1 Introduction

Implementation of this Area Structure Plan requires that Council approve the plan on the recommendation of the Administration. Area Structure Plans prepared for adjacent areas of proposed development must be reviewed to ensure that the plans are compatible. Changes to Area Structure Plans for adjacent properties must be adopted by amendments to the Bylaw approving the plan.

Development of the Plan Area may proceed only after the process of :

- amendment and/or adoption of plan(s)
- rezoning of parcels
- subdivision approval
- development agreement from subdivision approval
- development and building permits

Plan implementation is an integrated process involving Council, Administration, the Developers, and all other stakeholders working in the interest of the community.

7.2 Adoption of the West Bonnyville Business Park Area Structure Plan

Section 633 of the Municipal Development Act states that a council may adopt an Area Structure Plan by bylaw. Section 230 of the *Municipal Government Act* requires a public hearing be held prior to passing of a bylaw. The public must be notified of the hearing in accordance with section 606 of the *Act*. This process ensures that anyone with an interest in the development is afforded the opportunity of a hearing in the presence of Mayor and Council.

7.3 Review of Area Structure Plans for Adjacent Developments

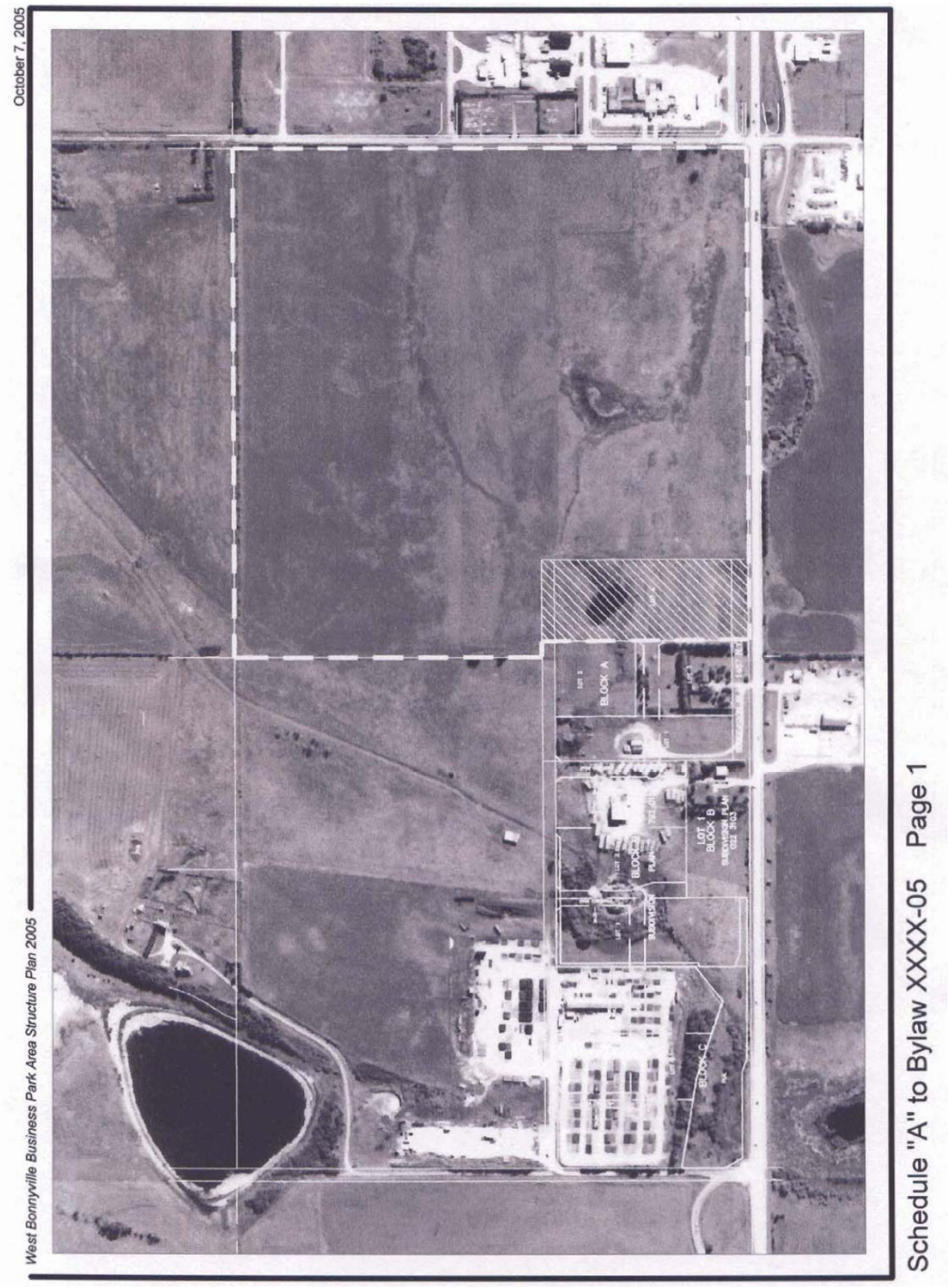
An Area Structure Plan was prepared for the south half of the SW¼ Sec. 14 Twp. 61 Rge. 6 W4M in 2003. The Ringuette Area Structure Plan was adopted by Bylaw 1233-03 in 2003. A small portion of that Plan in the south east area of the Plan requires amendment as shown on Schedule A Page 1 and Page 2.

8.0 Conclusions

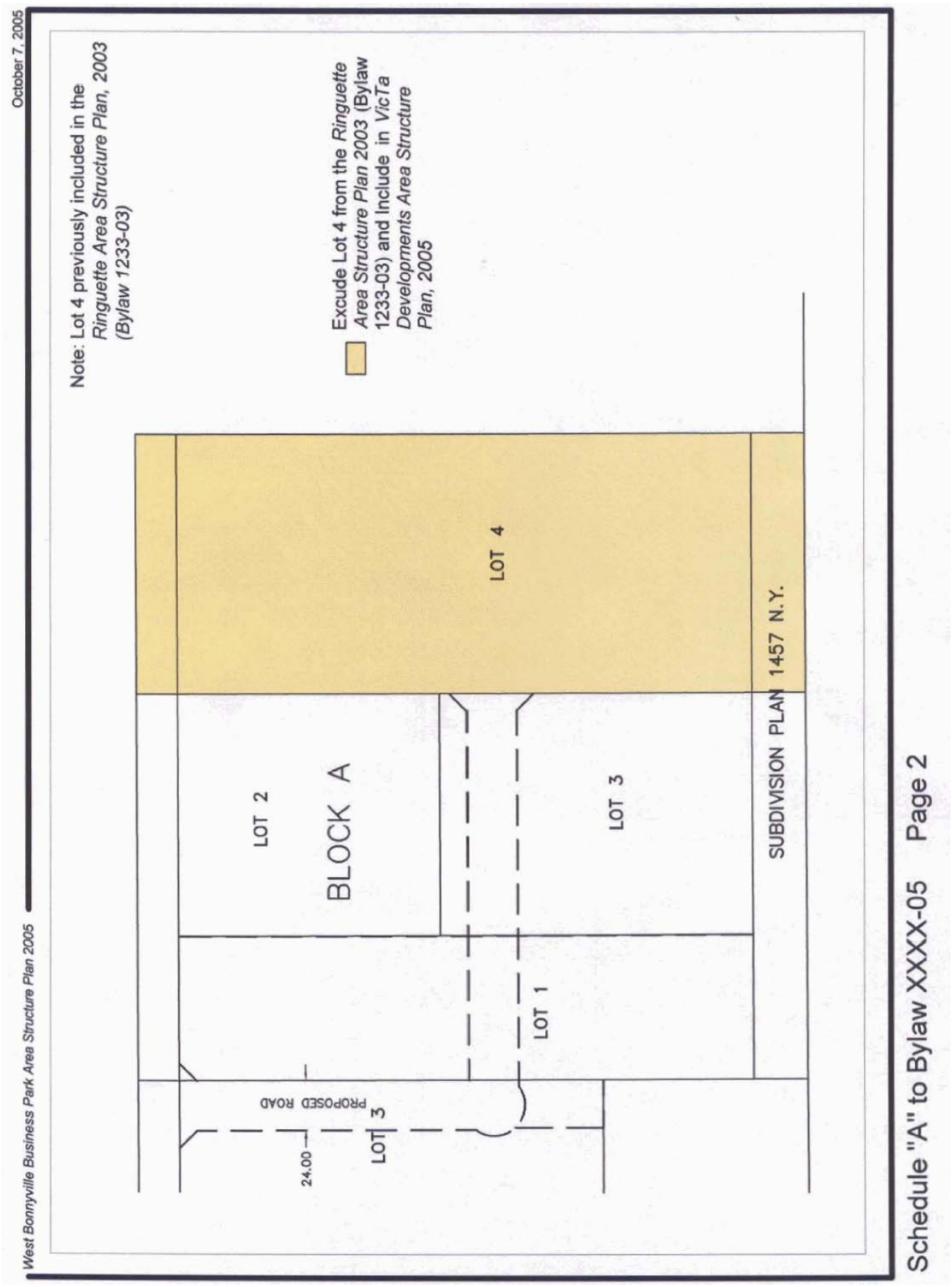
The "West Bonnyville Business Park Area Structure Plan, 2005" set a number of objectives at the outset of the preparation of the plan. All of the objectives were addressed with the following results:

- All available information related to the plan area has been assembled and included in this report,
- The proposed development addresses the existing demand for highway commercial and general industrial land within the Town of Bonnyville,
- The plan demonstrates that the proposed development can be supported by the physical dimensions of the plan area,
- The proposed development compliments existing and adjacent development,
- Transportation and roadways issues are addressed
- To the extent that it has been demonstrated that external and internal roadways can accommodate the orderly and efficient flow of traffic into, out of and within the subdivision,
- It has been demonstrated that servicing the proposed development can be undertaken in a manner that satisfies the requirements outlined by the Town of Bonnyville's Minimum Design Standards,
- A proposed method of phasing the development is suggested, and
- The plan addresses legislative changes that must be undertaken to adopt this plan and amend plans for proposed adjacent developments.

This plan offers a substantial investment in the community that will provide for growth and economic development as well as land development for many years into the future.



Schedule "A" to Bylaw XXXX-05 Page 1



Schedule "A" to Bylaw XXXX-05 Page 2

9.0 GLOSSARY OF TERMS

Act, or Municipal Act means the *Municipal Government Act of Alberta, Statues of Alberta, M-26, RSA 2000, as amended.*

Council means the Council of the Town of Bonnyville.

Design Guidelines means design standards intended to provide direction with respect to the form and character of new development.

Development means: A change in the intensity of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the intensity of use of the land or building.

Development Authority means the Town of Bonnyville Development Officer Municipal Planning Commission, the Subdivision and Development Appeal Board, or Council as the context requires.

General Industrial District has the same meaning as in the Town of Bonnyville *Land Use Bylaw*.

Highway Commercial Development has the same meaning as in the Town of Bonnyville's *Land Use Bylaw*.

Municipal Reserve means land required to be dedicated at the time of subdivision for park and open space use.

Nuisance means any use or activity which, at the discretion of the Development Authority, causes or may cause undue auditory, visual or olfactory disturbance and which, by virtue of that disturbance, reduces or interferes with the normal enjoyment of any land, building or structure.

Open Space means lands available to the population for recreational pursuits, which includes municipal and school reserves, environmental reserves, and additional lands that are currently owned or may be purchased by the Town of Bonnyville or other private sector groups for the purpose of enhancing the open system of the community.

Sanitary Sewer System means a municipally constructed or maintained system for the collection, treatment and disposal of sewage.

Screening means a fence, building, earth berm, trees or hedge used to visually and/or physically separate areas or functions.

Shall, Should and May

1. Shall means mandatory compliance;

2. Should means it is strongly advised that the action be taken, subject to the discretion of council or is approving authority where compliance is impractical or undesirable because of valid planning principles or circumstances unique to a specific application or development proposal;

3. May means a choice if available, with no particular direction or guidance intended.

Storm Drainage System or Storm Water Management means a municipally constructed or maintained system for the collection and disposal of storm water.

Storm Pond, Storm Water Retention Pond or Storm water Detention Pond means facilities either constructed or naturally occurring designed for the retention or detention of storm water. These facilities form part of the storm drainage system.

Town, Bonnyville, or Town of Bonnyville means the municipality of the Town of Bonnyville, as defined by the *Municipal Government Act*.

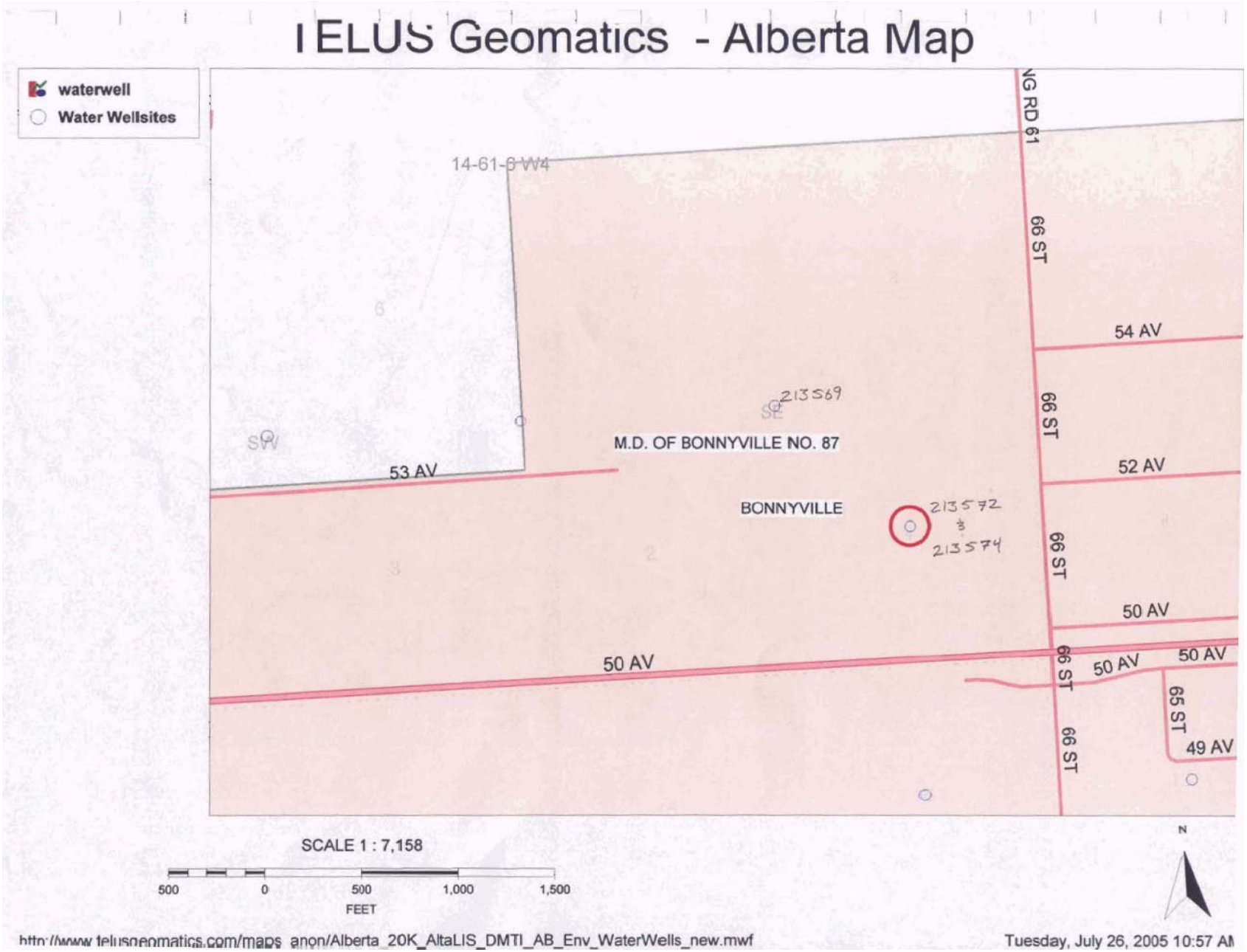
APPENDICIES

Appendix A	Water Well Reports
Appendix B	Oil Well and Petrochemical Report
Appendix C	Geotechnical Report
Appendix D	StormWater Drainage Report

Appendix “A”

Water Well Reports

#8242 Bylaw 1277-05



Alberta Environment

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I D:	0213569
Map Verified:	Not Verified
Date Report Received:	1979/01/31
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: ZIMMER, KIM	Well Location Identifier:	
P.O. Box Number: 321	Mailing Address: BONNYVILLE	Postal Code:
City:	Province	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
SE	14	061	06	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 1800 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Chemistry Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Unknown
Flowing Well:
Gas Present: No
Rate: Gallons
Oil Present: No

Proposed well use: Domestic
Anticipated Water Requirements/day: 0 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
Well Depth: 22 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at 0 FT	Top: 0 FT Bottom: 0 FT
Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Screen Type:	Screen ID: 0 Inches
from: 0 FT to: 0 FT	Slot Size: 0 Inches
Screen Type:	Screen ID: 0 Inches
from: 0 FT to: 0 FT	Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 1	Documents Held: 2
Pitless Adapter Type: Drop Pipe Type: Length: FT	Diameter: Inches
Comments:	

6. Well Yield

Test Date (yyyy/mm/dd): 1979/01/17	Start Time: 11:00 AM
Test Method:	
Non pumping static level	14 FT
Rate of water removal:	Gallons/Min
Depth of pump intake.	0 FT
Water level at end of pumping:	FT
Distance from top of casing to ground level:	Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: 0 FT

If water removal was less than 2 hr duration, reason why.

Recommended pumping rate: 0 Gallons/Min
Recommended pump intake: 0 FT
Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information?

7. Contractor Certification

Driller's Name:	UNKNOWN DRILLER
Certification No.:	

This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true
Signature Yr Mo Day

Report 1 Pump Test 1

Alberta Environment

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.:	0213572
Map Verified:	Map
Date Report Received:	1935/09/19
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No.: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: LAPOINTE	Well Location Identifier:	
P.O. Box Number:	Mailing Address:	Postal Code:
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
01	14	061	06	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 1822 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Federal Well Survey
Reclaimed Well
Date Reclaimed(yyyy/mm/dd): Materials Used:
Method of Drilling: Unknown
Flowing Well: Rate: Gallons
Gas Present: No Oil Present: No

Proposed well use: Unknown
Anticipated Water Requirements/day 0 Gallons

6. Well Yield

Test Date (yyyy/mm/dd): Start Time:
Test Method:
Non pumping static level: FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of casing to ground level: Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes.Sec Recovery

Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: Gallons/Min
Recommended pump intake: FT
Type pump installed
Pump type:
Pump model:
H.P.:
Any further pumptest information?

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
Well Depth: 75 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations from: 0 FT to: 0 FT from: 0 FT to: 0 FT from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches 0 Inches x 0 Inches 0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT Seal: from: 0 FT Seal: from: 0 FT	to: 0 FT to: 0 FT to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files.	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 0	Documents Held: 1
Pitless Adapter Type: Drop Pipe Type: Length:	Diameter:
Comments:	

7. Contractor Certification

Driller's Name:	UNKNOWN DRILLER
Certification No.:	

This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true.
Signature Yr Mo Day

Report 1

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy

Well I.D.:	0213574
Map Verified	Map
Date Report Received:	1974/08/24
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER		Drilling Company Approval No: 99999
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:
WellOwner's Name: LAPOINTE, RADUL	Well Location Identifier:	
P.O. Box Number:	Mailing Address: BONNYVILLE	Postal Code
City:	Province:	Country:

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
01	14	061	06	4

Location in Quarter
0 FT from Boundary
0 FT from Boundary

Lot Block Plan

Well Elev: 1805 FT
How Obtain: Estimated

3. Drilling Information

Type of Work: Well inventory
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used:
Method of Drilling: Unknown
Flowing Well
Gas Present: No
Rate: Gallons
Oil Present: No
Proposed well use: Unknown
Anticipated Water Requirements/day: 0 Gallons

6. Well Yield

Test Date (yyyy/mm/dd)	Start Time:
1974/08/24	11:00 AM
Test Method:	
Non pumping static level:	8 FT
Rate of water removal:	Gallons/Min
Depth of pump intake:	0 FT
Water level at end of pumping:	FT
Distance from top of casing to ground level:	Inches

Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: 0 FT

If water removal was less than 2 hr duration, reason why

Recommended pumping rate: 0 Gallons/Min
Recommended pump intake: 0 FT
Type Pump Installed
Pump Type
Pump Model:
H.P.:
Any further pumptest information?

4. Formation Log

Depth from ground level (feet)	Lithology Description

5. Well Completion

Date Started(yyyy/mm/dd):	Date Completed (yyyy/mm/dd)
Well Depth: 14 FT	Borehole Diameter: 0 Inches
Casing Type:	Liner Type:
Size OD: 0 Inches	Size OD: 0 Inches
Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
Perforations	Perforations Size:
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
from: 0 FT to: 0 FT	0 Inches x 0 Inches
Perforated by:	
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Seal: from: 0 FT	to: 0 FT
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
Screen Installation Method:	
Fittings Top:	Bottom:
Pack: Grain Size:	Amount:
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held: 2	Documents Held: 3
Pitless Adapter Type: Drop Pipe Type: Length: FT	Diameter: Inches
Comments:	

7. Contractor Certification

Driller's Name:	UNKNOWN DRILLER
Certification No.:	

	This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection & Enhancement Act. All information in this report is true. Signature Yr Mo Day	

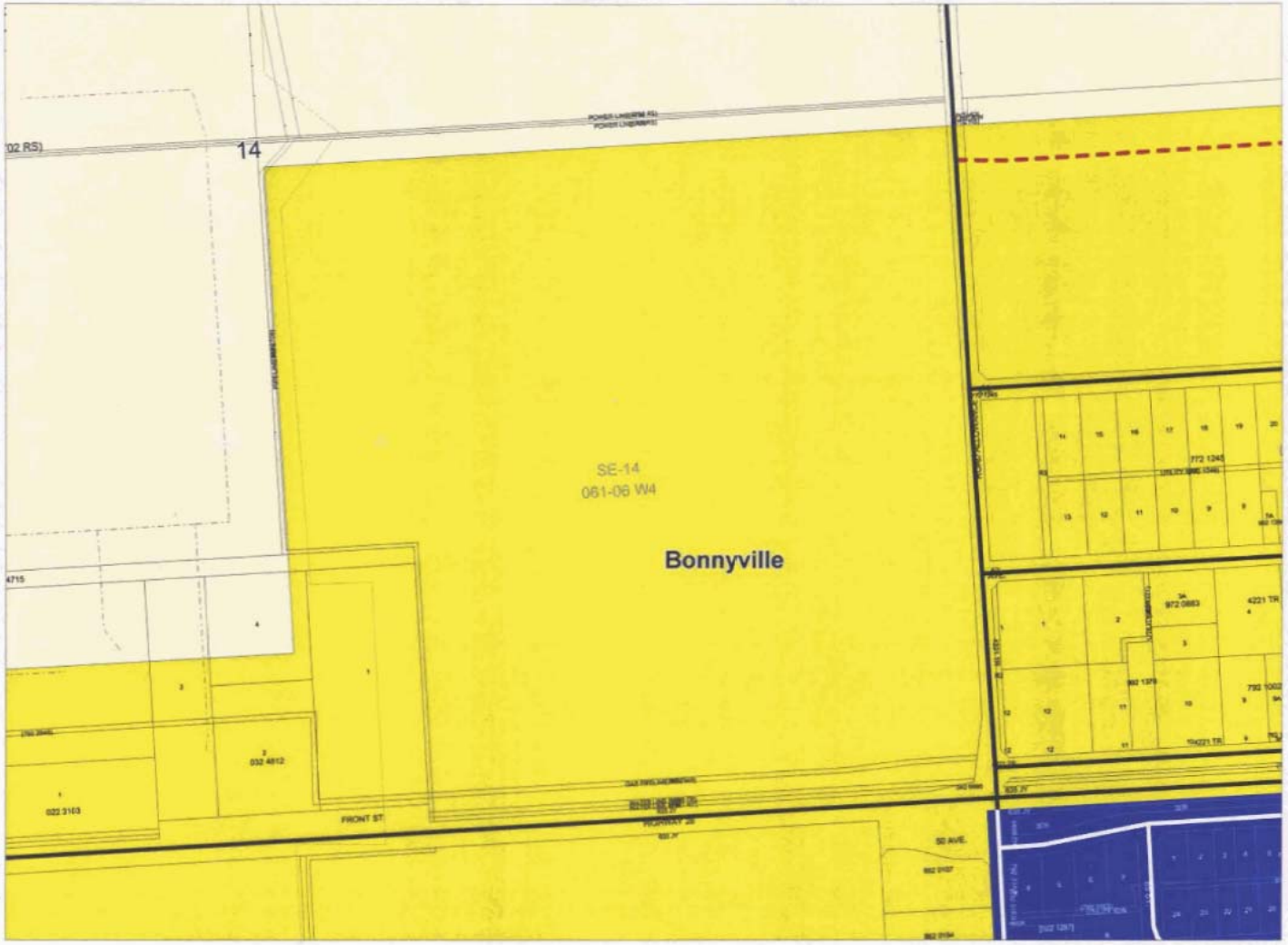
Report 1 Pump Test 1

Appendix “B”

Oil Well and Petrochemical Report

#8242 Bylaw 1277-05

Map1



SCALE 1 : 6,619

500 0 500 1,000 1,500

FEET

http://www.abacusdatagraphics.com/AbaData/Maps/AbacusMaps_web.mwf

Tuesday, July 26, 2005 10:48 AM

EUB Pipeline information for the SE 1/4 Sec.14 Twp.61 Rng.6 W4M

EUB PIPELINE INFORMATION CURRENT TO JUNE 2006			
LICENCE/LINE #:	40785 - 1	ABACUS #:	
APPROVAL DATE:	MAY 6, 1998		
COMPANY:	ALTAGAS LTD.		
FROM:	06-11-061-06 W4M PL		
TO:	10-23-061-06 W4M PL		
LENGTH (km):	4.19	STATUS:	O
SUBSTANCE:	NG	H2S (mol/kmol):	0
OD (mm):	114.3	WT (mm):	3.18
MATERIAL:	S	TYPE:	Z245.1
GRADE:	2901	MOP (kPa):	4960
JOINTS:	W	INTL COATING:	U
ENVIRONMENT:			

#8242 Bylaw 1277-05

Energy and Utilities Board Pipeline report for SE Sec. 14-61-6-W4M

LIC #	LINE #	COMPANY NAME	APPROVAL DATE	FR LSD	FR SEC	FR TWP	FR RGE	FR WOF	FR FAC	TO LSD	TO SEC	TO TWP	TO RGE	TO WOF	TO FAC	LGTH	STS	SUB CODE	H2S	OD	WT	MAT	TYPE	GRADE	MOP	JOINTS
40785	1	ALTAGAS LTD.	MAY 6 1998	6	11	61	6	4	PL	10	23	61	6	4	PL	4.19	O	NG	0	114.3	3.18	S	Z245.1	2901	4960	W

Source:http://www.abacusdatagraphics.com/AbaData/mgFrames.asp

EUB Company Report for SE 14-61-6-W4M

COMPANY NAME	ADDRESS	PHONE#
ALTAGAS LTD.	1700, 355 - 4 Avenue SW Calgary, AB T2P 0	(430) 691-7575

Sourcehttpwww.abacusdatagraphics.comAbaDatamgFrames.asp

#8242 Bylaw 1277-05

Land Status Report - SE 1/4 Sec.14 Twp.61 Rng.6 w4m.

General Land Data							
Location	Surface Ownership	Administrative Crown Agency	Titled Status	Surveyed Status	Existance	Water Coverage	Freehold Land Area (ha)
Township 61-6 W4M	MIXED	FLW-MLT	MIXED	SURVEYED	ALL EXISTENT	PARTLY COVERED	0
Section 14-61-6 W4M	MIXED	FLW-FRH	MIXED	SURVEYED	ALL EXISTENT	PARTLY COVERED	234.799
SE-14-61-6 W4M	FREEHOLD	FRHOLD	TITLED	SURVEYED	ALL EXISTENT	N	64.75

Geo-Administrative Data						
Location	Geo-Administrative Type	Geo-Administrative Name	Geo-Administrative Area	Administrative Agency	Status	Comments
Township 61-6 W4M	COAL DEVELOPMENT REGION	SETTLED	1		NOT ESSENTIAL	
	ENVIRONMENT CORPORATE REGION	NORTHERN	3	WATER MANAGEMENT OPERATIONS	ESSENTIAL	
	ENVIRONMENT CONS. & RECL. DISTRICT	NO. 7	007	ENVIRONMENT, DEPARTMENT OF	NOT ESSENTIAL	
	FOREST MANAGEMENT UNIT	LO1	L		NOT ESSENTIAL	
	FISH & WILDLIFE ADMIN REGION	ST. PAUL	4		ESSENTIAL	
	FISH AND WILDLIFE DISTRICT	BONNYVILLE	5		NOT ESSENTIAL	
	GENERAL LANDS CLASSIFICATION	WHITE	W		ESSENTIAL	
	GRAZING ZONE	C	C		NOT ESSENTIAL	
	INTEGRATED RESOURCE PLAN	COLD LAKE	C3	NORTH EAST AREA	NOT ESSENTIAL	
	LAND USE AREA	BONNYVILLE	NE1		ESSENTIAL	
	PUBLIC LAND DISTRICT	BONNYVILLE	5		NOT ESSENTIAL	
	RANGELAND DISTRICT	BONNYVILLE	NE		ESSENTIAL	
	SUSTAINABLE RESOURCE DEV CORP REGION	LAC LA BICHE	NE		ESSENTIAL	
SE-14-61-6 W4M	URBAN MUNICIPALITY	BONNYVILLE	T	ALBERTA MUNICIPAL AFFAIRS	NOT ESSENTIAL	

Crown Mineral Agreement Details Report - SE 1/4 Sec.14 Twp.61 Rng.6 w4m.

CROWN MINERAL AGREEMENT # 0747401050003							
Status:	ACTIVE	Last Update:	May 17 2005	Term Date:	May 3 2001	Expiry Date:	May 3 2016

Client Name	Role	Pct.
DEVON ARL CORPORATION	BOTH	100%

Zone Qualifier	Zone	Susbstance
IN THE	MANNVILLE GRP	OIL SANDS

From Location	To Location	Desc 1	Desc 2	Desc 3	Desc 4	Desc 5
02 - 061 - 06 W4M	-	N				
10 - 061 - 06 W4M	-					
11 - 061 - 06 W4M	-					
13 - 061 - 06 W4M	-					
14 - 061 - 06 W4M	-					

Crown Mineral Agreements Details Report - SE 1/4 Sec.14 Twp.61 Rng.6 w4m.

CROWN MINERAL AGREEMENT # A93 050305207							
Status:	ACTIVE	Last Update:	Jul 22 2005	Term Date:	Jul 18 2005	Expiry Date:	

Client Name	Role	Pct.
SANDSWAMP EXPLORATION LTD.	BOTH	100%

Zone Qualifier	Zone	Susbstance

From Location	To Location	Desc 1	Desc 2	Desc 3	Desc 4	Desc 5
01 - 061 - 06 W4M	18					
20 - 061 - 06 W4M	-					
21 - 061 - 06 W4M	-	S	NW			
22 - 061 - 06 W4M	26					
35 - 061 - 06 W4M	-	N	SE			
36 - 061 - 06 W4M	-					
01 - 062 - 06 W4M	-					
02 - 062 - 06 W4M	-	NE				
11 - 062 - 06 W4M	12					
13 - 062 - 06 W4M	-	S	NE			
14 - 062 - 06 W4M	-					
23 - 062 - 06 W4M	24					
01 - 061 - 07 W4M	-	S	NE			
12 - 061 - 07 W4M	-	SE				

Appendix “C”

Geotechnical Report

GEOTECHNICAL REPORT
PROPOSED COMMERCIAL AND INDUSTRIAL SUBDIVISION
SE ¼ - SEC. 14 – TWP 61 – RGE 6 – W4M
BONNYVILLE, ALBERTA

Submitted To:

489786 ALBERTA LIMITED
BONNYVILLE, ALBERTA

Submitted By:

AMEC EARTH & ENVIRONMENTAL
LLOYDMINSTER, ALBERTA

JUNE 2005

File No. AX4677

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LIST OF APPENDICES

1.0 INTRODUCTION

AMEC Earth & Environmental (AMEC) was retained by 489786 Alberta Limited to carry out a geotechnical investigation for a proposed commercial and industrial subdivision site in Bonnyville, Alberta. Written authorization to proceed with the investigation was given by Mr. Bob Hoggs on 5 April 2005.

The purpose of AMEC's investigation was to identify the soil and groundwater conditions at the borehole locations, and to provide geotechnical recommendations relative to the proposed development. The scope of work conducted by AMEC was based on our proposal LP04-176 dated 19 October 2004, and included drilling boreholes, conducting laboratory soil tests, performing geotechnical engineering analyses, and preparation of this report.

This report summarizes the results of the field and laboratory testing programs and presents geotechnical recommendations for the design and construction of the foundation systems, slabs-on-grade, flexible pavement designs for local asphalt paved roads, cement type for subsurface concrete, trench excavation for underground utilities, and site preparation.

2.0 SITE AND PROJECT DESCRIPTION

The proposed development site covers an area of about 800 m x 800 m. The topography of the site was relatively rolling terrain, with a low-lying area/slough covering approximately a 300 m x 200 m area in the central southern portion of the site

It is AMEC's understands that the proposed subdivision will consist of commercial and industrial building lots, associated underground site services, and asphalt surfaced local roadways. A preliminary site layout plan has been prepared by Stewart, Weir, &Co., Ltd., and is reproduced as Figure 1.

3.0 FIELD AND LABORATORY PROGRAMS

Prior to field drilling, AMEC conducted a "First Call" for underground utility clearances at the proposed borehole locations. Borehole locations were selected by AMEC to provide adequate coverage of the site. The boreholes were staked in the field by Stewart, Weir, &Co., Ltd. based on the borehole location plan prepared by AMEC.

Field drilling was conducted on 13, 14 and 21 April 2005. A total of 28 boreholes, designated as BH-1 through BH-17 and BH-19 through BH-29, were drilled at the locations as indicated on the borehole location plan, Figure 1, Appendix A. The location of BH-18 was inaccessible at the time of the investigation and thus was not drilled.

The boreholes were advanced to depths ranging between 4.3 m and 8.8 m below ground surface. Drilling was conducted using a truck-mounted auger drill rig advancing continuous

flight, 150 mm diameter, solid-stem augers. McAllister Drilling Inc. of Lloydminster performed the drilling, and AMEC geotechnical personnel logged the soil samples and auger cuttings.

Field classification of the soil types encountered was based on the auger cuttings. The soils were logged according to the Modified Unified Soil Classification System, which is described on the explanation of terms and symbols in Appendix B. Due to the method by which the soil cuttings are returned to surface, the depths noted on the borehole logs may vary by plus or minus 0.3 m from those recorded.

The soil sampling and testing sequences are shown on the borehole logs. In general, disturbed auger samples were obtained at approximately 0.75 m depth intervals for the determination of in-situ moisture profiles in each borehole. Standard Penetration Tests (SPT's) were conducted at selected depths (typically every 1.5m) to assess the in-situ strength of the soil types encountered. Pocket penetrometer (pp) readings were also taken on relatively low disturbance cohesive soil samples to obtain an indication of the unconfined strengths of disturbed samples soils from the auger.

The groundwater seepage conditions were monitored during drilling. In addition, 25 mm diameter standpipes were installed in 10 boreholes to facilitate short-term monitoring of groundwater levels. The standpipe installation details are provided on the corresponding borehole logs. Groundwater levels were measured at the completion of drilling and again on 30 April 2005 by AMEC.

The geotechnical laboratory testing program consisted of soil moisture contents, six sets of Atterberg limits, three grain size distribution analyses, and four water-soluble sulphate concentration tests on representative soil samples. The results of the laboratory tests are presented on the borehole logs in Appendix A.

4.0 SUBSURFACE CONDITIONS

The generalized soil profile at the borehole locations consisted of topsoil over glacial clay till. Sand layers of varying thicknesses were encountered within the clay till layer and/or between the topsoil and clay till layer in 16 of the 28 boreholes.

Detailed descriptions of the soil conditions encountered are provided on the borehole logs in Appendix A. The following is a brief description of the soil types encountered.

4.1. TOPSOIL

Topsoil was encountered at the surface of all boreholes. The topsoil was black, organic and contained grass and roots. The thickness of the topsoil ranged between 0.1 m to 0.45 m. Different thickness of topsoil might be present at other locations on the site. The topsoil is generally a weak and compressible material.

4.2. SAND

Sand layers (or silt in BH-1) were encountered within the clay till strata in boreholes 1, 3, 7, 10, 13, 16, 19, 22, 25, 27, and 28; and directly below the topsoil in boreholes 9, 11, 13, 14, 15, and 21. These layers varied between approximately 0.1 m and 3.0 m in thickness.

The sand was generally compact to dense. SPT "N" values ranged between 10 and 52 with an average of 27. The sand layers were generally wet and exhibited sloughing conditions. Grain size distribution analysis tests on selected sand samples indicated that the sand was mainly fine grained. It is expected that the surficial sand soils at the subject site are frost susceptible and may experience frost heave.

4.3. GLACIAL CLAY TILL

Glacial till was encountered below the topsoil or sand soils in all the boreholes, and extended beyond the exploration depth. The glacial clay till consisted of a mixture of clay, silt and sand. The clay till contained silt and sand pockets and layers. Cobbles and boulders were encountered in some of the boreholes. It is to be noted that clay till deposits commonly contain scattered cobbles and large boulders.

The SPT "N" values in the till ranged from 7 to greater than 50 blows per 15 cm penetration with an average of approximately 33. The clay till was assessed to be stiff to hard in consistency.

Liquid and plastic limits of samples from the clay till were in the order of 26-34 percent and 9-15 percent respectively. Moisture contents of recovered samples of the glacial till were between 7 percent and 39 percent with an average of about 13 percent. It is expected that the in-situ moisture content of clay till is close to its optimum moisture content.

4.4. GROUNDWATER CONDITIONS

Groundwater seepage was noted in some of the boreholes at the completion of drilling. The groundwater levels as measured at the site are shown in the table below:

Table 1: Measured Groundwater Depths below Grade (m)

Borehole No.	Depth (m) of Borehole	Groundwater Level (m) Upon Completion of Drilling	Groundwater Level (m) On 30 April 2005
BH-1	8.8	No Accumulation	5.1
BH-2	4.3	No Accumulation	Standpipe Not Installed
BH-3	8.8	No Accumulation	7.2
BH-4	4.3	No Accumulation	Standpipe Not Installed
BH-5	8.8	No Accumulation	No Accumulation
BH-6	4.3	No Accumulation	Standpipe Not Installed
BH-7	4.3	No Accumulation	Standpipe Not Installed
BH-8	4.3	No Accumulation	Standpipe Not Installed
BH-9	8.8	No Accumulation	4.2
BH-10	4.3	3.5	Standpipe Not Installed
BH-11	4.3	1.2	Standpipe Not Installed
BH-12	8.8	No Accumulation	4.0
BH-13	4.3	No Accumulation	Standpipe Not Installed
BH-14	8.8	No Accumulation	2.5
BH-15	4.3	No Accumulation	Standpipe Not Installed
BH-16	4.3	3.7	Standpipe Not Installed
BH-17	4.3	No Accumulation	Standpipe Not Installed
BH-18	***Not Drilled***		
BH-19	8.8	5.5	2.9
BH-20	4.3	No Accumulation	Standpipe Not Installed
BH-21	8.8	No Accumulation	1.8
BH-22	4.3	3.5	Standpipe Not Installed
BH-23	8.8	No Accumulation	1.3
BH-24	4.3	No Accumulation	Standpipe Not Installed
BH-25	8.8	3.0	1.1
BH-26	4.3	No Accumulation	Standpipe Not Installed
BH-27	4.3	3.0	Standpipe Not Installed
BH-28	4.3	No Accumulation	Standpipe Not Installed
BH-29	4.3	No Accumulation	Standpipe Not Installed

The depth of the groundwater table typically fluctuates seasonally depending upon several factors that include the local geology and hydrogeology and effects of recharge due to infiltration from snowmelt and precipitation.

Sloughing and groundwater infiltration should be anticipated during excavations, such as pile holes and trenches, especially if the excavation intercepts a sand layer. It is expected however, that conventional groundwater control measures such as perimeter drainage trenches, granular

drainage layers at base of utility trenches draining to a sump equipped with a pump, and casing for pile holes would be sufficient to control potential groundwater infiltration.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1. GEOTECHNICAL CONSIDERATIONS

The subsurface conditions at this site are considered to be suitable for the proposed development since the native soil deposits at shallow depths have adequate bearing characteristics. It is expected that future industrial buildings will impose light to moderate structural loads. As such, the subsurface conditions are suited to strip and spread footing foundations, as well as pile foundations.

The soil conditions at the site are also well suited for installation of underground utilities, construction of slab-on-grade floors, and construction of asphalt surfaced roadways.

5.2. SITE PREPARATION

The preliminary development configuration was proposed, but design grades for the subdivision were unknown at the time of preparation of this report. It is anticipated, however, that some site grading including cut and backfill will be required prior to the subdivision development. It should be emphasized that surface grades should be designed to minimize the depth of fill across building footprints to reduce the potential for settlements.

It is recommended to strip all topsoil from areas to be developed. The surface of the exposed subgrade following removal of the topsoil and site grading should be proofrolled to identify any weak spots. Any localized soft areas encountered should be sub-excavated and replaced with suitable engineered fill. The depth of excavation should be sufficient to remove the soft material, or to bridge over the material to give proper support for earthmoving and or paving equipment.

Soft subgrade conditions
Soft subgrade conditions are not expected to be an issue. However, if soft subgrade conditions are encountered, subgrade improvement techniques should be used.

Subgrade improvement would involve the use granular fill. The thickness of the initial gravel lift required to bridge the soft areas is typically in the order of 300 to 500 mm or more depending on the actual condition of the subgrade at the time of construction. The granular layer should be placed in one lift, using a hoe to keep traffic off the subgrade and subsequently static rolled. Subsequent lifts of fill should be placed in maximum 0.3 m thick lifts.

New Fill Placement
Engineered fill to bring the site subgrade up to design grade should consist of low to medium plastic clay or a well-graded granular material. Sand which is uniformly graded, or which

contains more than 10 percent passing the 0.080 mm sieve should not be used. If gravel is to be used, aggregate sizes larger than 80 mm should be removed prior to placement. All fill soils should be free from any organic materials, contamination and deleterious construction debris. Fill materials should not be placed in a frozen state, or placed on a frozen subgrade. All lumps of materials larger than 100 mm should be broken down during placement.

Native clay till is considered suitable for use as engineered fill. The use of the native sand is not recommended due to the difficulty in compacting these soils in an unconfined area. However, if the sand is to be used, close control of soil moisture will be required to achieve specified compaction.

For areas requiring subgrade support such as floor slabs or aprons, it is recommended to compact the fill to a minimum 100 percent of Standard Proctor Maximum Dry Density (SPMDD). Uniformity of compaction is most important. Engineered fill under roadways and parking should be compacted to at least 96 percent of SPMDD.

To reduce compactive effort, it is suggested to place the granular fill at moisture contents within 2 percent of Optimum Moisture Content (OMC; ASTM D698), and clay fill at moisture contents between 1 percent below optimum and 2 percent above OMC. The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. It is recommended to use lifts with a maximum thickness of 200 mm for granular soils and a maximum of 150 mm for cohesive soil.

If imported gravel fill is used to raise the grades, it should consist of a minus 80 mm gravel within the gradation limits given in Table 2. Other gravel fills with gradation limits slightly outside of those given in Table 2 may be considered upon approval by the geotechnical engineer.

TABLE 2: GRADATION LIMITS FOR 80 MM PIT RUN GRAVEL

Sieve Size	Percent Passing
80 mm	100
5 mm	25 to 50
80 µm	0 to 10

Settlement of backfill should be expected, even for well compacted soils placed and compacted under ideal conditions. Settlements in the order of 1 to 3 percent of fill thickness are typical in clay soils compacted between 95 percent and 98 percent of SPMDD.

The quality and placement of fill soils should be monitored by qualified geotechnical personnel with field density tests for each lift of fill. Monitoring should be conducted on a full time basis for structural fills. The completed subgrade surface should be proof-rolled to confirm that surface deflections are minimal under the influence of construction traffic, and to verify that an acceptable degree of compaction has been obtained.

Site Grading

The areas to be developed should be graded in the early stages of construction to provide positive drainage for surface runoff. To reduce accumulation of surface runoff and softening of the subgrade, site grades should be designed to minimize ponding of water on the surface and to provide positive drainage away from the proposed building and pavement areas.

Surficial Sands

Surficial fine grained sands have been observed at several locations on the site. These sands are expected to be sensitive to disturbance in wet condition. In addition, these sands might be subject to frost heave in areas with high groundwater table. Reducing the risk of frost heave by removing the sand and replacing it with clay soils might be cost prohibitive.

It is recommended to grade the roadways and delay the placement of asphalt by at least one construction season (i.e., allow the subgrade to experience one frost thaw cycle). Based on the performance of the roadway following the frost thaw cycle, it might be necessary to subexcavate and repair a specific section of the roadway that has experienced frost heave prior to asphalt placement. It is to be noted that long-term maintenance of the roadway might be required in areas experiencing frost heave.

5.3. BUILDING FOUNDATIONS AND SLAB SYSTEMS

Site-specific geotechnical investigations are recommended for each development in this subdivision. The site-specific investigation would assess local soil conditions, groundwater table, and fill considerations resulting from site grading. Below are some general guidelines for building foundations and slab systems.

5.3.1. Footings

Shallow footings will likely be founded in either sand or glacial clay till soils. On a preliminary basis, footings based on native soils may be designed using allowable bearing pressures of 120 kPa. The allowable bearing pressures above are presented as general information for use in preliminary design. Allowable bearing pressures higher than the preliminary values presented above may be appropriate in some areas, particularly where the footing bearing surface consists of gravel or very stiff to hard clay till soils. Allowable bearing pressures for detailed design should be established through separate project-specific geotechnical evaluations as individual lots are developed.

Footings should be based directly on undisturbed inorganic native soils free from loosened material, or on engineered fill constructed in accordance with the recommendations provided in Section 5.2. The bearing surface of each footing base should be excavated in a manner to minimize disturbance of the subgrade. Cleaning of the bases of the footing excavations will likely be required to remove loosened soil debris. Should softened soils be encountered at the design footing depth, the footing excavation should be deepened such that footings bear on

competent soils. The bearing soils at each footing excavation should be inspected and approved by qualified geotechnical personnel prior to concrete placement.

The bearing surfaces should be protected from wetting or drying, including inflow of surface water. The foundation soils may experience loss of bearing strength should they be subjected to increases in moisture.

The foundation soils beneath the footings must not be allowed to freeze during construction or during the service life of the building. Footings founded on frozen soil during construction may settle when the founding soils thaw. Bearing soils that become frozen during construction should be removed and replaced with concrete, or the embedment depths should be extended to the unfrozen zone.

For protection against frost action, perimeter footings in heated structures should be founded at least 1.5 m below finished grade. Interior footings in heated buildings require a minimum 0.3 m embedment depth below the surface of the native soil. Footings supporting unheated buildings or unheated parts of buildings should have a minimum 2.1 m of soil cover. Rigid insulation can be considered to reduce the depth of frost penetration and the required depths for foundations. Design insulation configurations can be provided once the desired footing embedments have been established.

The design and construction of footings should comply with relevant Alberta Building Code requirements.

5.3.2. Grade Supported Slabs

Concrete floor slabs supported on the engineered fill or on subgrade prepared as outlined in Section 5.2 under "Site Preparation", are considered feasible. It is assumed that the proposed building floor slabs are subjected to loads less than 10 kPa, and that the buildings will be heated in the winter.

A layer of gravel base course, at least 150 mm in thickness, is recommended directly beneath the concrete floor slabs. The gravel should be placed in a single lift and uniformly compacted to a minimum of 100 percent of SPMDD using a plate tamper or smooth drum roller. The gravel should be well graded, free draining with a maximum aggregate size of 20 mm and less than 3 percent passing the 0.080 mm sieve.

Small vertical movements may be experienced due to moisture change in the subgrade clay soils. Provisions should be made for movements between partitions and adjoining columns or load bearing walls. In general, grade supported slabs should be allowed to float relative to adjacent foundation elements, except possibly at doorways. In addition, where partitions are placed under structural members, a space should be left at the top of the partition to allow vertical movement (at least 25 mm). If some differential movement cannot be tolerated, then consideration should be given to structural slab systems.

Service connections should be designed to accommodate some movements. Waterlines should not be placed below slab on grade floors. Waste water lines below slabs should be installed carefully to minimize the potential for breakage and leaks. Heating ducts below grade should be insulated to prevent drying of the subgrade soils.

5.4. SIDEWALKS AND APRON SLABS

Exterior sidewalks and the apron slabs should be free-floating and should not be doweled into foundation elements except possibly at doorways. It is to be noted that site soils are moderately frost susceptible particularly in areas with shallow groundwater table.

The separation joint at the sidewalk/building interface should be sealed in order to limit seepage of surface runoff into the subgrade soils. The subgrade beneath the exterior flatwork or concrete sidewalks adjacent to the building should be sloped away from the building at gradients of not less than 2 percent.

5.5. BURIED UTILITIES

It is expected that buried services will be installed to depths of about 3.0 m to 4.0 m below finished grade with some potential for slightly deeper major service trunks. It is expected that soil conditions in the trench bottoms and walls will mostly consist of clay till and/or sand.

5.5.1. Service Trench Excavation

The stable sideslope angle for conventional unsupported trench excavations is dependent on the local soil conditions. Conventional trench excavations with cut slopes are considered to be appropriate.

The side slopes of conventional unsupported trench excavations would be dependent on the local soil conditions. In general, for excavations up to 4 m depth, it is recommend that side slopes be cut back to a minimum of 1 horizontal to 1 vertical (1H:1V). If seepage zones or sandy/silty soils are encountered, flatter side slopes up to 3H:1V may be required. For excavations deeper than 4 m, flatter side slopes or temporary excavation support might be required.

Surface grading should be undertaken so that surface water is not allowed to pond adjacent to trenches. In addition, the degree of stability of a steeply excavated trench wall decreases with time and, therefore, construction should be directed at minimizing the length of time trenches are left open.

Stockpiles of materials and excavated soil should be placed away from the crest of trench slopes by a distance equal to at least half the depth of the excavation. Similarly, wheel loads should be kept back at least 1 m from the crests of excavations. Larger setback distances should be established for heavy trucks such as those hauling soil or concrete. Greater setbacks

are recommended for excavations that remain open for extended periods of time. Monitoring and maintenance of the slope should be carried out on a regular basis.

Installation of underground services and utilities requires an observational approach be adopted which should combine local experience, the installation contractor's experience and geotechnical input. It would be desirable for the excavation contractor to be experienced in similar conditions, and/or alternatively to excavate test pits in advance of construction to familiarize field personnel with subsurface conditions. Quality workmanship is essential.

The latest edition of the Construction Safety Regulations of the Occupational Health and Safety Act of Alberta should be followed.

In the event of significant groundwater seepage or wet base conditions, a free draining gravel layer (draining to a sump equipped with a pump) should be placed across the trench base. This layer of gravel is intended to form a stable working base, and the thickness required will be based on keeping groundwater below the working surface.

5.5.2. Pipe Bedding

Minor deflections of the trench bedding are expected. Underground utility pipes should be of a type which will maintain watertight joints (i.e. rubber gasket) after minor shifting has occurred.

Bedding requirements are a function of the class of pipe and trench configuration, as well as site specific geotechnical considerations. In general, granular pipe bedding should be relatively well graded sand or sand/gravel mixture which can be readily compacted around the pipe to achieve high frictional strength. Bedding granular materials must have an appropriate gradation so that migration of natural soils into the granular system is restricted. Uniform gravels or gap-graded sands and gravels should not be used as bedding materials unless adequate provision is made to surround such soils with a geotextile filter.

5.5.3. Trench Backfill

Fill materials and placement techniques used to bring the site to grade after excavation should conform to recommendations given in Section 5.2 under "Site Preparation". The native clay till is considered acceptable for use as trench backfill material. The use of the native sand is not recommended due to the difficulty in compacting these soils. However, if the sand is to be used, close control of soil moisture will be required to achieve specified compaction.

Trench backfill should be uniformly compacted to a minimum of 95 percent of the SPMDD to within 1.5 m of the finished ground surface and to a minimum 98 percent of the SPMDD from 1.5 m below ground surface to grade. Compaction testing and inspection of backfill placement is recommended to monitor the quality of workmanship during placement.

It should be recognized that some settlement of the compacted backfill in trenches under self-weight will occur. The magnitude and rate of settlement will be dependent on the backfill soil

type, the moisture condition of the backfill at the time of placement, the depth of the service trench, drainage conditions and the initial density achieved during compaction. Generally, total settlement of 1 - 3 percent of fill thickness is expected for soils compacted to between 98 and 95 percent of the SPMDD. Wetter backfill compacted to reduced density standards may be subject to greater settlements, particularly in the event of long term downward groundwater changes.

Clay materials with variable moisture contents compacted as trench backfill would not be expected to provide uniform roadway subgrades for the support of pavement sections. Design considerations required for roadway subgrade construction are discussed in the following section of this report.

5.6. SUBSURFACE CONCRETE

Laboratory tests performed on soil samples from the site indicate negligible water soluble sulphate concentrations. The potential for attack on subsurface concrete at the site is considered to be low. Therefore normal (Type 10) Portland cement may be used in the manufacture of subsurface concrete in contact with soil at the site. Should any fine-grained materials be imported to the site for use as backfill, it should be tested for potential chemical attack on concrete. All concrete exposed to a freezing environment either during or after construction should be air entrained.

5.7. ROADWAY CONSTRUCTION

5.7.1. Roadway Subgrade

All existing organic topsoil should be removed down to the native soils within the proposed traffic areas. The exposed roadway subgrade surface should be proof-rolled to identify soft and/or weak areas. The soft areas should be subcut and replaced with suitable fill material compacted to 95 percent of SPMDD. The depth of excavation should be sufficient to remove the soft material or to bridge over the soft spots to give proper support to traffic loads. Fill materials and placement techniques used to bring to the design grade after excavation should conform to recommendations given in Section 5.2 under "Site Preparation".

5.7.2. Pavement Design Parameters

Two flexible pavement designs are proposed for this subdivision, a moderate traffic section for the local industrial streets, and a heavy traffic section for the industrial collectors. The assumed Design Traffic (80 kN axles) is 8 x 10^5 Equivalent Axle Loads (EAL's) for the industrial local roads and 2 X 10^6 EAL's for the collectors over a design period of 20 years.

The soaked CBR value for the clay till and/or sand subgrade at the site is estimated be 2 to 4, which is representative of the subgrade soils in a weakened condition during the period of spring thaw. The proposed pavement design assumes that soft areas in the subgrade have been improved as described in Section 5.5.

Based on the preceding assumptions the following flexible pavement sections are proposed:

TABLE 3 FLEXIBLE PAVEMENT DESIGN

	Local Roads (Moderate Traffic)	Collector Roads (Heavy Traffic)
Asphalt Concrete	75 mm	150 mm
Crushed Granular Base (20 mm minus)	50 mm	100 mm
80 mm minus Subbase Course	300 mm	300 mm

The performance of the proposed pavement design sections will be, in large part, dependent on achieving a stable subgrade with adequate drainage. Drainage grades should be provided at the subgrade level (e.g. crowning), and provision should be made for seepage from subbase and base gravel to drain into catch basins or storm manholes. The design pavement structures outlined above are based on having a subgrade that provides a stable surface with a minimum of deflection under construction traffic. If subgrade deflections or rutting, is occurring during preparation of the subgrade, it will be necessary to rework and dry the upper 0.3 m of the subgrade, to increase the thickness of the subbase gravel or to provide other means of stabilizing the pavement structure at the subgrade level.

The recommended levels of compaction for the granular materials in the pavement section should be a minimum of 95 percent SPMDD for sub-base course gravel, and 100 percent of SPMDD for base course gravel. The asphalt concrete should be compacted to a minimum of 97 percent of Marshall density based on a 75 blow laboratory Marshall test.

5.7.3. Pavement Materials

It is recommended to use asphalt pavement materials conforming to the following specifications.

TABLE 4: ASPHALT CONCRETE SPECIFICATION	
Stability	5.4 kN (minimum)
Flow	2 - 4 mm
Air Voids	3 - 5 percent
VMA	14.5 percent (minimum)
Asphalt Cement (penetration grade)	150 - 200 (A)

Aggregate materials should be composed of sound, hard, durable particles free from organics and foreign material. It is recommended that aggregate materials conform to the following Alberta Transportation (AT) specifications:

- Asphalt Gravel — Designation 1, Class 16
- Crushed Base Course — Designation 2, Class 20 or Designation 2, Class 25
- Subbase Gravel — Designation 6, Class 80

The applicable sections of the AT aggregate specifications, are provided in Appendix C. Based on availability of local materials at the time of the tendering or construction, alternate materials could be considered upon review by the geotechnical engineer.

5.7.4. Surface Grades

The road surface should be sloped and graded to effectively remove all surface water as rapidly as possible. To minimize the occurrence of surface water ponding in the roadways, finished surface grades and cross slopes in the order of two percent are recommended. Allowing water to pond on the pavement surface will lead to infiltration of water into the subgrade which could result in weakening of the subgrade soils, and also encourage the formation of potholes during spring thaw. It is recommended that drainage also be provided at the subgrade level by crowning the subgrade and by providing access for any accumulated water through weepers into catch basins and/or manholes.

5.7.5. Pavements Over Trenches

No special pre-design considerations such as thickening the pavement section over backfilled trenches are required. The settlement of trenches is caused mainly by the long term self weight of the fill, not the short term live loads from traffic. The road section or the thickness of granular subbase placed in the road subgrade should be determined by the level of support expected

from the subgrade, based on field observations. To minimize distress to pavement structures, trench backfill should be placed as discussed in Section 5.5 "Buried Service Installation".

To minimize the effects of potential settlements on completed roadway surfaces, it is recommended that staged asphalt pavement construction be adopted and that placement of final asphalt concrete surfacing materials be delayed as long as possible subsequent to completion of trench backfilling.

5.8. INSPECTION

All engineering design recommendations presented herein are based on the assumption that a qualified contractor will be retained to carry out the work and that adequate monitoring will be provided by geotechnical personnel during construction. It is recommended that inspections of fill or backfill placement be conducted on a full-time basis by a qualified geotechnical technologist, and include field density testing. Foundation bearing surfaces should be reviewed by a geotechnical engineer prior to the installation of footings.

6.0 CLOSURE

This report is based on the findings at 28 borehole locations. Should different subsoil or groundwater conditions be encountered during construction, AMEC must be notified and recommendations submitted herein will be reviewed and revised as required.

Soil conditions, by their nature, can be highly variable across a site. A contingency amount should be included in construction budgets to allow for the possibility of variations in soil conditions that may result in modification of the design and/or changes to construction procedures.

This report has been prepared for the exclusive use of 489786 Alberta Limited and their agents for specified application of this project. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

Respectfully submitted,

AMEC Earth & Environmental

PROFESSIONAL ENGINEER ALBERTA
JAY JABER
14 June 05

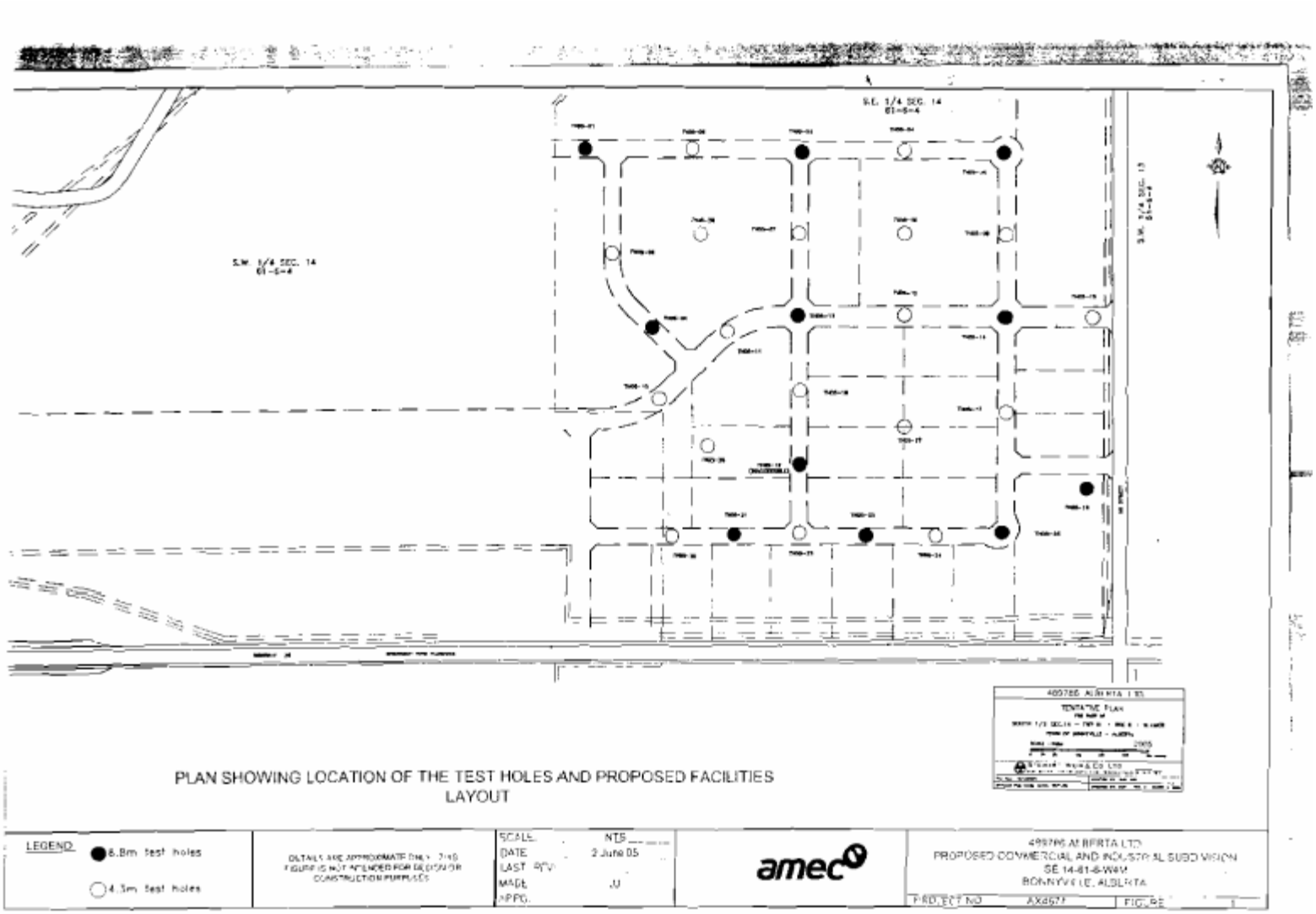
PERMIT TO PRACTICE
AMEC Earth & Environmental
a Division of AMEC Americas Limited
Signature
Date 14 June 05
PERMIT NUMBER: P-04546
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Jay Jaber, M.Sc., P.Eng.
Geotechnical Engineer
Manager, Lloydminster/Bonnyville Offices

Reviewed by:

Kevin Spencer, M.Eng., P.Eng.
Senior Geotechnical Engineer

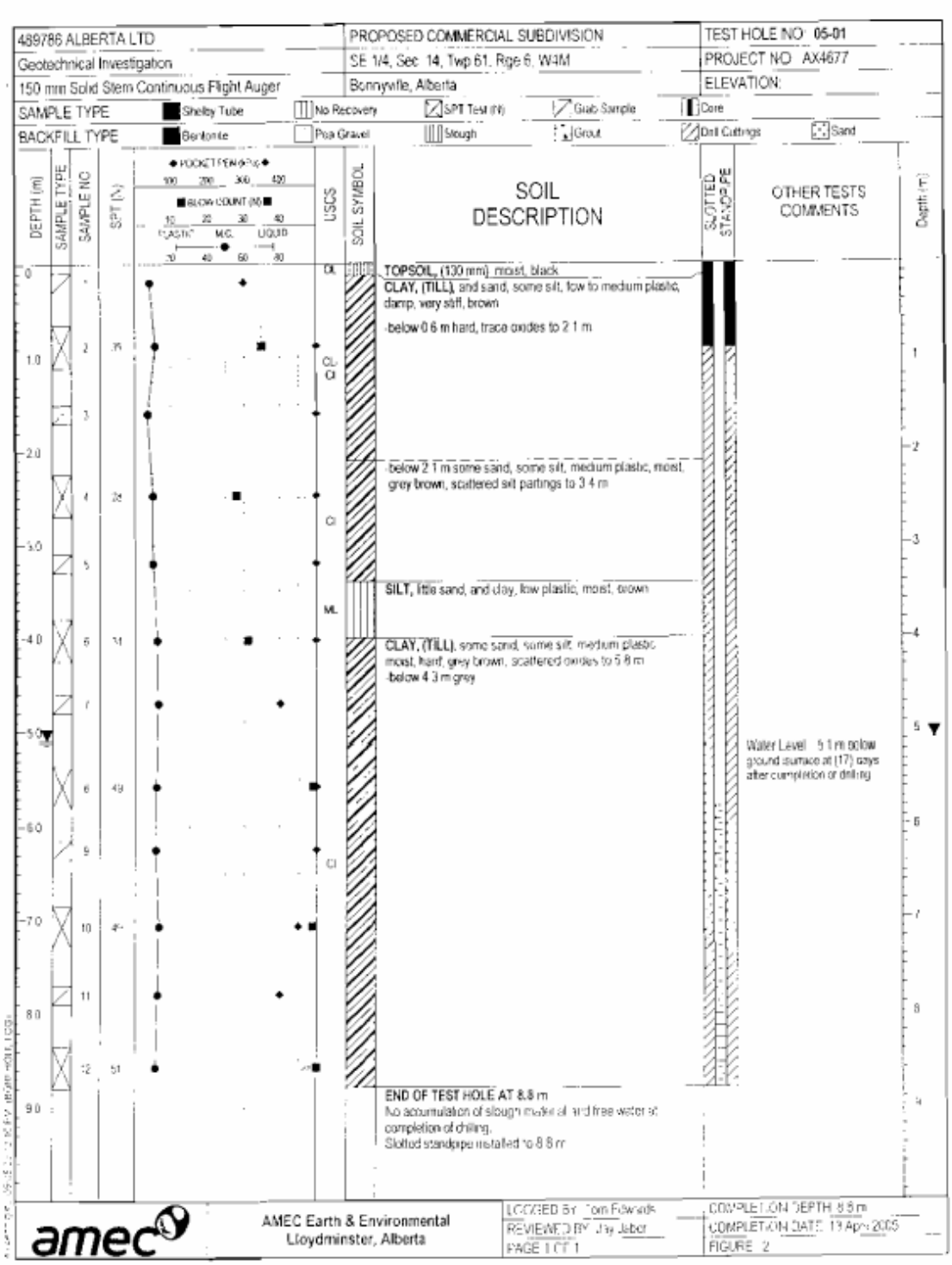
#8242 Bylaw 1277-05

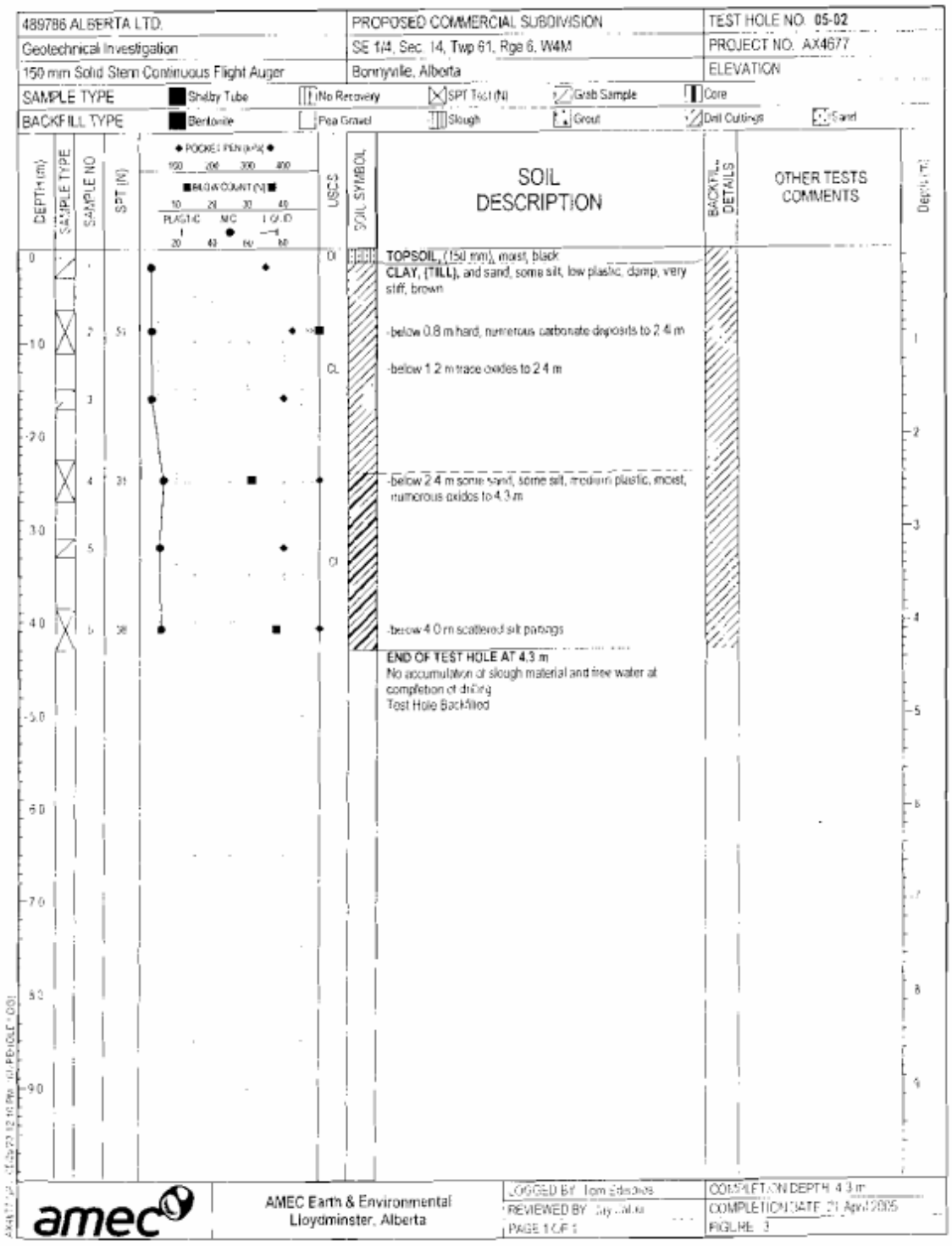


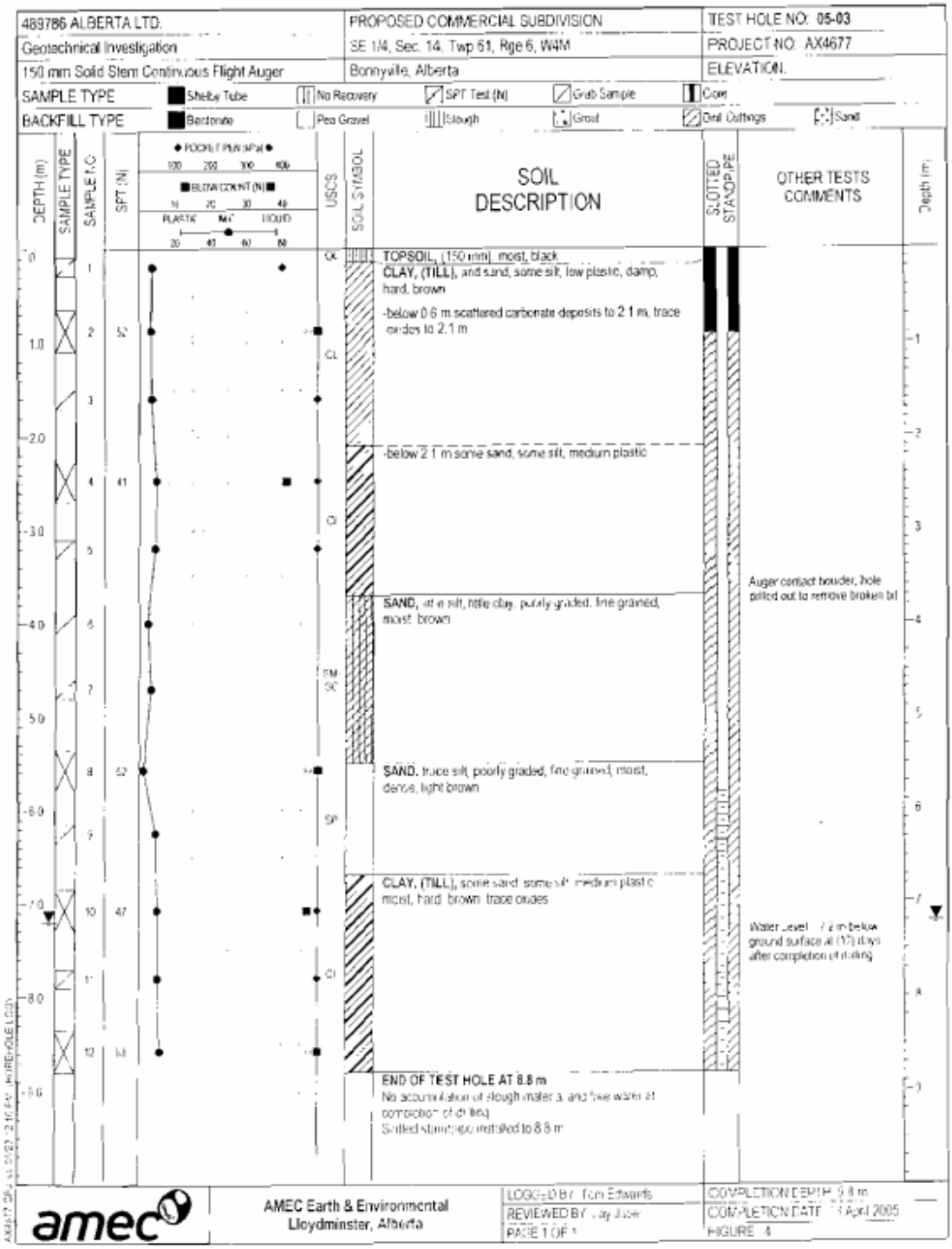
PLAN SHOWING LOCATION OF THE TEST HOLES AND PROPOSED FACILITIES LAYOUT

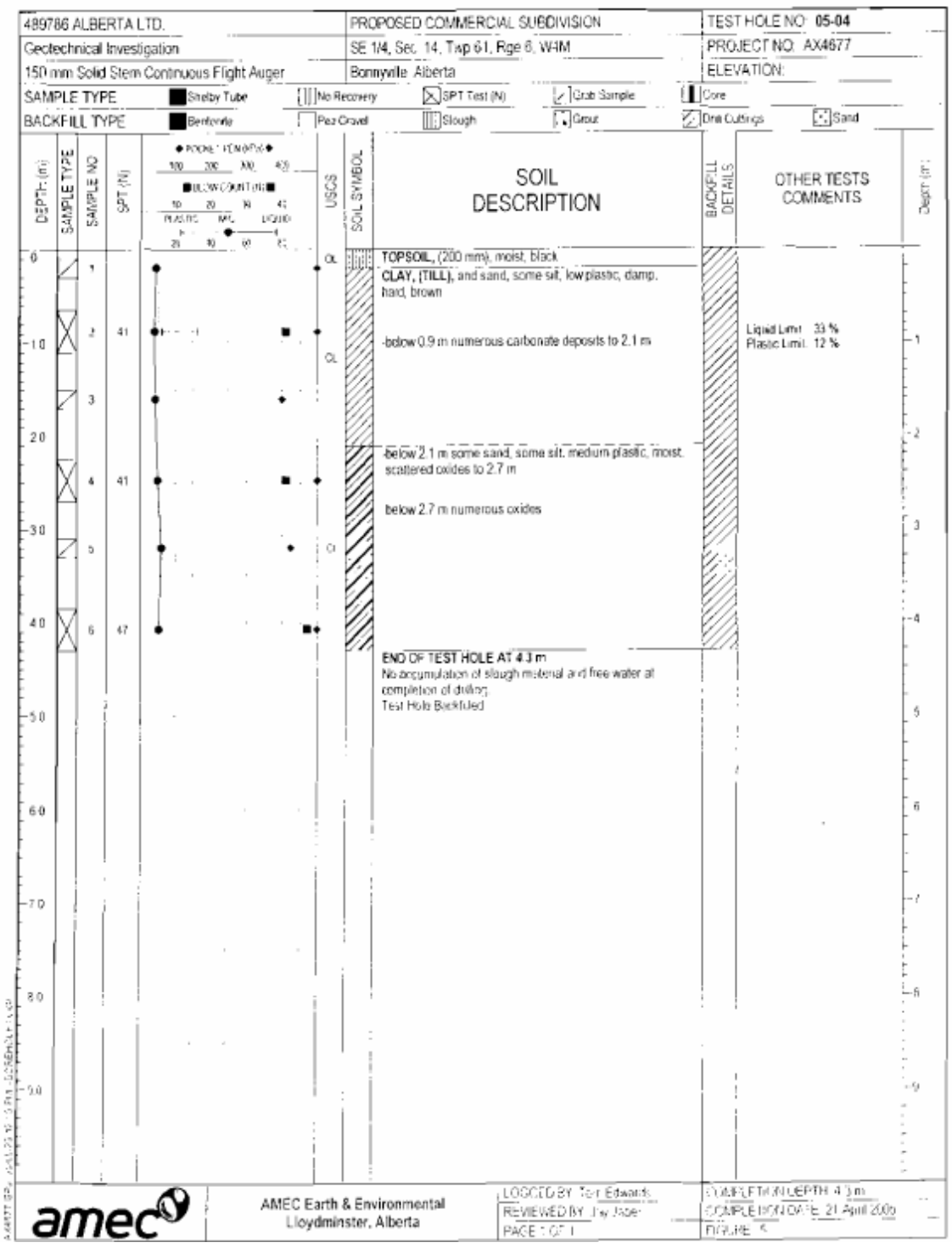
APPENDIX A

Figure 1: Borehole Locations
Borehole Logs


489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO 05-01
PROJECT NO AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (130 mm), moist, black
CLAY, (TILL), and sand, some silt, low to medium plastic, damp, very stiff, brown
below 0.6 m hard, trace oxides to 2.1 m
below 2.1 m some sand, some silt, medium plastic, moist, grey brown, scattered silt partings to 3.4 m
SILT, trace sand, and clay, low plastic, moist, brown
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, grey brown, scattered oxides to 5.8 m
below 4.3 m grey
Water Level 5.1 m below ground surface at (17) days after completion of drilling
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling.
Slotted standpipe installed to 8.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Fawcett
REVIEWED BY Jay Jabs
PAGE 1 OF 1
COMPLETION DEPTH 8.8 m
COMPLETION DATE 19 Apr 2005
FIGURE 2


489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO. 05-02
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO. AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M/C
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (ft)
TOPSOIL, (150 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, very stiff, brown
-below 0.8 m hard, numerous carbonate deposits to 2.4 m
-below 1.2 m trace oxides to 2.4 m
-below 2.4 m some sand, some silt, medium plastic, moist, numerous oxides to 4.3 m
-below 4.0 m scattered silt pockets
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 Apr/2005
FIGURE 3


489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 51, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-03
PROJECT NO: AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (150 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown
-below 0.6 m scattered carbonate deposits to 2.1 m, trace oxides to 2.1 m
-below 2.1 m some sand, some silt, medium plastic
SAND, some silt, little clay, poorly graded, fine grained, moist, brown
Auger contact boulder, hole pulled out to remove broken bit
SAND, trace silt, poorly graded, fine grained, moist, dense, light brown
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, brown, trace oxides
Water Level 7.2 m below ground surface at (17) days after completion of drilling
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling
Slotted standpipe installed to 8.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jose
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 14 April 2005
FIGURE 4


489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-04
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
TOPSOIL, (200 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown
-below 0.9 m numerous carbonate deposits to 2.1 m
Liquid Limit 33 %
Plastic Limit 12 %
-below 2.1 m some sand, some silt, medium plastic, moist, scattered oxides to 2.7 m
below 2.7 m numerous oxides
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
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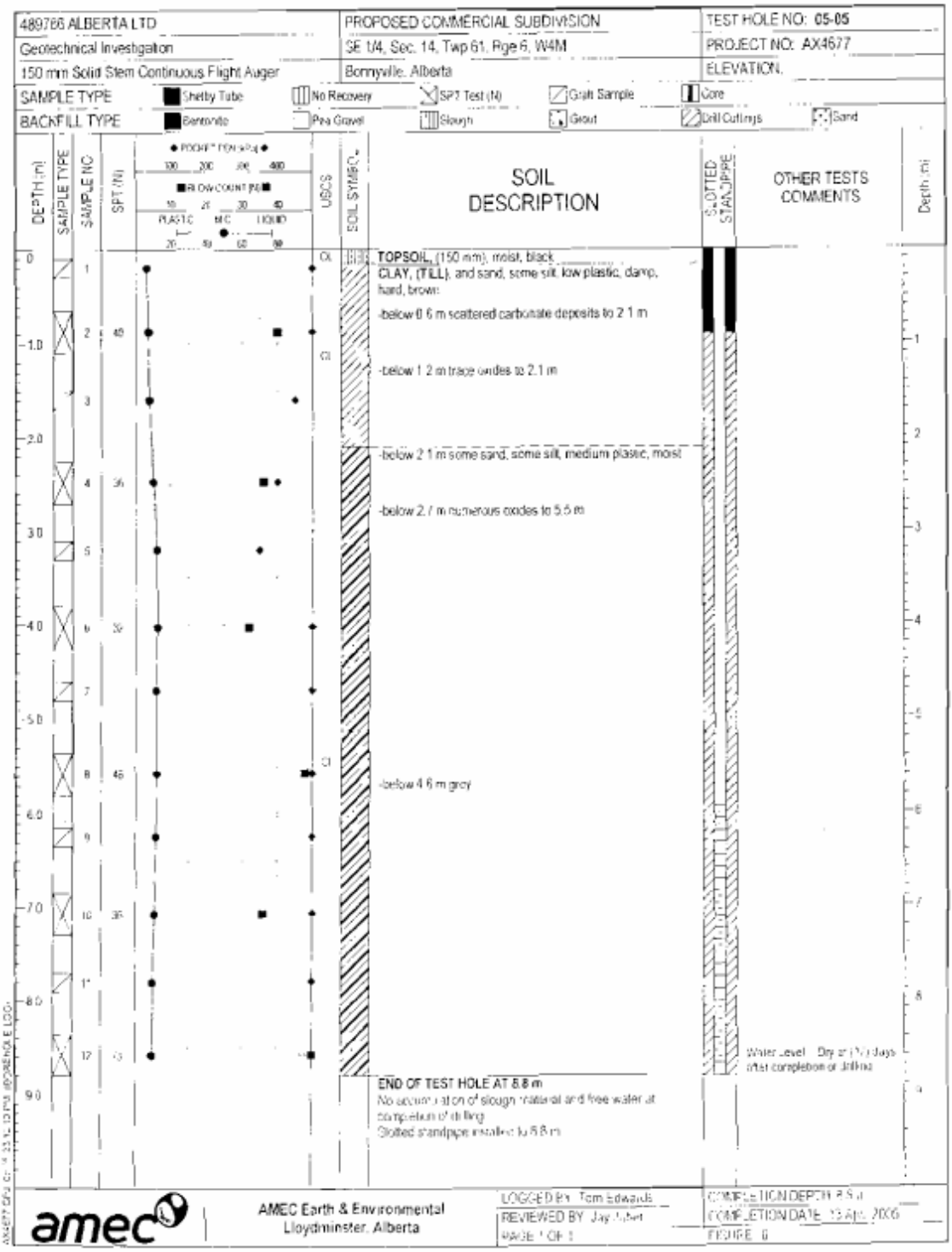
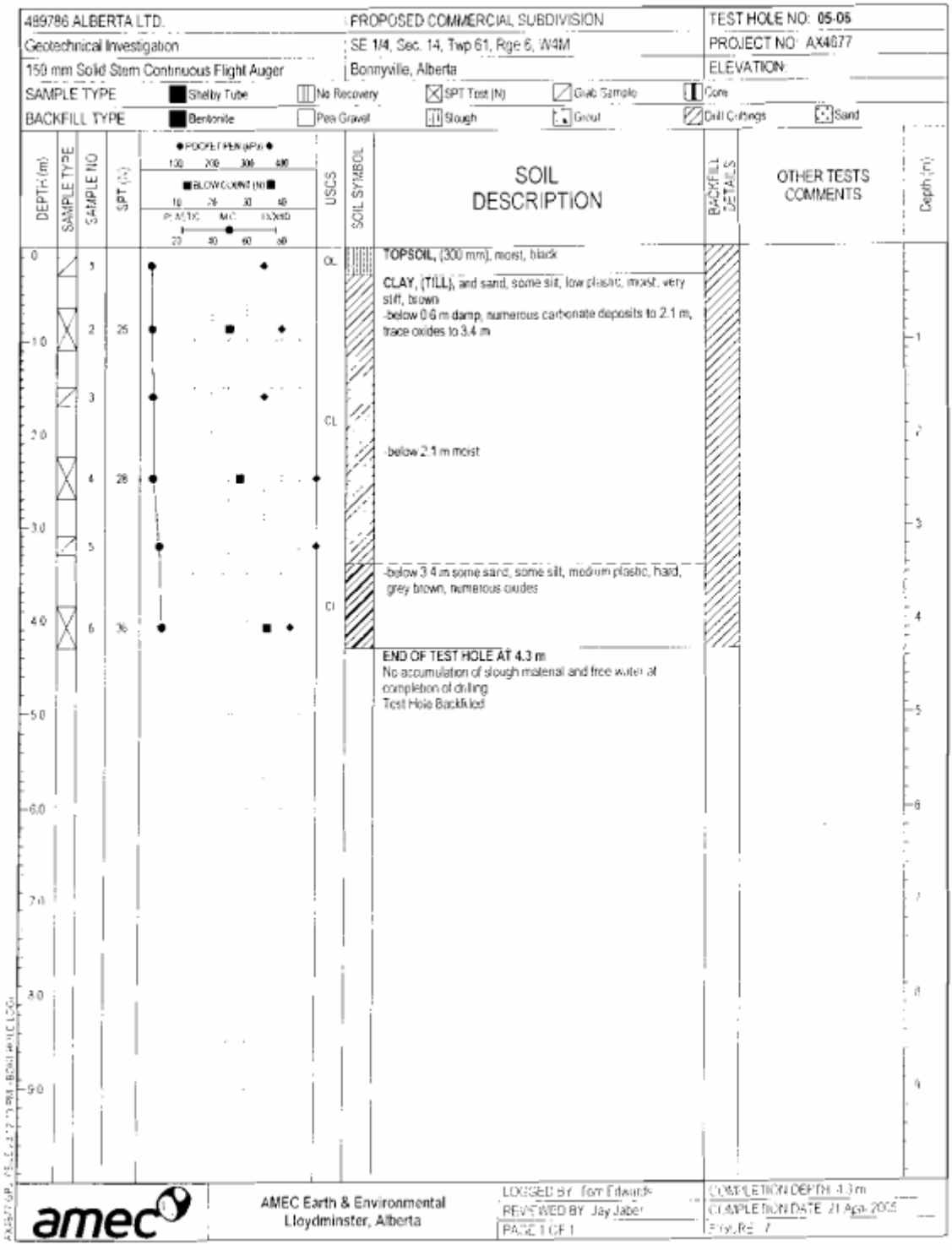
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tori Edwards
REVIEWED BY: Jay Jade
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2009
DRILLER:


489766 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-05
PROJECT NO: AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (150 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown
-below 0.6 m scattered carbonate deposits to 2.1 m
-below 1.2 m trace oxides to 2.1 m
-below 2.1 m some sand, some silt, medium plastic, moist
-below 2.7 m numerous oxides to 5.5 m
-below 4.6 m grey
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling
Slotted standpipe installed to 8.8 m
Water Level: Dry at (?) days after completion of drilling
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Gilbert
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 19 Apr. 2005
FIGURE 6


489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-05
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (300 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, moist, very stiff, brown
-below 0.6 m damp, numerous carbonate deposits to 2.1 m, trace oxides to 3.4 m
-below 2.1 m moist
-below 3.4 m some sand, some silt, medium plastic, hard, grey brown, numerous oxides
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
CL
CI
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 Apr 2005
FIGURE 7

489786 ALBERTA LTD.	PROPOSED COMMERCIAL SUBDIVISION	TEST HOLE NO: 05-07
Geotechnical Investigation	SE 1/4, Sec. 14, Twp 61, Rge 6, W4M	PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger	Bonnyville, Alberta	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

Columns: DEPTH (m) | SAMPLE TYPE | SAMPLE NO | SPT (N) | ◆ POCKET PEN (kPa) ◆ 100 200 300 400; ■ BLOW COUNT (N) ■ 10 20 30 40; PLASTIC M.C. LIQUID 20 40 60 80 | USCS | SOIL SYMBOL | SOIL DESCRIPTION | BACKFILL DETAILS | OTHER TESTS COMMENTS | Depth (m)

Sample No	SPT (N)
1	
2	23
3	
4	30/150
5	
6	25

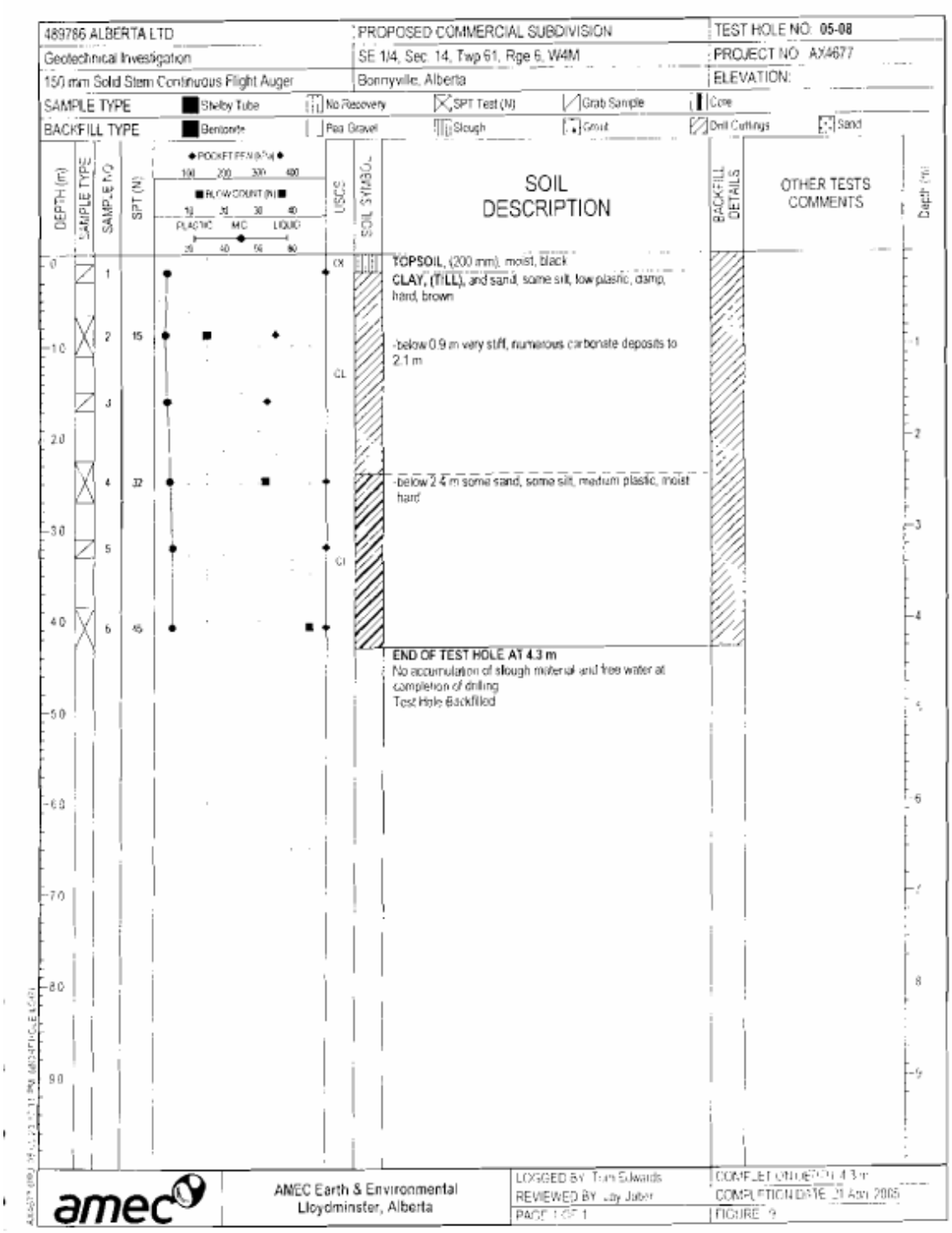
USCS	SOIL DESCRIPTION	OTHER TESTS COMMENTS
SL	**TOPSOIL**, (300 mm), moist, black	
CL	**CLAY, (TILL)**, and sand, some silt, low plastic, damp, very stiff, brown -below 0.8 m numerous carbonate deposits to 2.4 m, trace oxides to 2.4 m	
SP	**SAND**, trace silt, trace clay, poorly graded, fine grained, moist, dense, light brown	SPT contact rock Grain Size Distribution: Gravel 0 %, Sand 88 %, Silt/Clay 12 %
CI	**CLAY, (TILL)**, some sand, some silt, medium plastic, moist, stiff, brown	
	END OF TEST HOLE AT 4.3 m No accumulation of slough material and free water at completion of drilling Test Hole Backfilled	

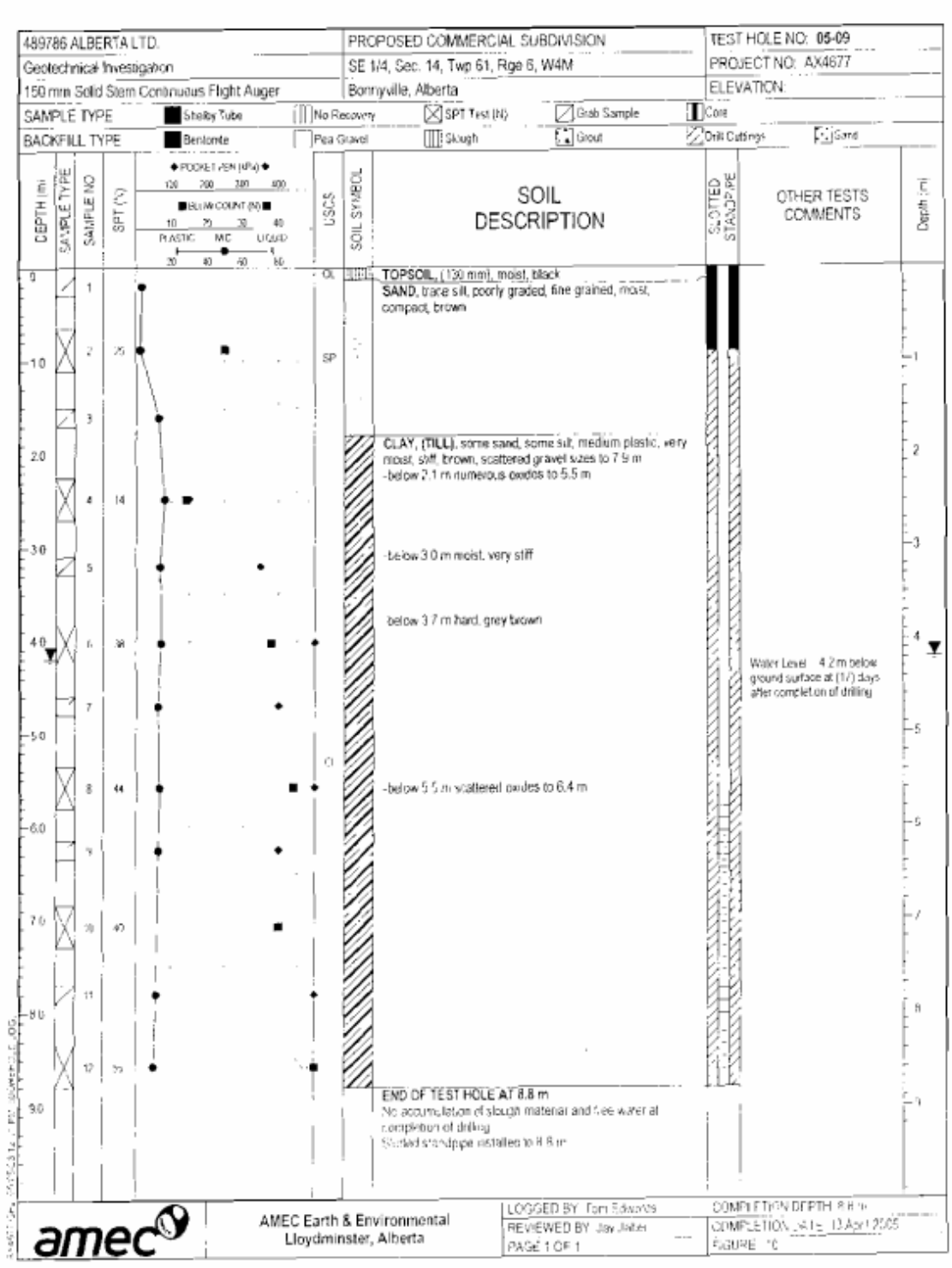
AX4677.GPJ [illegible] (BOREHOLE LOG)

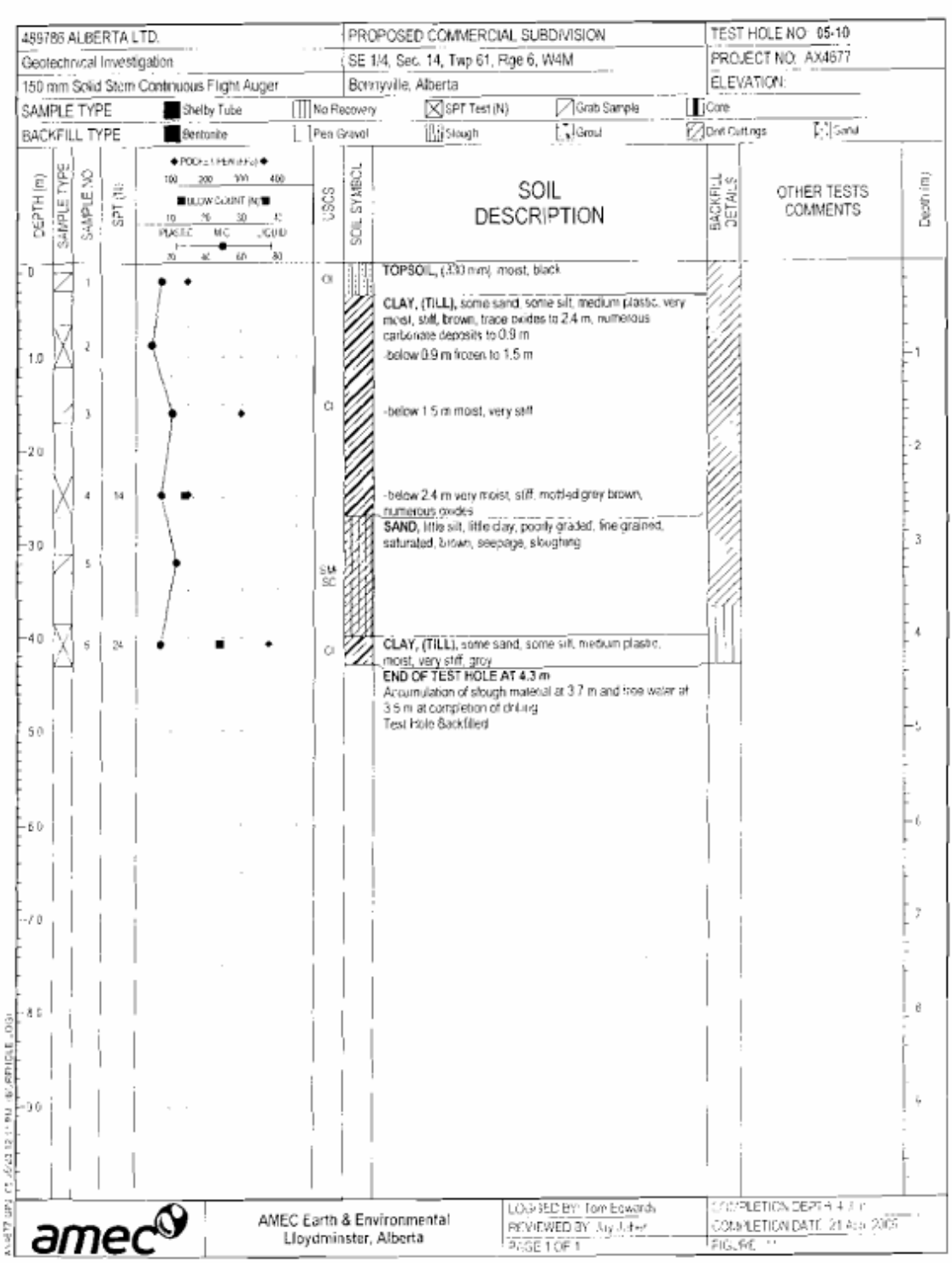
amec

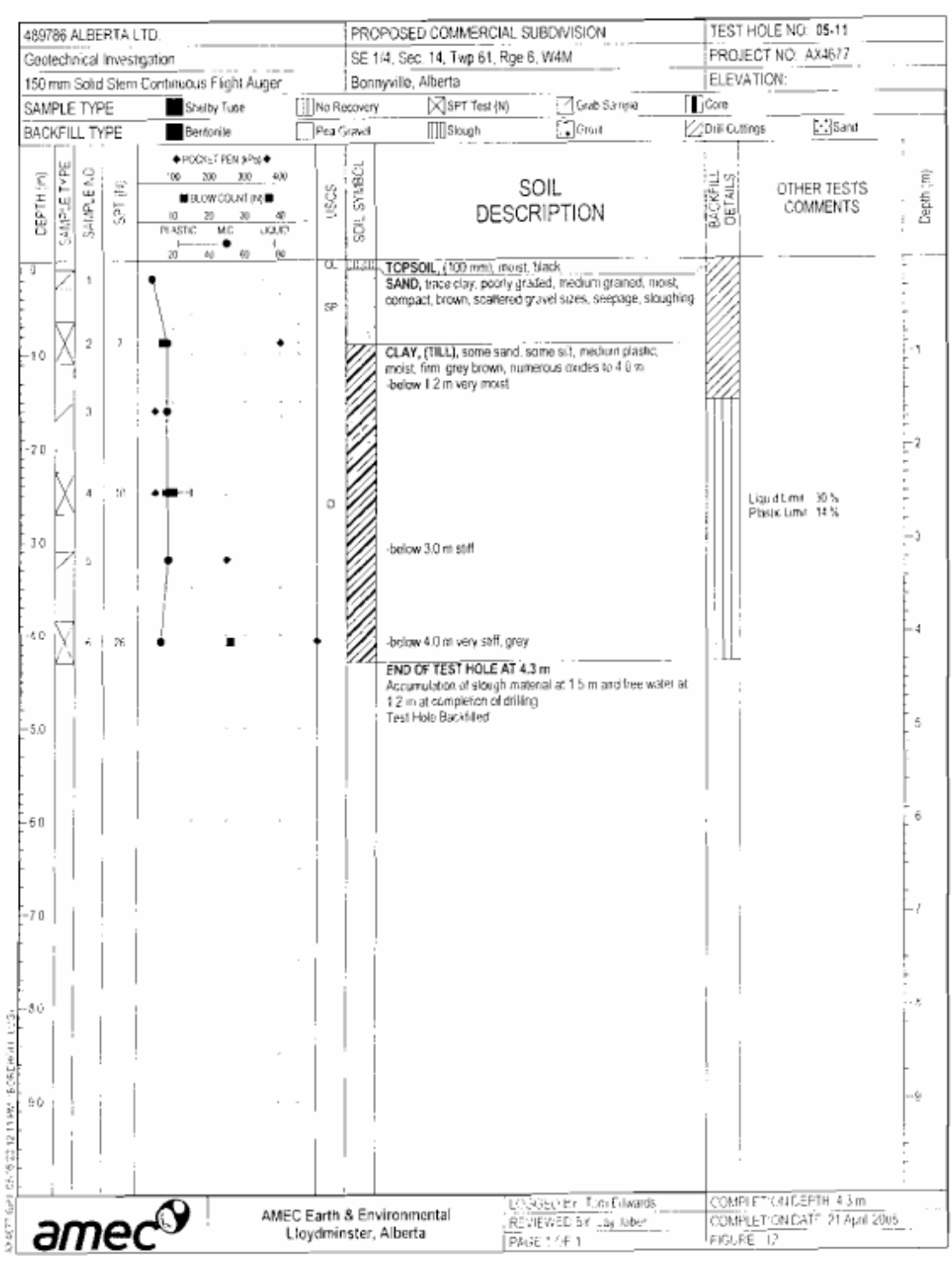
AMEC Earth & Environmental
Lloydminster, Alberta

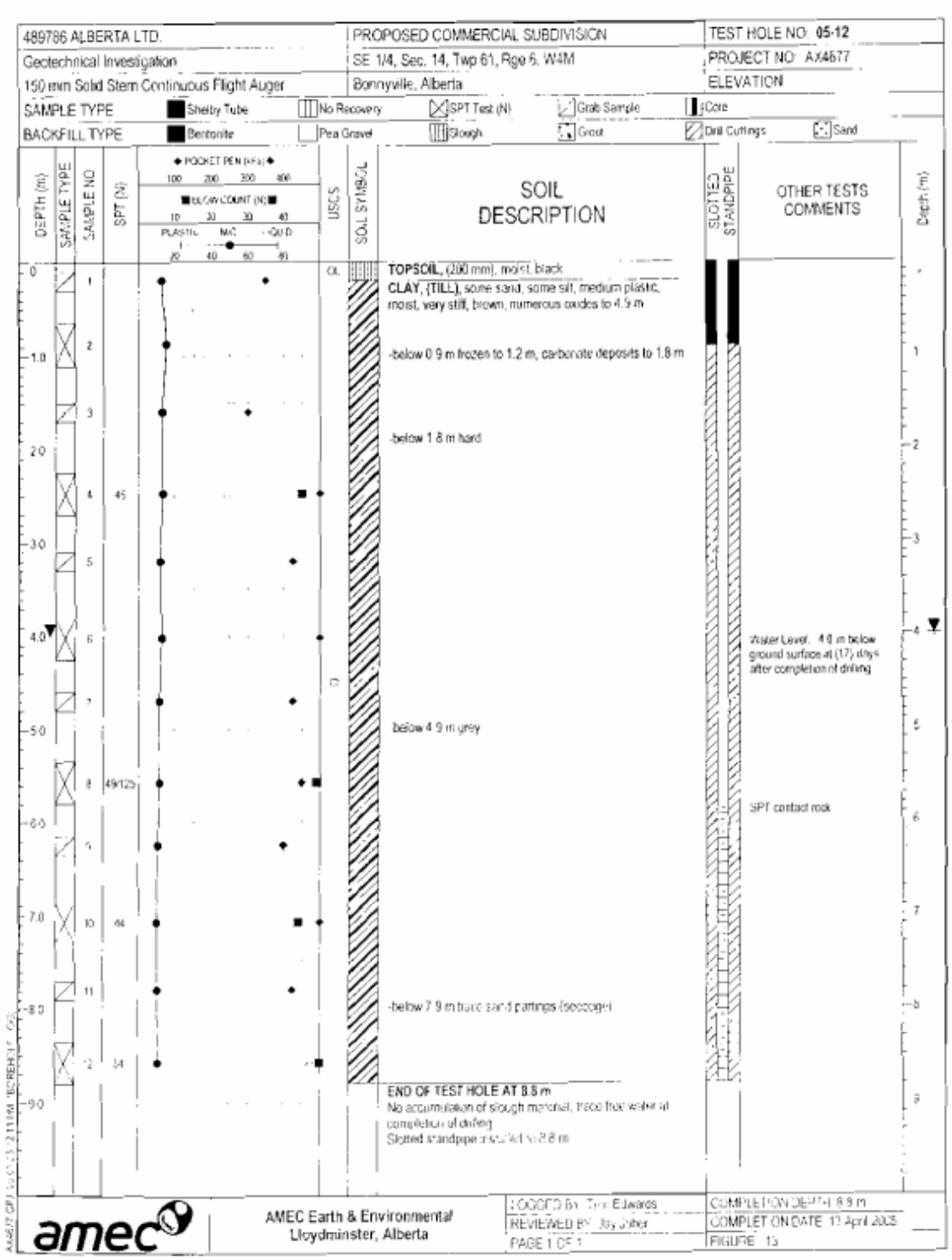
LOGGED BY: Tom Edwards	COMPLETION DEPTH: 4.3 m
REVIEWED BY: Jay [illegible]	COMPLETION DATE: 21 [illegible]
PAGE 1 OF 1	FIGURE: 8

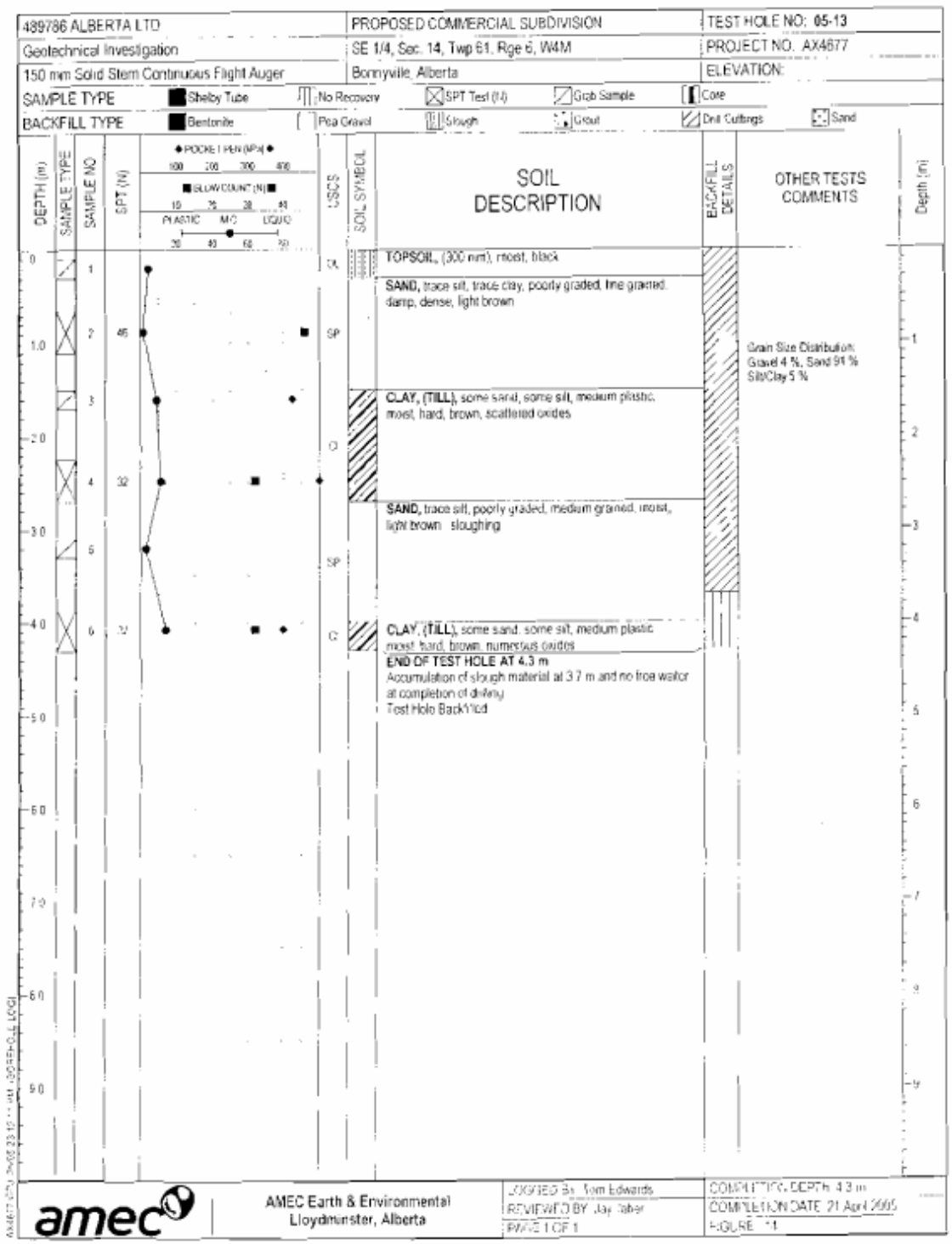

489786 ALBERTA LTD
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-08
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
MC
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
TOPSOIL, (200 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown
-below 0.9 m very stiff, numerous carbonate deposits to 2.1 m
-below 2.4 m some sand, some silt, medium plastic, moist hard
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY Jay Jubin
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 28 Apr 2005
FIGURE 9

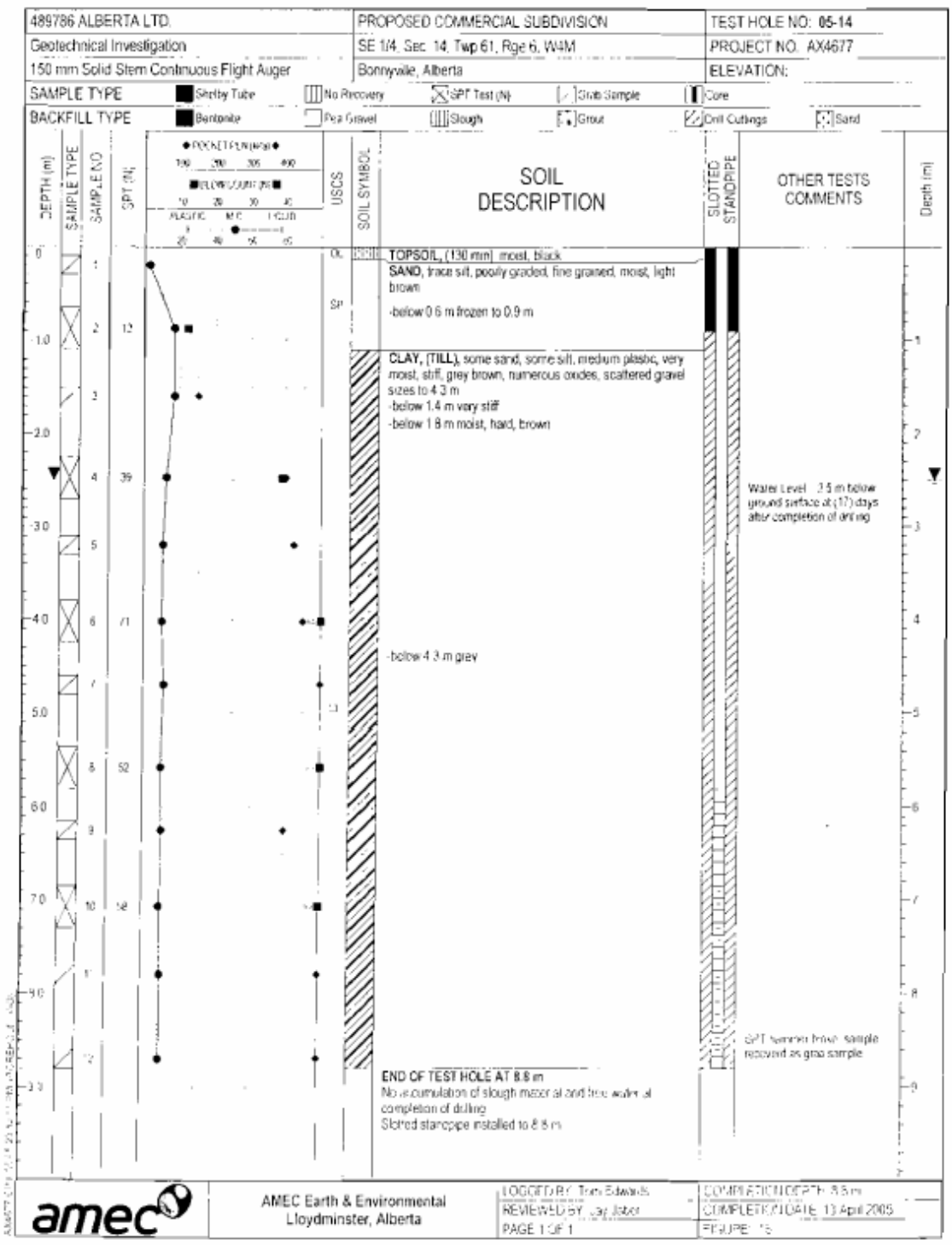

489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-09
PROJECT NO: AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
MC
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (130 mm), moist, black
SAND, trace silt, poorly graded, fine grained, moist, compact, brown
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, scattered gravel sizes to 7.9 m
-below 2.1 m numerous oxides to 5.5 m
-below 3.0 m moist, very stiff
below 3.7 m hard, grey brown
-below 5.5 m scattered oxides to 6.4 m
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling
Slotted standpipe installed to 8.8 m
Water Level 4.2 m below ground surface at (1/) days after completion of drilling
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jhaveri
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 13 Apr 2005
FIGURE: 10

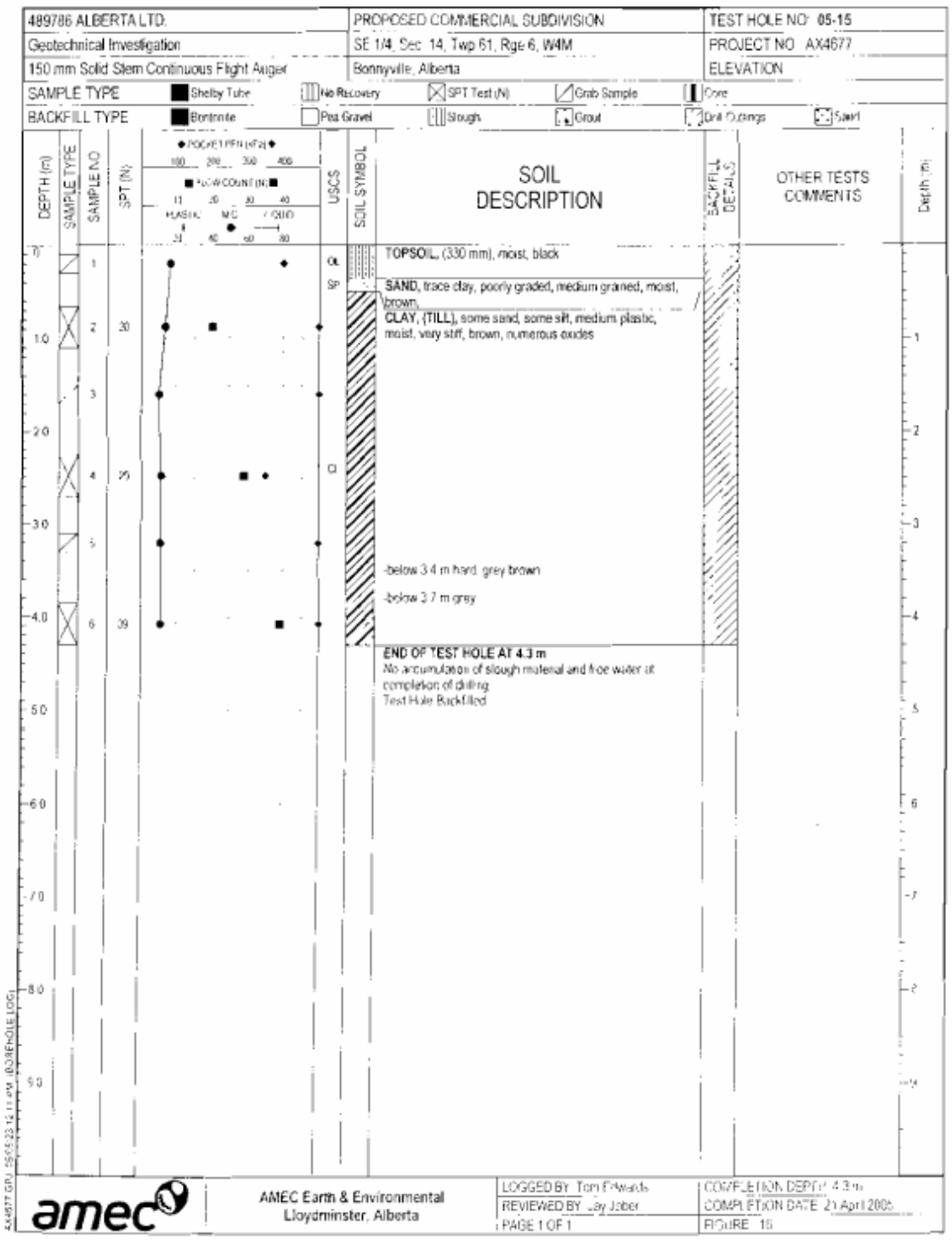

489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO 05-10
PROJECT NO. AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (330 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, trace oxides to 2.4 m, numerous carbonate deposits to 0.9 m
below 0.9 m frozen to 1.5 m
-below 1.5 m moist, very stiff
-below 2.4 m very moist, stiff, mottled grey brown, numerous oxides
SAND, little silt, little clay, poorly graded, fine grained, saturated, brown, seepage, sloughing
CLAY, (TILL), some sand, some silt, medium plastic, moist, very stiff, grey
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 3.7 m and free water at 3.5 m at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Usher
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE: 21 Aug 2005
FIGURE

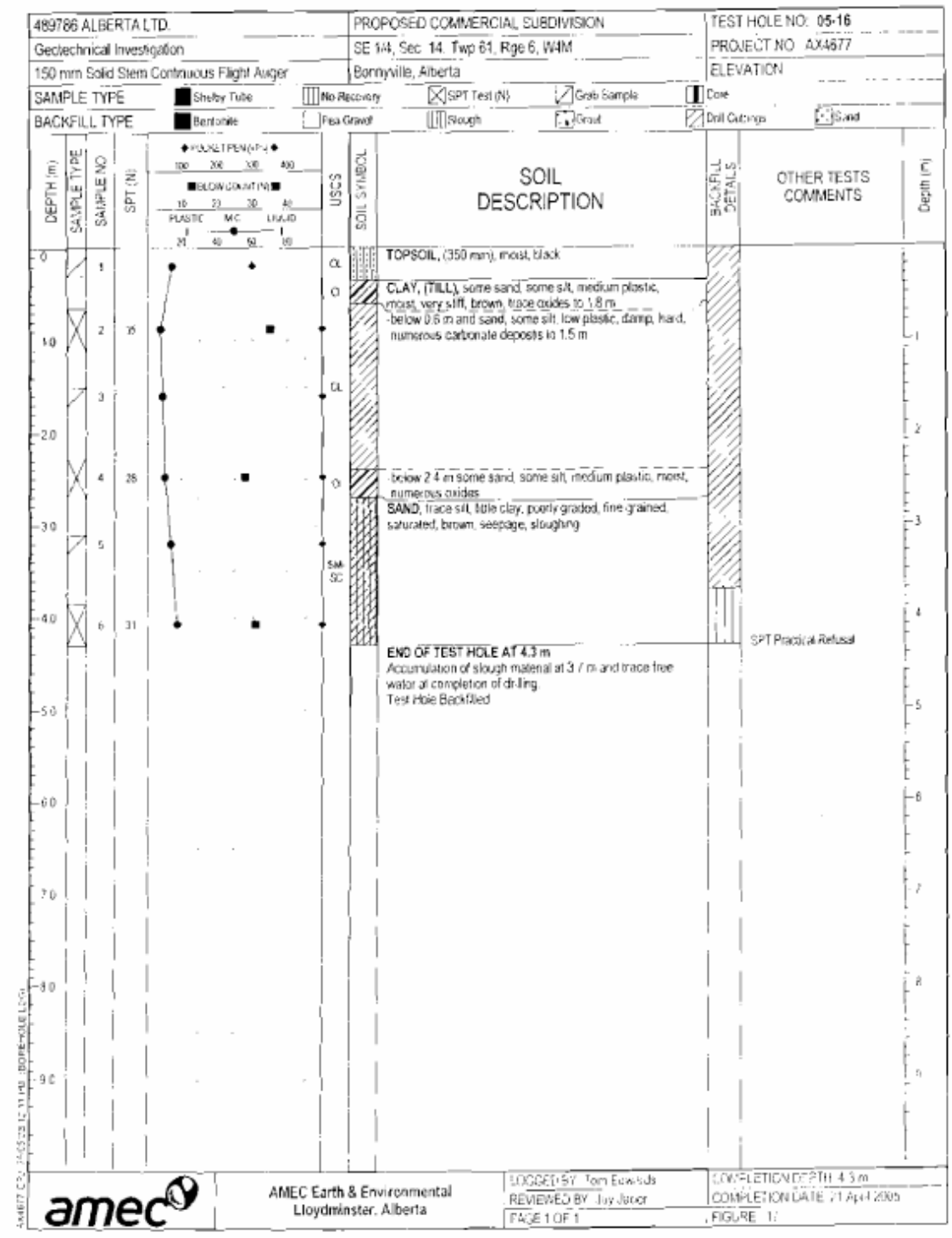

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-11
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO.
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (100 mm), moist, black
SAND, trace clay, poorly graded, medium grained, moist, compact, brown, scattered gravel sizes, seepage, sloughing
CLAY, (TILL), some sand, some silt, medium plastic, moist, firm grey brown, numerous oxides to 4.0 m
-below 1.2 m very moist
Liquid Limit 30 %
Plastic Limit 14 %
-below 3.0 m stiff
-below 4.0 m very stiff, grey
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 1.5 m and free water at 1.2 m at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Isber
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 12

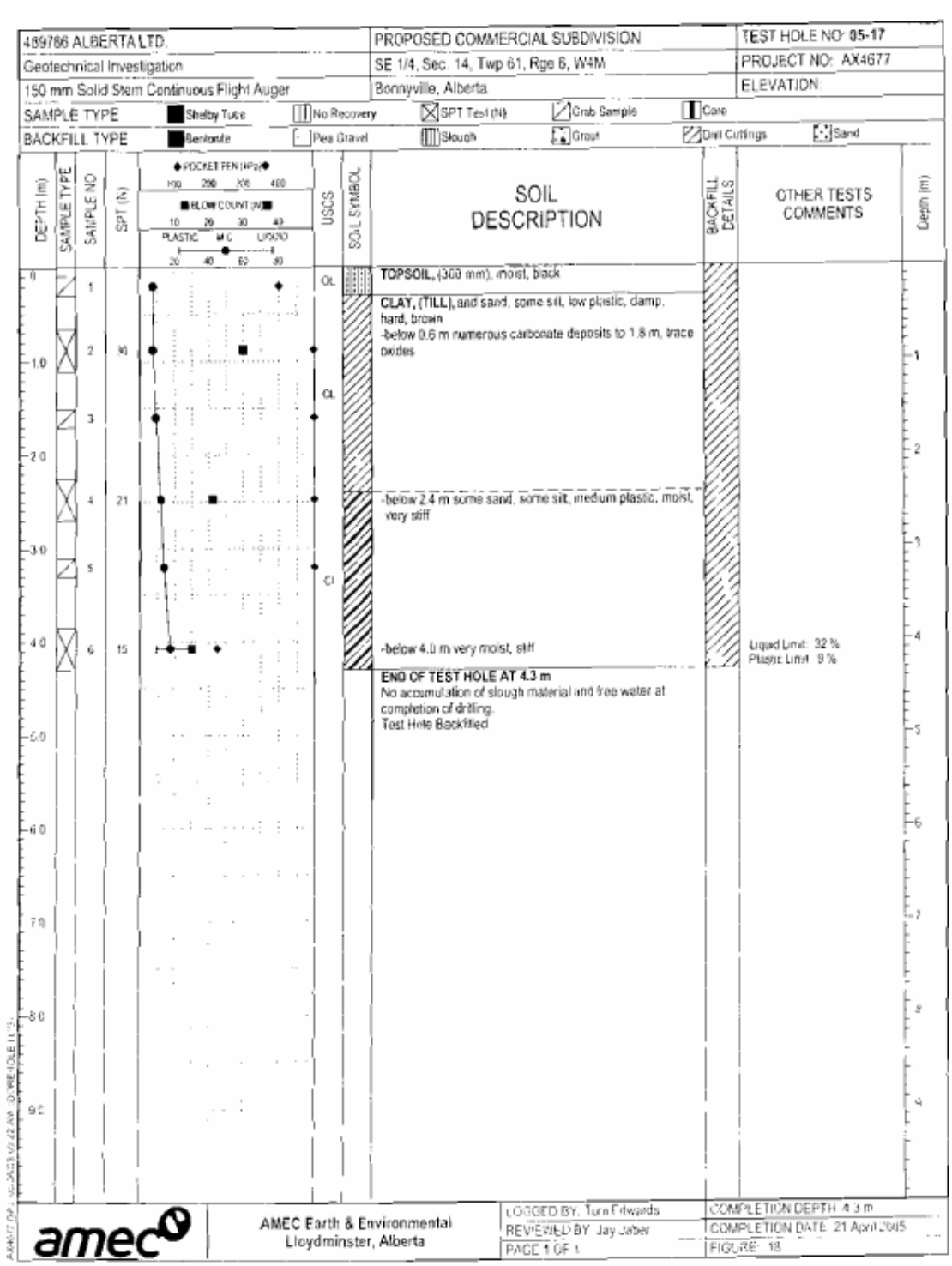

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-12
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO.
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
NAT
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (200 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, moist, very stiff, brown, numerous oxides to 4.9 m
-below 0.9 m frozen to 1.2 m, carbonate deposits to 1.8 m
-below 1.8 m hard
-below 4.9 m grey
49/125
SPT contact rock
Water Level, 4.6 m below ground surface at (17) days after completion of drilling
-below 7.9 m trace sand partings (seepage)
END OF TEST HOLE AT 8.8 m
No accumulation of slough material, free from water at completion of drilling
Slotted standpipe installed to 8.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED By: Tim Edwards
REVIEWED BY: Jay Jolliffe
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 17 April 2005
FIGURE: 15

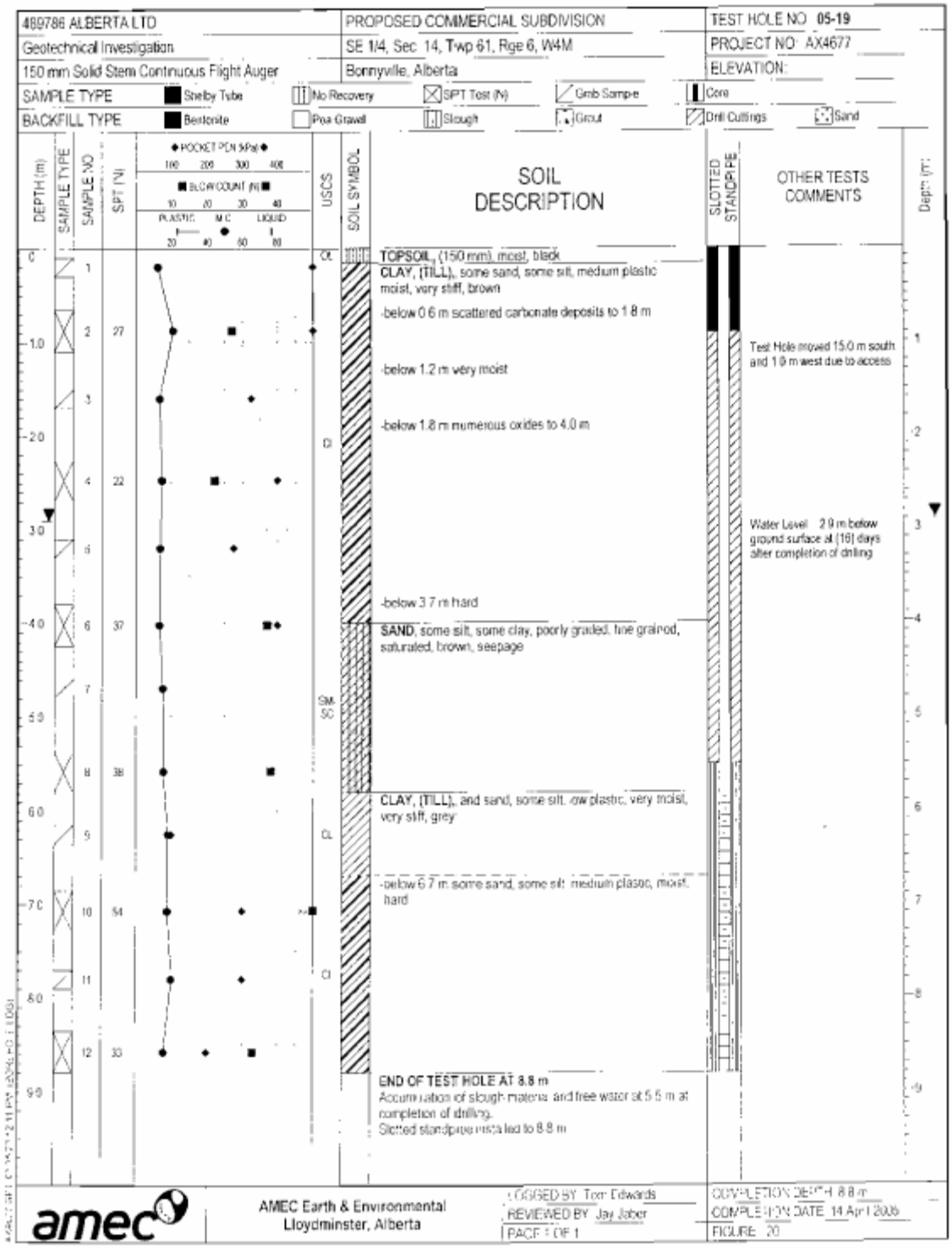

489786 ALBERTA LTD
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-13
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO. AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (300 mm), moist, black
SAND, trace silt, trace clay, poorly graded, fine grained, damp, dense, light brown
SP
Grain Size Distribution: Gravel 4 %, Sand 91 %, Silt/Clay 5 %
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, brown, scattered oxides
CL
SAND, trace silt, poorly graded, medium grained, moist, light brown sloughing
SP
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, brown, numerous oxides
CL
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 3.7 m and no free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED By: Tom Edwards
REVIEWED BY: Jay Taber
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 11

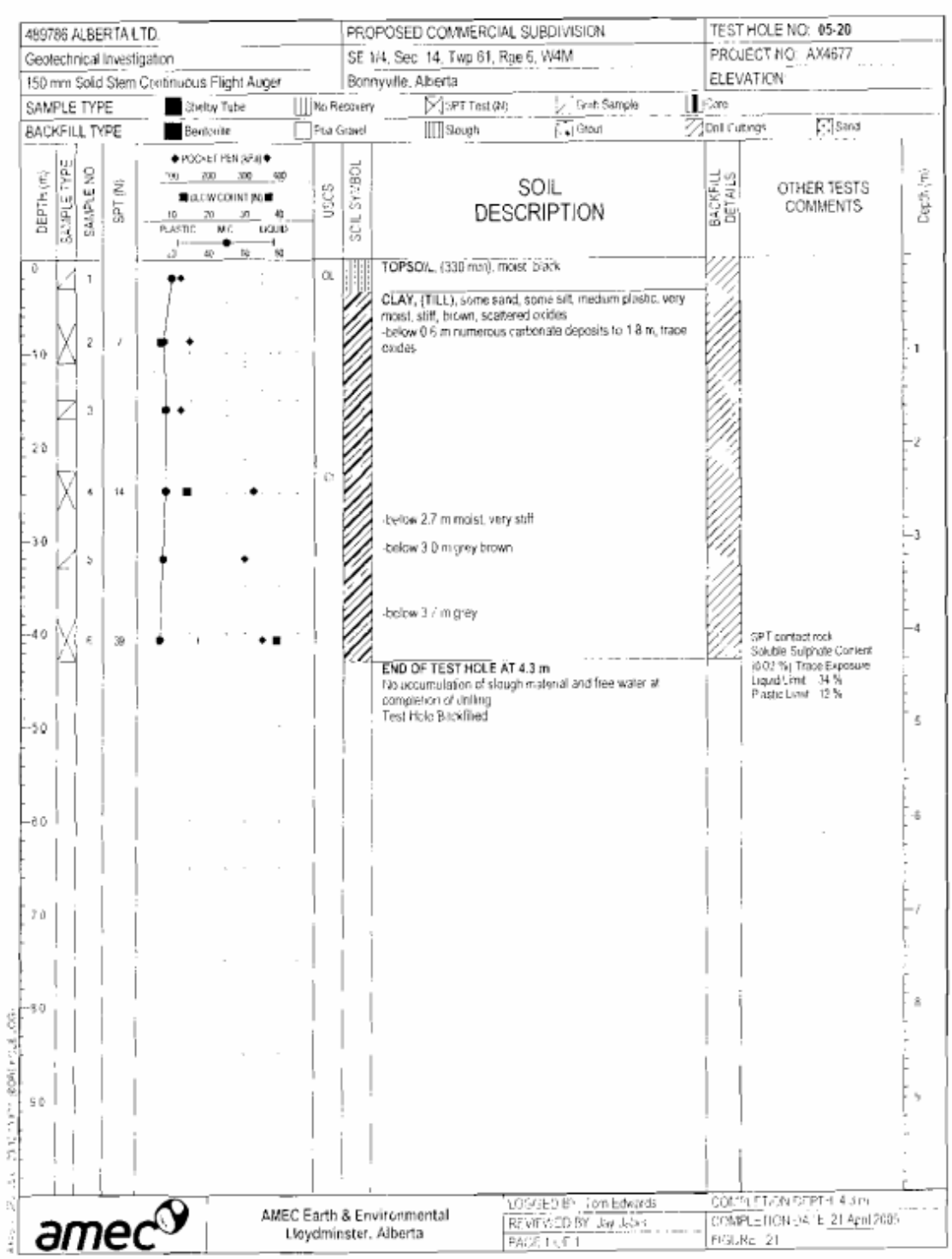

489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-14
PROJECT NO. AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (130 mm) moist, black
SAND, trace silt, poorly graded, fine grained, moist, light brown
-below 0.6 m frozen to 0.9 m
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, grey brown, numerous oxides, scattered gravel sizes to 4.3 m
-below 1.4 m very stiff
-below 1.8 m moist, hard, brown
-below 4.3 m grey
Water Level 3.5 m below ground surface at (17) days after completion of drilling
SPT hammer blow/ sample recovered as grab sample
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling
Slotted standpipe installed to 8.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jobe
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETE/ DATE: 13 April 2005
FIGURE: 15

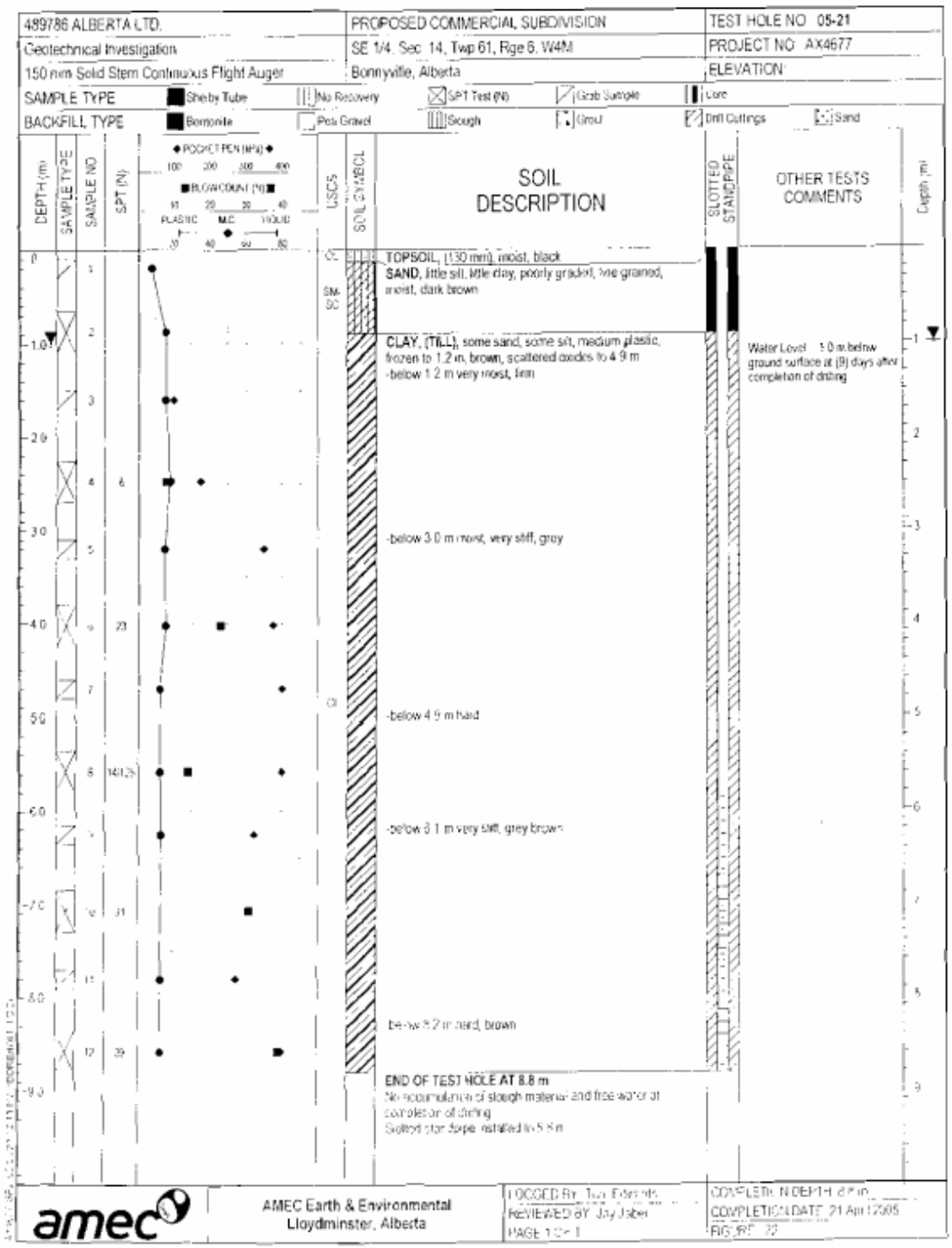

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO 05-15
Geotechnical Investigation
SE 1/4, Sec 14, Twp 61, Rge 6, W4M
PROJECT NO AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
LOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (ft)
TOPSOIL, (330 mm), moist, black
SAND, trace clay, poorly graded, medium grained, moist, brown
CLAY, (TILL), some sand, some silt, medium plastic, moist, very stiff, brown, numerous oxides
-below 3.4 m hard, grey brown
-below 3.7 m grey
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and hoe water at completion of drilling
Test Hole Backfilled
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 April 2005
FIGURE 15

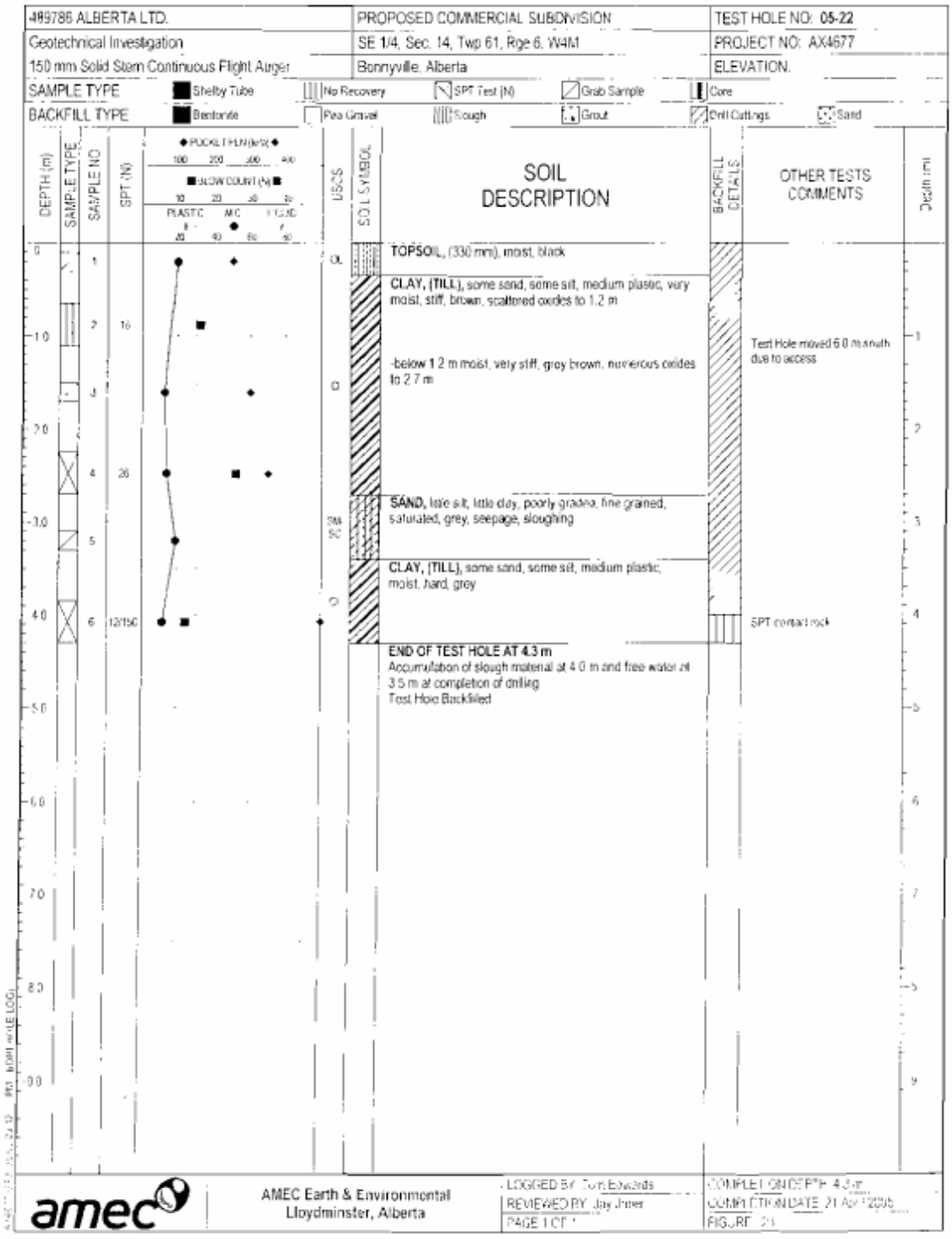

489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-16
PROJECT NO: AX4677
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (350 mm), moist, black
CL
CLAY, (TILL), some sand, some silt, medium plastic, moist, very stiff, brown, trace oxides to 1.8 m
-below 0.6 m and sand, some silt, low plastic, damp, hard, numerous carbonate deposits to 1.5 m
CL
-below 2.4 m some sand, some silt, medium plastic, moist, numerous oxides
CI
SAND, trace silt, little clay, poorly graded, fine grained, saturated, brown, seepage, sloughing
SM
SC
SPT Practical Refusal
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 3.7 m and trace free water at completion of drilling.
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jasor
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 1

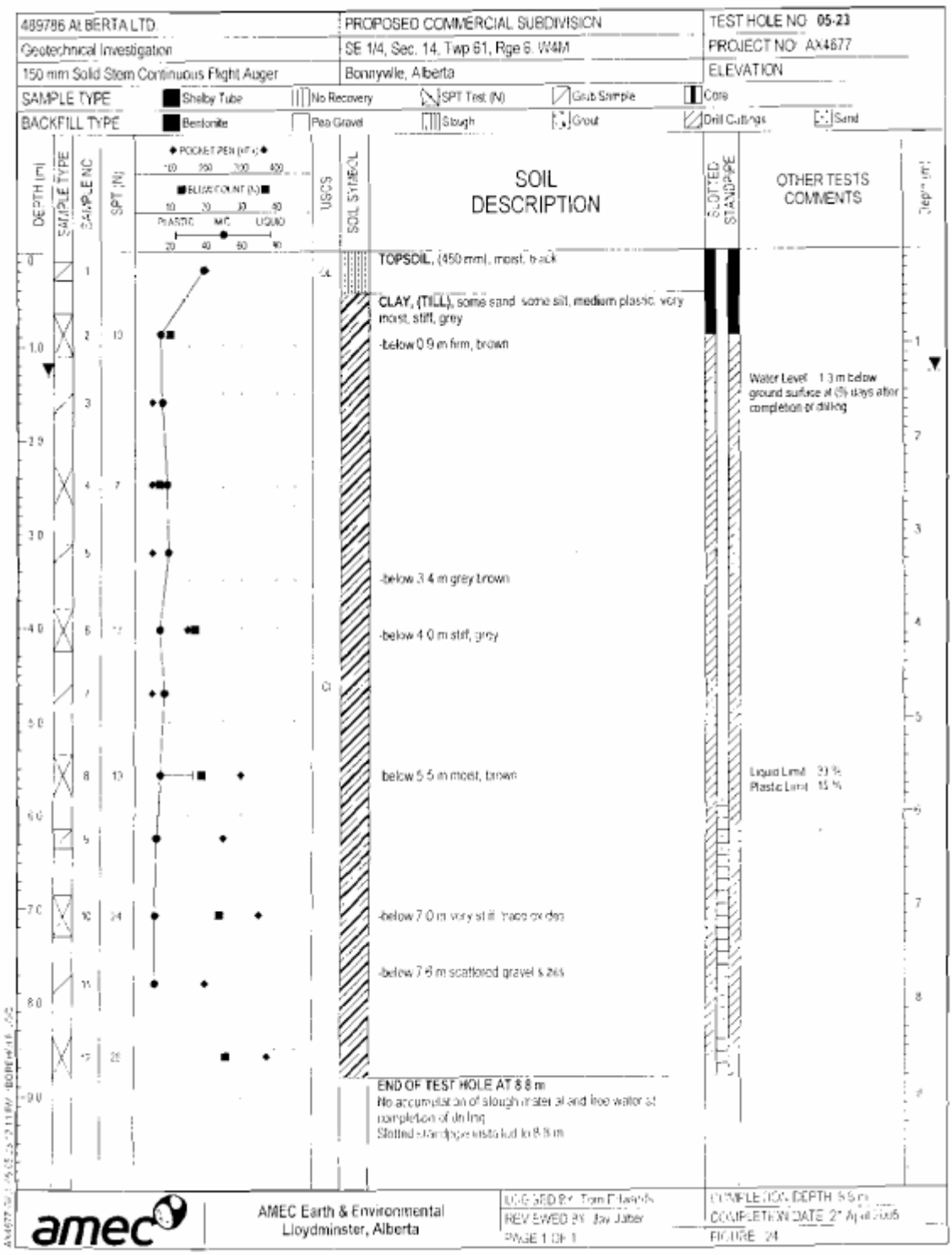

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-17
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO.
SPT (N)
POCKET PEN. (kPa)
BLOW COUNT (N)
PLASTIC
M C
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (300 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown
-below 0.6 m numerous carbonate deposits to 1.8 m, trace oxides
-below 2.4 m some sand, some silt, medium plastic, moist, very stiff
-below 4.0 m very moist, stiff
Liquid Limit: 32 %
Plastic Limit: 9 %
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling.
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 18

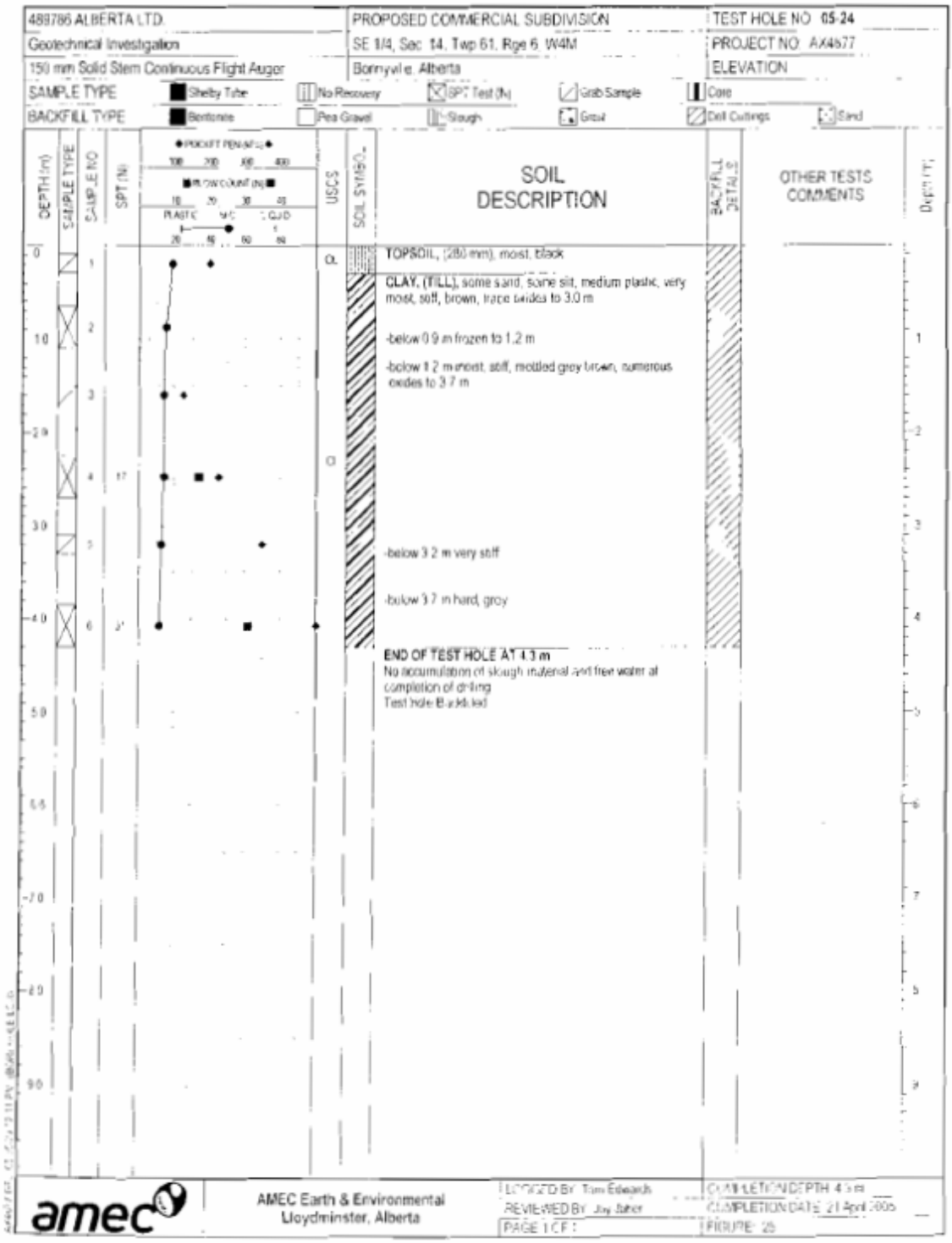

489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO 05-19
PROJECT NO AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN kPa
BLOW COUNT (N)
PLASTIC
M C
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (150 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic moist, very stiff, brown
-below 0.6 m scattered carbonate deposits to 1.8 m
-below 1.2 m very moist
-below 1.8 m numerous oxides to 4.0 m
-below 3.7 m hard
SAND, some silt, some clay, poorly graded, fine grained, saturated, brown, seepage
CLAY, (TILL), and sand, some silt, low plastic, very moist, very stiff, grey
-below 6.7 m some sand, some silt, medium plastic, moist, hard
END OF TEST HOLE AT 8.8 m
Accumulation of slough material and free water at 5.5 m at completion of drilling.
Slotted standpipe installed to 8.8 m
Test Hole moved 15.0 m south and 1.0 m west due to access
Water Level 2.9 m below ground surface at (16) days after completion of drilling
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH 8.8 m
COMPLETION DATE 14 Apr 2006
FIGURE 20

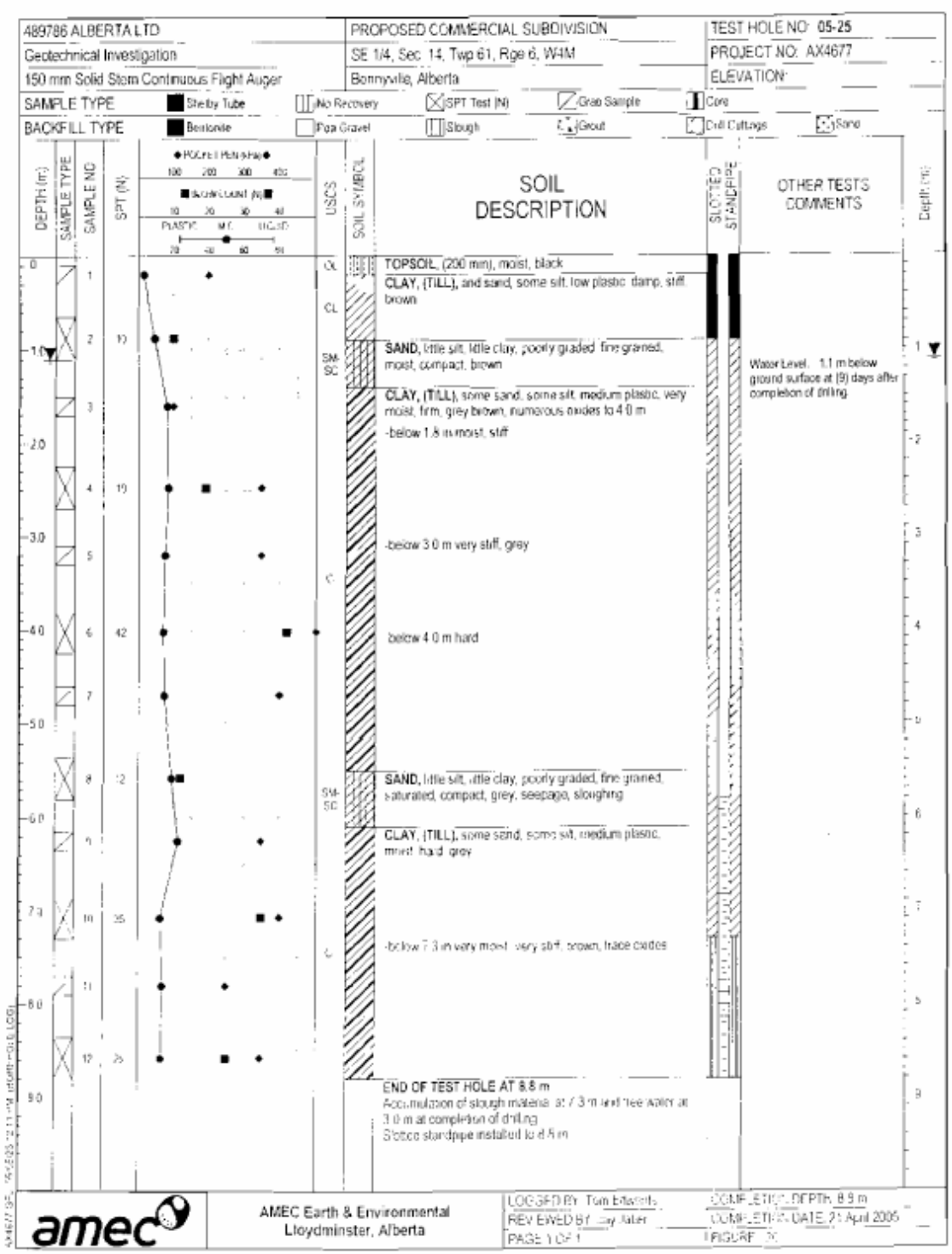

489786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-20
PROJECT NO: AX4677
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M/C
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (330 mm), moist, black
OL
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, scattered oxides
-below 0.6 m numerous carbonate deposits to 1.8 m, trace oxides
-below 2.7 m moist, very stiff
-below 3.0 m grey brown
-below 3.7 m grey
SPT contact rock
Soluble Sulphate Content (0.02 %) Trace Exposure
Liquid Limit 34 %
Plastic Limit 12 %
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Joe Jobin
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 21

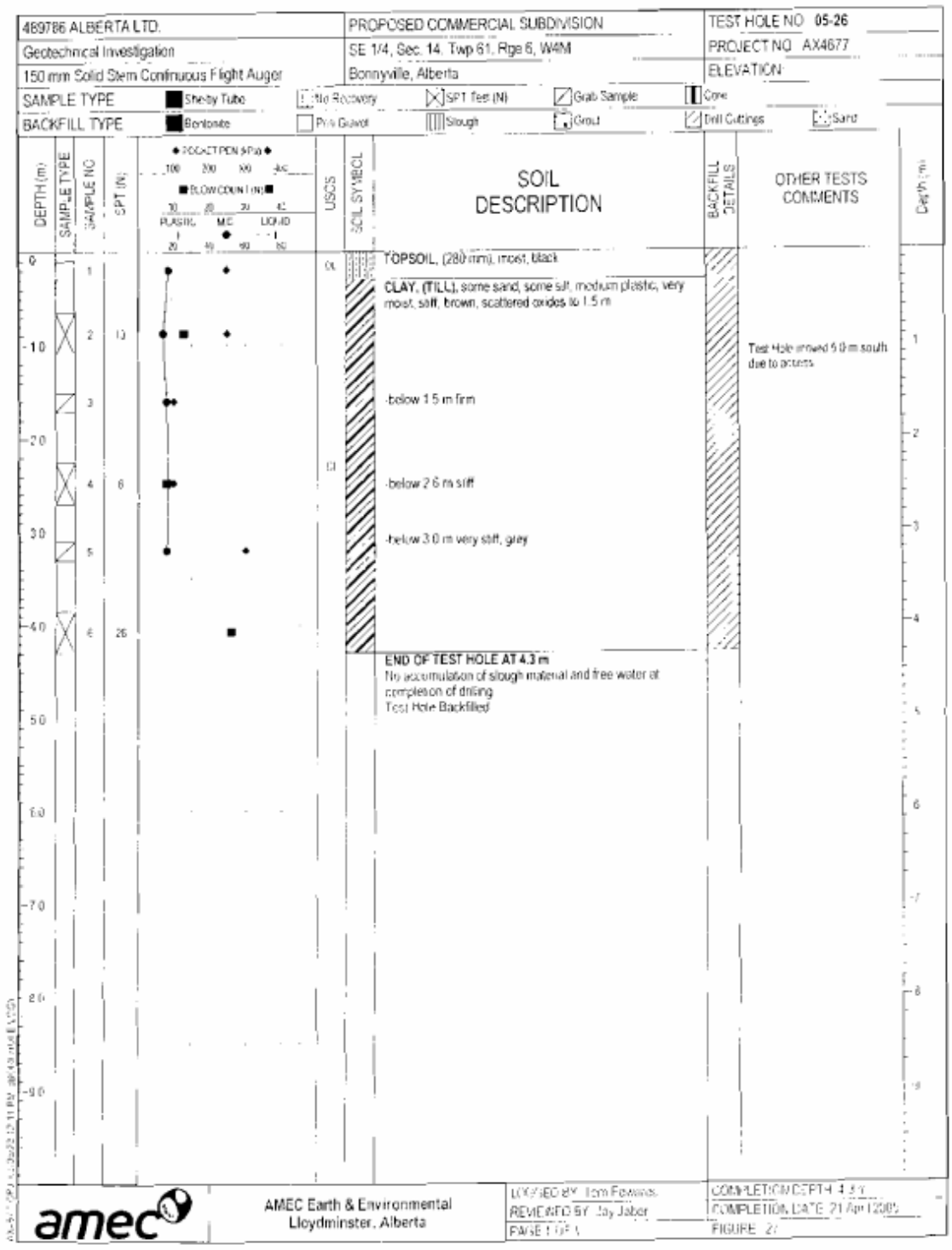

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO 05-21
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOWCOUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (130 mm), moist, black
SAND, little silt, little clay, poorly graded, fine grained, moist, dark brown
SM-SC
CLAY, (TILL), some sand, some silt, medium plastic, frozen to 1.2 m, brown, scattered oxides to 4.9 m
-below 1.2 m very moist, firm
-below 3.0 m moist, very stiff, grey
-below 4.9 m hard
-below 8.1 m very stiff, grey brown
below 8.2 m hard, brown
CL
Water Level 1.0 m below ground surface at (9) days after completion of drilling
END OF TEST HOLE AT 8.8 m
No accumulation of slough material and free water at completion of drilling
Slotted standpipe installed to 5.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Eisenhuth
REVIEWED BY Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH 8.8 m
COMPLETION DATE 21 Apr 2005
RIG/RF 22

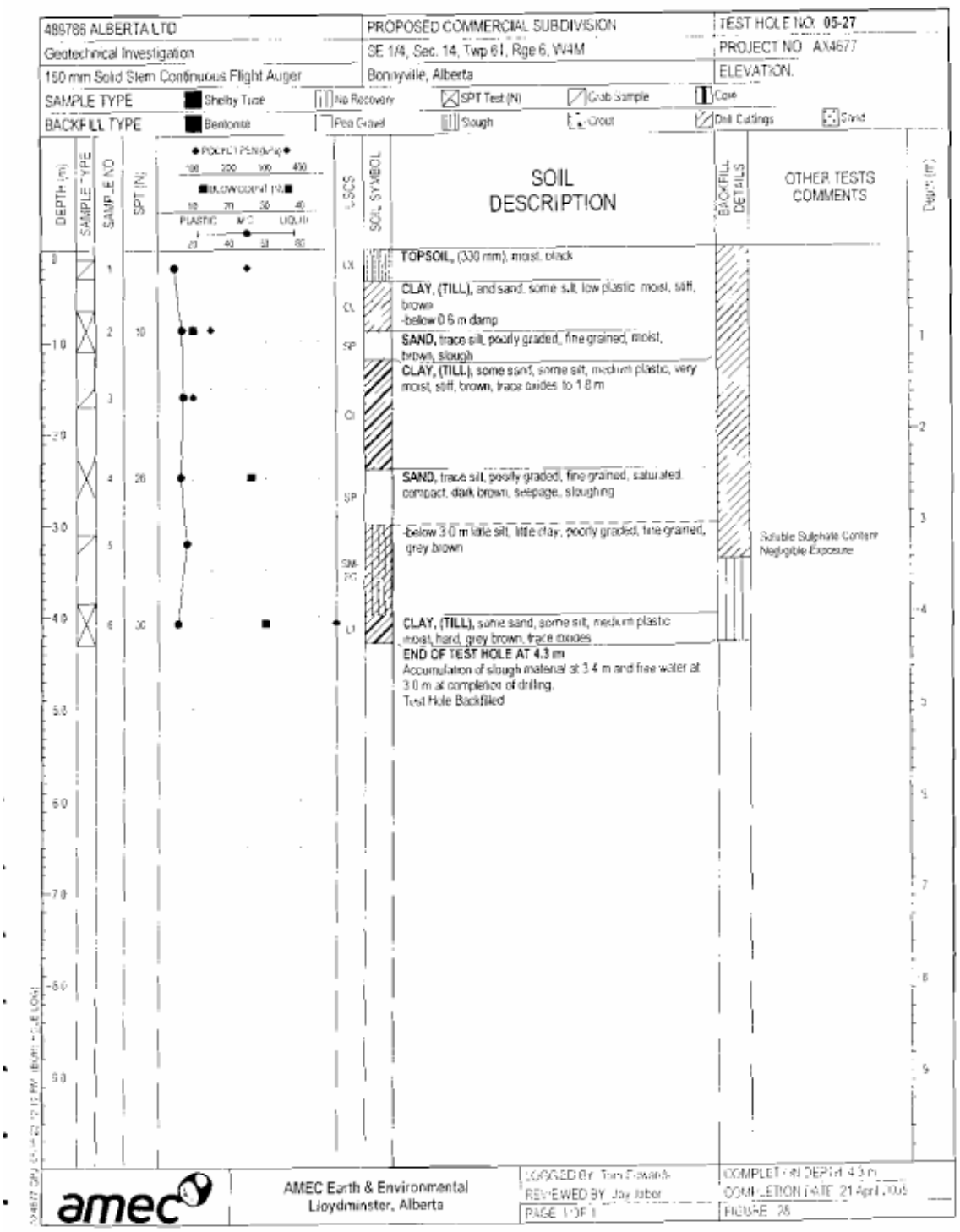

499786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO: 05-22
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO: AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (330 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, scattered oxides to 1.2 m
-below 1.2 m moist, very stiff, grey brown, numerous oxides to 2.7 m
Test Hole moved 6.0 m south due to access
SAND, little silt, little clay, poorly graded, fine grained, saturated, grey, seepage, sloughing
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, grey
SPT contact refusal
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 4.0 m and free water at 3.5 m at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Edwards
REVIEWED BY Jay Jutras
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 Apr 2005
FIGURE 21

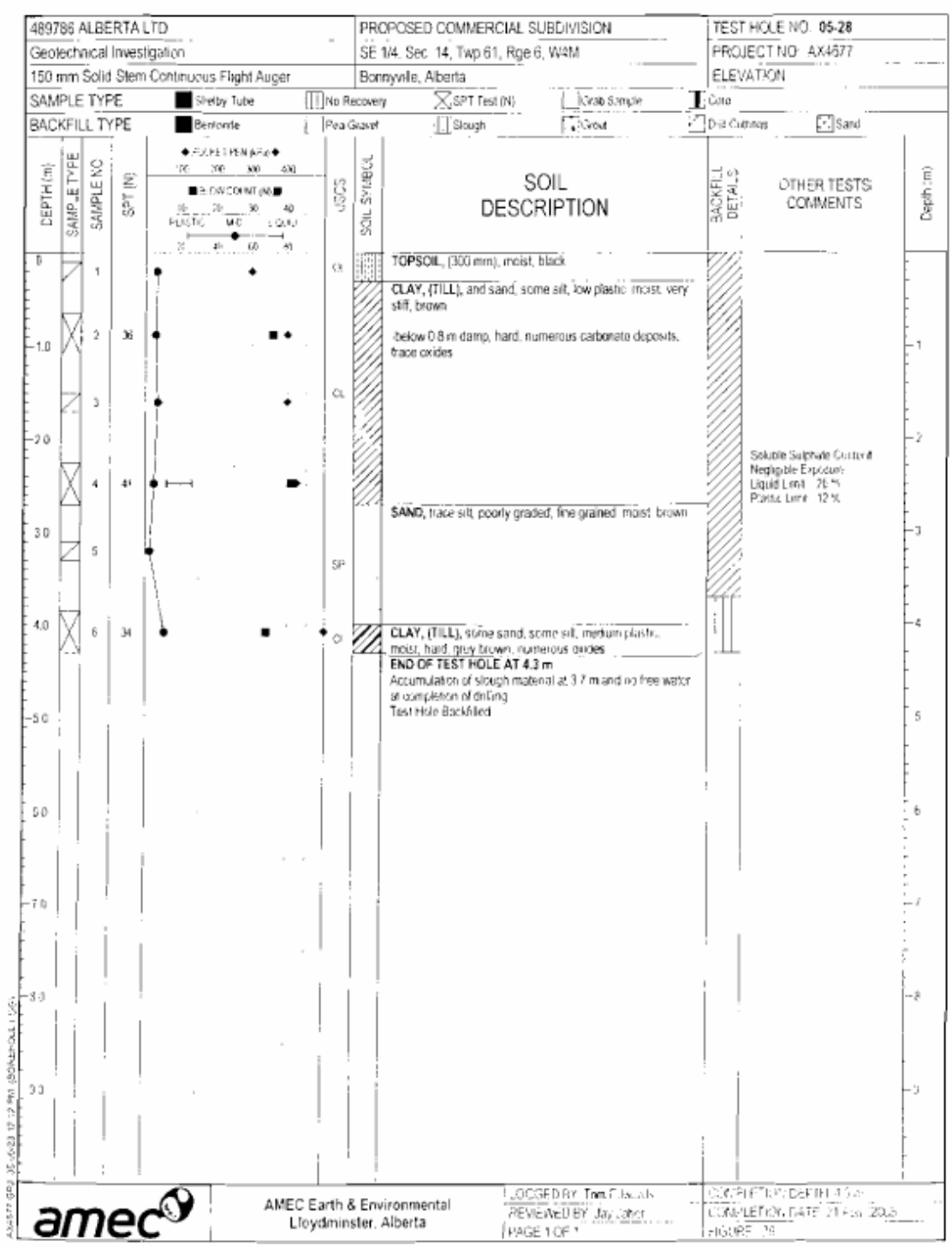

489786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO 05-23
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO AX4877
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
NAT
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
TOPSOIL, (450 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, grey
-below 0.9 m firm, brown
Water Level 1.3 m below ground surface at (3) days after completion of drilling
-below 3.4 m grey brown
-below 4.0 m stiff, grey
below 5.5 m moist, brown
Liquid Limit 31 %
Plastic Limit 15 %
-below 7.0 m very stiff, trace oxides
-below 7.6 m scattered gravel & pebbles
END OF TEST HOLE AT 8.8 m
No accumulation of slough/water at and free water at completion of drilling
Slotted standpipe installed to 8.8 m
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Daniels
REVIEWED BY Jay Jaber
PAGE 1 OF 1
COMPLETION DEPTH 8.8 m
COMPLETION DATE 27 April 2005
FIGURE 24

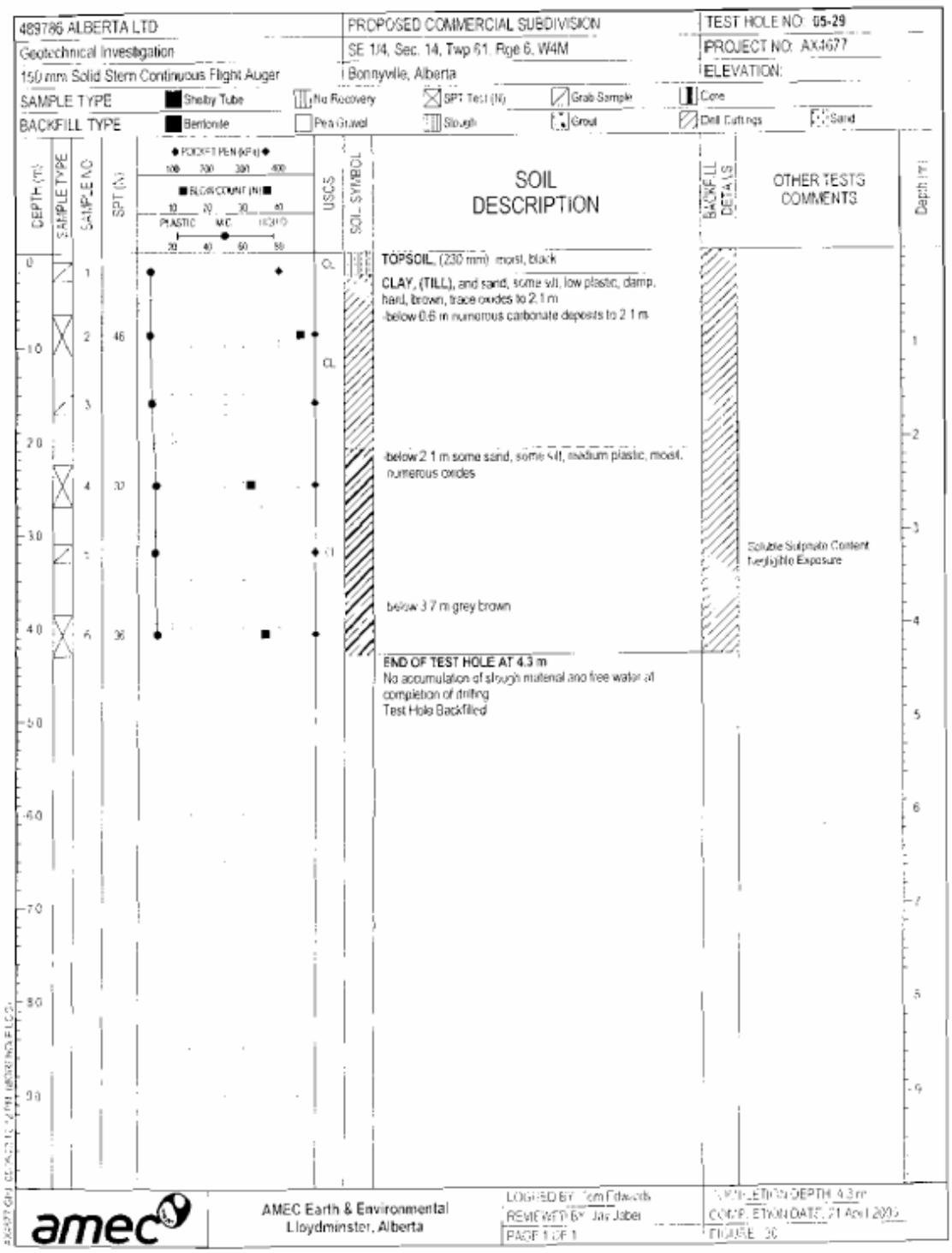

488786 ALBERTA LTD.
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO 05-24
PROJECT NO AX4677
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (ft)
TOPSOIL, (280 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, trace oxides to 3.0 m
-below 0.9 m frozen to 1.2 m
-below 1.2 m moist, stiff, mottled grey brown, numerous oxides to 3.7 m
-below 3.2 m very stiff
-below 3.7 m hard, grey
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tim Edwards
REVIEWED BY Jay Asher
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 April 2005
FIGURE 25

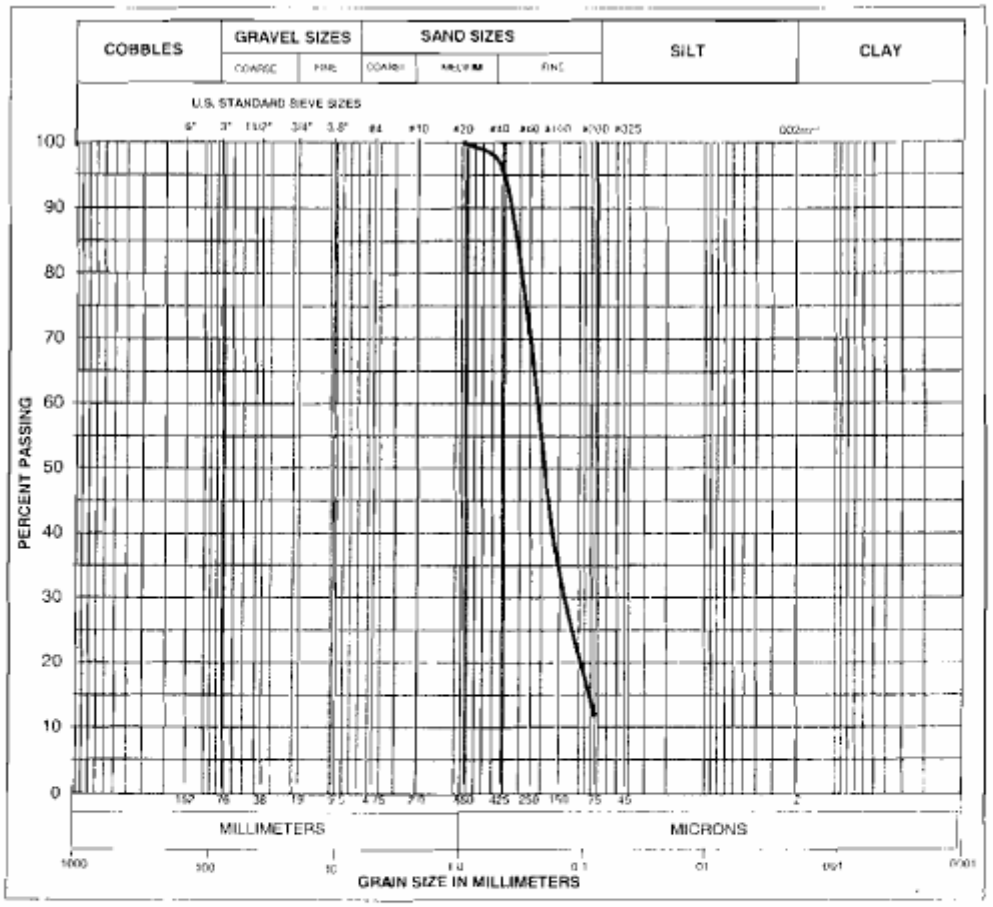

489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-25
PROJECT NO: AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Slime
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
SLOTTED STANDPIPE
OTHER TESTS COMMENTS
Depth (ft)
TOPSOIL, (200 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, stiff, brown
SAND, little silt, little clay, poorly graded, fine grained, moist, compact, brown
CLAY, (TILL), some sand, some silt, medium plastic, very moist, firm, grey brown, numerous oxides to 4.0 m
-below 1.8 m moist, stiff
-below 3.0 m very stiff, grey
-below 4.0 m hard
SAND, little silt, little clay, poorly graded, fine grained, saturated, compact, grey, seepage, sloughing
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, grey
-below 7.3 m very moist, very stiff, brown, trace oxides
END OF TEST HOLE AT 8.8 m
Accumulation of slough material at 7.3 m and free water at 3.0 m at completion of drilling
Slotted standpipe installed to 8.5 m
Water Level: 1.1 m below ground surface at (9) days after completion of drilling
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jay Jalter
PAGE 1 OF 1
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 21 April 2005
FIGURE


469786 ALBERTA LTD.
PROPOSED COMMERCIAL SUBDIVISION
TEST HOLE NO 05-26
Geotechnical Investigation
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
PROJECT NO AX4677
150 mm Solid Stem Continuous Flight Auger
Bonnyville, Alberta
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN kPa
BLOW COUNT (N)
PLASTIC
MC
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (280 mm), moist, black
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, scattered oxides to 1.5 m
Test Hole moved 5.0 m south due to access
-below 1.5 m firm
-below 2.6 m stiff
-below 3.0 m very stiff, grey
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Fewings
REVIEWED BY Jay Jabor
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 Apr 2005
FIGURE 27


489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-27
PROJECT NO: AX4677
ELEVATION:
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMPLE TYPE
SAMPLE NO
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
M.C.
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (330 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, moist, stiff, brown
-below 0.6 m damp
SAND, trace silt, poorly graded, fine grained, moist, brown, slough
CLAY, (TILL), some sand, some silt, medium plastic, very moist, stiff, brown, trace oxides to 1.8 m
SAND, trace silt, poorly graded, fine grained, saturated, compact, dark brown, seepage, sloughing
-below 3.0 m little silt, little clay, poorly graded, fine grained, grey brown
Soluble Sulphate Content Negligible Exposure
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, grey brown, trace oxides
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 3.4 m and free water at 3.0 m at completion of drilling.
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tim Edwards
REVIEWED BY: Jay Jabs
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
FIGURE: 26


489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO. 05-28
PROJECT NO. AX4577
ELEVATION
SAMPLE TYPE
Shelby Tube
No Recovery
SPT Test (N)
Grab Sample
Core
BACKFILL TYPE
Bentonite
Pea Gravel
Slough
Grout
Drill Cuttings
Sand
DEPTH (m)
SAMP_E TYPE
SAMPLE NO
SPT (N)
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (300 mm), moist, black
CLAY, (TILL), and sand, some silt, low plastic, moist, very stiff, brown
below 0.8 m damp, hard, numerous carbonate deposits, trace oxides
SAND, trace silt, poorly graded, fine grained, moist, brown
CLAY, (TILL), some sand, some silt, medium plastic, moist, hard, grey brown, numerous oxides
END OF TEST HOLE AT 4.3 m
Accumulation of slough material at 3.7 m and no free water at completion of drilling
Test Hole Backfilled
Soluble Sulphate Content
Negligible Exposure
Liquid Limit 28 %
Plastic Limit 12 %
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY Tom Clauds
REVIEWED BY Jay Labat
PAGE 1 OF 1
COMPLETION DEPTH 4.3 m
COMPLETION DATE 21 Feb 2005
FIGURE 28


489786 ALBERTA LTD
Geotechnical Investigation
150 mm Solid Stem Continuous Flight Auger
SAMPLE TYPE
BACKFILL TYPE
Shelby Tube
Bentonite
No Recovery
Pea Gravel
SPT Test (N)
Slough
Grab Sample
Grout
Core
Drill Cuttings
Sand
PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, Sec. 14, Twp 61, Rge 6, W4M
Bonnyville, Alberta
TEST HOLE NO: 05-29
PROJECT NO: AX4677
ELEVATION:
DEPTH (m)
SAMPLE TYPE
SAMPLE NO.
SPT (N)
POCKET PEN (kPa)
BLOW COUNT (N)
PLASTIC
NAT
LIQUID
USCS
SOIL SYMBOL
SOIL DESCRIPTION
BACKFILL DETAILS
OTHER TESTS COMMENTS
Depth (m)
TOPSOIL, (230 mm) moist, black
CLAY, (TILL), and sand, some silt, low plastic, damp, hard, brown, trace oxides to 2.1 m
-below 0.6 m numerous carbonate deposits to 2.1 m
CL
-below 2.1 m some sand, some silt, medium plastic, moist, numerous oxides
Soluble Sulphate Content Negligible Exposure
below 3.7 m grey brown
END OF TEST HOLE AT 4.3 m
No accumulation of slough material and free water at completion of drilling
Test Hole Backfilled
amec
AMEC Earth & Environmental
Lloydminster, Alberta
LOGGED BY: Tom Edwards
REVIEWED BY: Jas Jabal
PAGE 1 OF 1
COMPLETION DEPTH: 4.3 m
COMPLETION DATE: 21 April 2005
ELEVATION:



REMARKS: SAND, TRACE SILT, TRACE CLAY, POORLY GRADED, FINE GRAINED, MOIST, DENSE, LIGHT BROWN	**SUMMARY**
	D_{10} ____ mm — GRAVEL 0 %
	D_{30} ____ mm — SAND 88 %
	D_{60} ____ mm — SILT 12 %
	C_u ____ mm — CLAY ____
NOTE. UNIFIED SOIL CLASSIFICATION SYSTEM SP	C_c ____ mm

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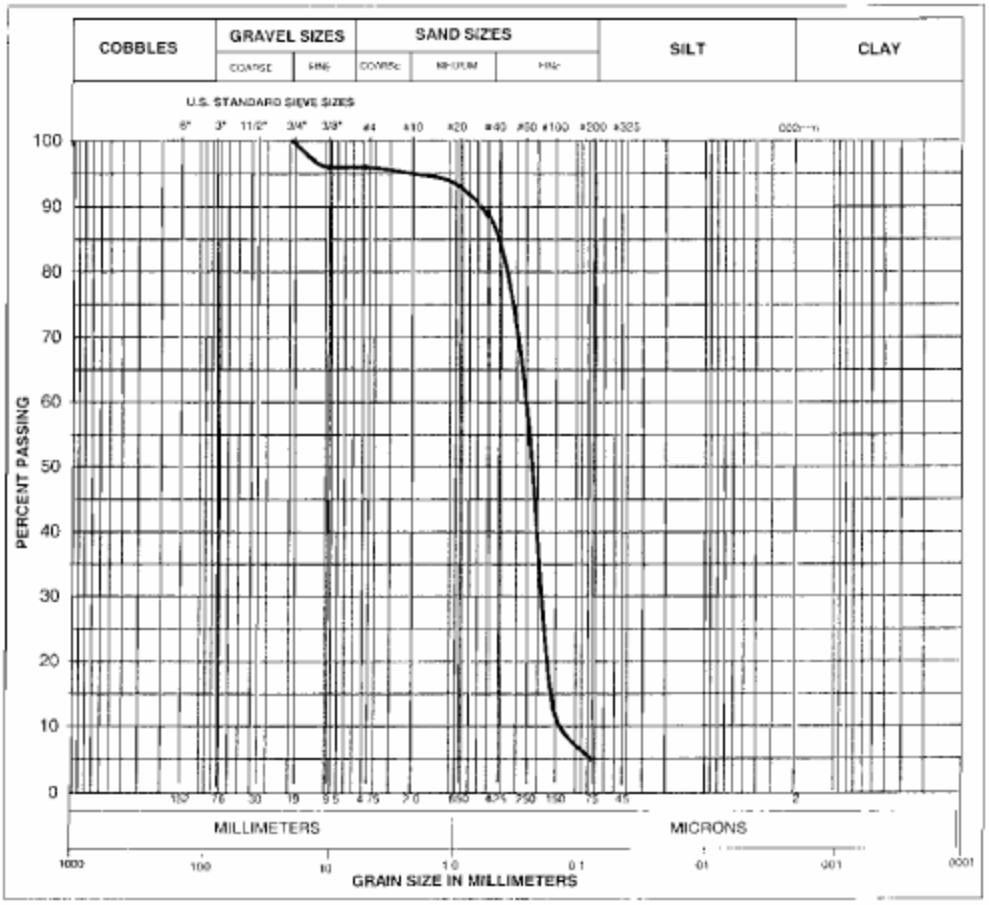
SE 1/4, SEC. 14, TWP. 61, RGE. 6, W4M
BONNYVILLE, ALBERTA

TEST HOLE NO 05-07 SAMPLE 5 DEPTH 3.2 m

GRAIN SIZE DISTRIBUTION | PROJECT NO AX4677 | FIGURE



REMARKS: SAND, TRACE SILT, TRACE CLAY, POORLY GRADED, FINE GRIANED, DAMP, DENSE, LIGHT BROWN

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM SP

SUMMARY

D_{10}	mm	GRAVEL	4 %
D_{30}	mm	SAND	91 %
D_{60}	mm	SILT	5 %
C_u	mm	CLAY	
C_c	mm		

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PROPOSED COMMERCIAL SUBDIVISION
SE 1/4, SEC. 14, TWP. 61, RGE. 6, W4M
BONNYVILLE, ALBERTA

TEST HOLE NO 05-13 SAMPLE 2 DEPTH 1.0 m

GRAIN SIZE DISTRIBUTION

PROJECT NO. AX4677 FIGURE

APPENDIX B

Explanation of Terms and Symbols

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in these pages.

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation test	*ST	Swelling test
D_R	Relative density	TV	Torvane shear strength
*k	Permeability coefficient	VS	Vane shear strength
*MA	Mechanical grain size analysis and hydrometer test	w	Natural Moisture Content (ASTM D2216)
		w_l	Liquid limit (ASTM D 423)
N	Standard Penetration Test (CSA A119.1-60)	w_p	Plastic Limit (ASTM D 424)
N_d	Dynamic cone penetration test	E_f	Unit strain at failure
NP	Non plastic soil	γ	Unit weight of soil or rock
pp	Pocket penetrometer strength	γ_d	Dry unit weight of soil or rock
*q	Triaxial compression test	ρ	Density of soil or rock
q_u	Unconfined compressive strength	ρ_d	Dry Density of soil or rock
*SB	Shearbox test	C_u	Undrained shear strength
SO_4	Concentration of water-soluble sulphate	▸	Seepage
		▼	Observed water level

* The results of these tests are usually reported separately

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual[2].

Relative Density and Consistency:

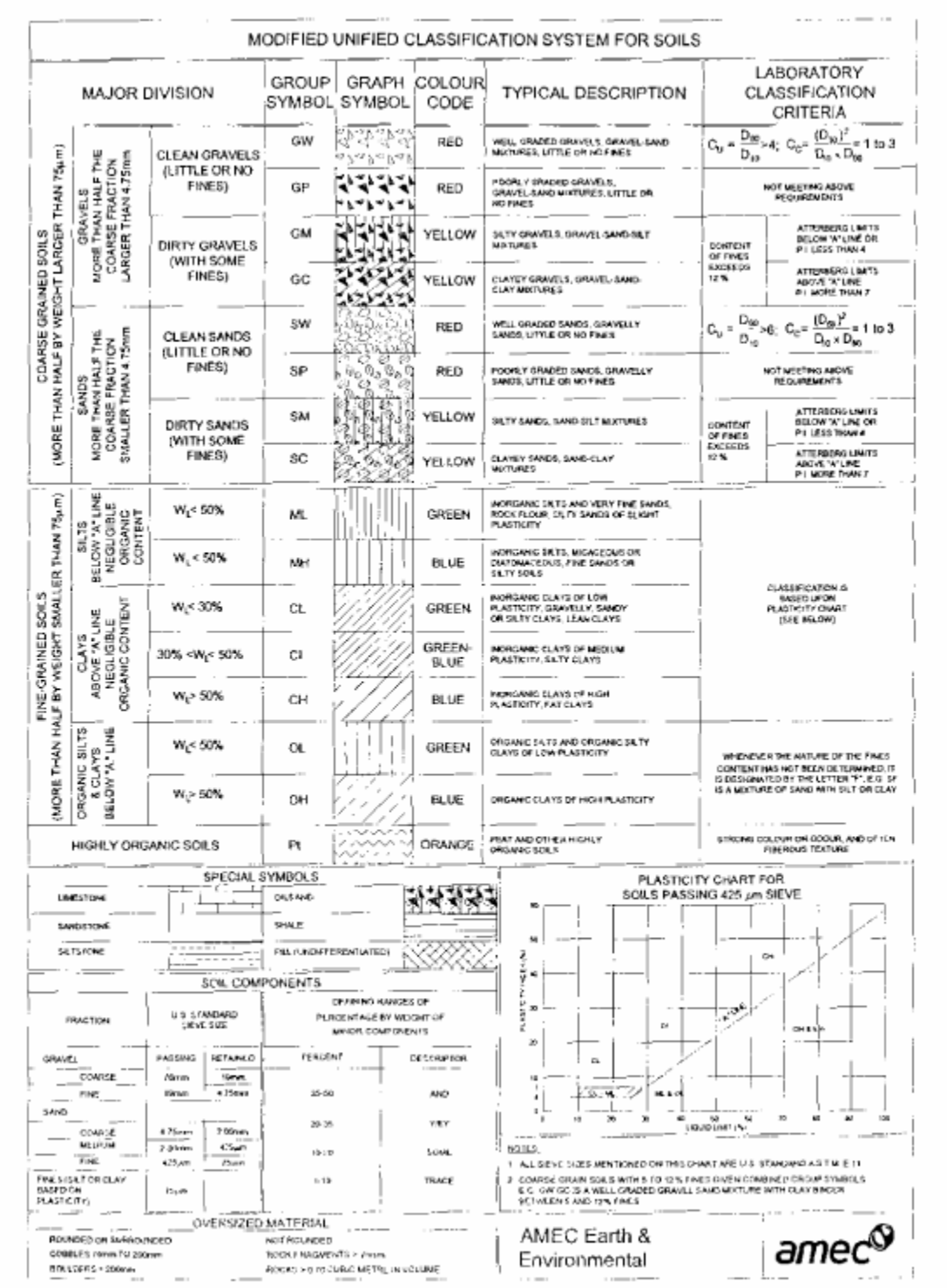
Cohesionless Soils		Cohesive Soils	
Relative Density	SPT (N) Value	Consistency	Undrained Shear Strength c_u (kPa)
Very Loose	0-4	Very Soft	0-10
Loose	4-10	Soft	10-25
Compact	10-30	Firm	25-50
Dense	30-50	Stiff	50-100
Very Dense	>50	Very Stiff	100-200
		Hard	>200

Standard Penetration Resistance ("N" value)
The number of blows by a 63.6kg hammer dropped 760 mm to drive a 50 mm diameter open sampler attached to "A" drill rods for a distance of 300 mm.

---

1 "Unified Soil Classification System", Technical Memorandum 3(-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army. Vol. 1 March 1953

2 "Canadian Foundation Engineering Manual", 3rd Edition, Canadian Geotechnical Society, 1992.


MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
MAJOR DIVISION
GROUP SYMBOL
GRAPH SYMBOL
COLOUR CODE
TYPICAL DESCRIPTION
LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75μm)
GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm
CLEAN GRAVELS (LITTLE OR NO FINES)
GW
RED
WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
GP
RED
POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
NOT MEETING ABOVE REQUIREMENTS
DIRTY GRAVELS (WITH SOME FINES)
GM
YELLOW
SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
CONTENT OF FINES EXCEEDS 12 %
ATTERBERG LIMITS BELOW "A" LINE OR PI LESS THAN 4
GC
YELLOW
CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
ATTERBERG LIMITS ABOVE "A" LINE PI MORE THAN 7
SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm
CLEAN SANDS (LITTLE OR NO FINES)
SW
RED
WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
SP
RED
POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
NOT MEETING ABOVE REQUIREMENTS
DIRTY SANDS (WITH SOME FINES)
SM
YELLOW
SILTY SANDS, SAND-SILT MIXTURES
CONTENT OF FINES EXCEEDS 12 %
ATTERBERG LIMITS BELOW "A" LINE OR PI LESS THAN 4
SC
YELLOW
CLAYEY SANDS, SAND-CLAY MIXTURES
ATTERBERG LIMITS ABOVE "A" LINE PI MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75μm)
SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT
W_L < 50%
ML
GREEN
INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
W_L < 50%
MH
BLUE
INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDS OR SILTY SOILS
CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT
W_L < 30%
CL
GREEN
INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS
CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
30% < W_L < 50%
CI
GREEN-BLUE
INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS
W_L > 50%
CH
BLUE
INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
ORGANIC SILTS & CLAYS BELOW "A" LINE
W_L < 50%
OL
GREEN
ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY
W_L > 50%
OH
BLUE
ORGANIC CLAYS OF HIGH PLASTICITY
HIGHLY ORGANIC SOILS
Pt
ORANGE
PEAT AND OTHER HIGHLY ORGANIC SOILS
STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE
SPECIAL SYMBOLS
LIMESTONE
SANDSTONE
SILTSTONE
GRAVEL
SAND
SHALE
FILL (UNDIFFERENTIATED)
SOIL COMPONENTS
FRACTION
U.S. STANDARD SIEVE SIZE
DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS
PERCENT
DESCRIPTOR
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
PASSING
RETAINED
35-50
AND
20-35
"EY
10-20
SOME
1-10
TRACE
FINES (SILT OR CLAY BASED ON PLASTICITY)
OVERSIZED MATERIAL
ROUNDED OR SUBROUNDED
COBBLES 75mm TO 200mm
BOULDERS > 200mm
NOT ROUNDED
ROCK FRAGMENTS > 75mm
ABOUT > 0.03 CUBIC METRE IN VOLUME
PLASTICITY CHART FOR SOILS PASSING 425 μm SIEVE
PLASTICITY INDEX (%)
LIQUID LIMIT (%)
CL
CH
OH & MH
NOTES
1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD A.S.T.M. E 11
2. COARSE GRAIN SOILS WITH 5 TO 12 % FINES GIVEN COMBINED GROUP SYMBOLS E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5 AND 12% FINES
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APPENDIX C

Alberta Transportation Aggregate Specifications

DESIGNATION		1			2					3						4			5	6		7	8	9	DESIGNATION
CLASS (mm)		10	12.5	16	16	20	25	40	50	12.5A	12.5AW	12.5B	12.5BW	12.5C	16	20	25	40	10	80	125	40	40	8	CLASS (mm)
PER CENT PASSING METRIC SIEVE (CSB & CP - 240 µm)	125 000																				100				125 000
	80 000																			100					80 000
	50 000								100											95-100	95-100				50 000
	40 000							100										100				100	100		40 000
	25 000						100		63-90								100			38-100	38-100				25 000
	20 000					100										100		55-90							20 000
	16 000			100	100		70-94	55-85	47-79						100					32-85	32-85				16 000
	12 500		100	80-92						100	100	100	100	100	72-95										12 500
	10 000	100	83-92	70-84	70-93	63-86	52-79	44-74	38-70	35-65	35-65	55-75	55-75	70-93	53-82	35-77	30-77	25-72	100			85-100	78-95		10 000
	8 000																							100	8 000
	5 000	60-75	55-70	50-65	50-70	40-67	35-64	32-62	28-59	0-15	0-15	0-15	0-15	30-60	27-54	15-55	15-55	8-55	45-70	20-85	20-85		60-85	85-100	5 000
	1250	26-45	26-45	26-45	26-45	20-43	18-43	17-43	16-42	0-3	0-3	0-3	0-3	9-28	9-28	0-30	0-30	0-30	20-45			40-100	27-57	45-75	1250
	630	18-38	18-38	18-38	18-38	14-34	12-34	12-34	12-34															30-50	630
	315	12-30	12-30	12-30	12-30	9-26	8-26	8-26	8-26					0-15	0-15				9-22	6-30	6-30	17-100	5-29	18-30	315
	160	8-20	8-20	8-20	8-20	5-18	5-18	5-18	5-18					0-11	0-11				5-15				0-15	10-21	160
	80	4-10	4-10	4-10	4-10	2-10	2-10	2-10	2-10	0-2	0-0.3	0-2	0-0.3	0-8	0-8	0-12	0-12	0-12	0-10	2-10	2-15	6-30	0-5	5-15	80
% FRACTURE BY WEIGHT (2 FACES)	ALL +5000	60+	60+	60+	60+	60+	60+	50+	40+	75+	75+	75+	75+	60+	60+	40+	40+	25+	N/A	N/A	N/A	N/A	N/A	N/A	% FRACTURE BY WEIGHT (2 FACES) ALL +5000
PLASTICITY INDEX (PI)		0-4	0-4	0-4	0-6	0-6	0-6	0-6	0-6	N/A	N/A	N/A	N/A	0-4	0-4	0-8	0-8	0-8	0-6	0-8	0-8	0-10	0-5	0-4	PLASTICITY INDEX (PI)
L.A. ABRASION LOSS PER CENT MAX.		40	40	40	50	50	50	50	50	35	35	35	35	35	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	35	L.A. ABRASION LOSS PER CENT MAX.
FLAKINESS INDEX		N/A								MAX 15				N/A											FLAKINESS INDEX
COEFFICIENT OF UNIFORMITY (Cu)		N/A																				3+	N/A		COEFFICIENT OF UNIFORMITY (Cu)

DESIGNATION

1. ASPHALT CONCRETE AGGREGATE (CLASS 10 FOR SURFACE PREPARATION COURSE ONLY)
2. GRANULAR AND ASPHALT STABILIZED BASE COURSES, SUB-BASES AND DUST ABATEMENT AGGREGATES
3. SEAL COAT AGGREGATE
4. GRAVEL SURFACING AGGREGATE
5. SANDING MATERIAL
6. PIT-RUN GRAVEL FILL
7. CEMENT STABILIZED BASE COURSE AGGREGATE
8. GRANULAR FILTER AGGREGATE
9. SLURRY SEAL AGGREGATE

No.	REVISIONS	BY	DATE
2	REVISED	R.H.	NOV./90
1	REVISED	R.H.	NOV./90

Approved:

Director,
Materials Engineering Branch

Date: NOV./27 .1990

Alberta
TRANSPORTATION AND UTILITIES
Engineering and Operations Division

SPECIFICATIONS FOR AGGREGATE

Prepared By: R.H.	Checked By: R.H.	Scale: N.T.S.	Dwg No.: CDB-3.2A

Appendix “D”

Storm Water Drainage Report

West Bonnyville Industrial Park

SE¼ Sec. 14 Twp. 61 Rge. 6 W4 M

Storm Water Drainage Report

Prepared as Part of

West Bonnyville Industrial Park

Area Structure Plan

October 4, 2005

#8242 Bylaw 1277-05

Table of Contents

Appendix A

1.0 Introduction

VicTa is proposing to subdivide the SE¼ Sec. 14 Twp. 61 Rge. 6 W4 M into Highway Commercial and Industrial lots. Application for approval for subdivision must be accompanied by an Area Structure Plan. The Town of Bonnyville also requested that a storm water drainage review of on-site and off-site storm water considerations be undertaken. Overall on-site storm water drainage considerations are included in the main body of the ASP. This report has been prepared to address specific concerns put forward by the Town including the following:

- review of storm water drainage that may flow onto this property from adjacent properties,
- identification of the overland drainage route (e.g. ditch system or pond) and how it will drain to a drainage facility and/or off site;
- the means for conveyance of storm water from the site (an outlet and outfall should be incorporated on the plan drawings),
- through computer simulation, the developer should also be required to describe how storm water created by the new development will be attenuated at pre-development flows,
- engineering proof that storm water discharge from on-site storm water management facilities will not exceed the pre-development flow rate; and
- demonstration that the development will result in no negative downstream impacts.

The remainder of this report addresses each of the points outlined above through the use of excerpts from national topographical maps, and computer simulation of various rainfall events.

2.0 Review of the Storm Water Flows Associated with the Area Being Considered for Development

A review of the topography of the land surrounding the proposed development was undertaken on the basis of Topographic Maps produced by the Canada Centre for Mapping and on the oblique coloured aerial photo of the overall drainage system that allows storm water to flow to Moose Lake. The specific topographic map that became the basis of the review of storm drainage for the proposed development is entitled “Bonnyville Alberta”. Figure 1 indicates the location of the proposed development in relation to the westerly built-up area of the Town. The drainage arrows indicate the direction of the flow of storm drainage on the proposed area of development and on the land adjacent to the proposed development. A drainage channel that traverses the land immediately to the west of the proposed development is clearly visible on Figure 1. Figure 2 provides an expanded view of the area being considered for development. Figure 3 provides an orthographic view of the same property. The orthographic view clearly indicates that water on adjacent land flows away from the proposed development area. Figure 4 is an oblique color aerial photo of the storm water flow channels that allow water to flow to Moose Lake from the proposed area of development.

The flows of storm water that must be accommodated were calculated using a storm water flow computerized modelling program.

Figure 1: West Bonnyville

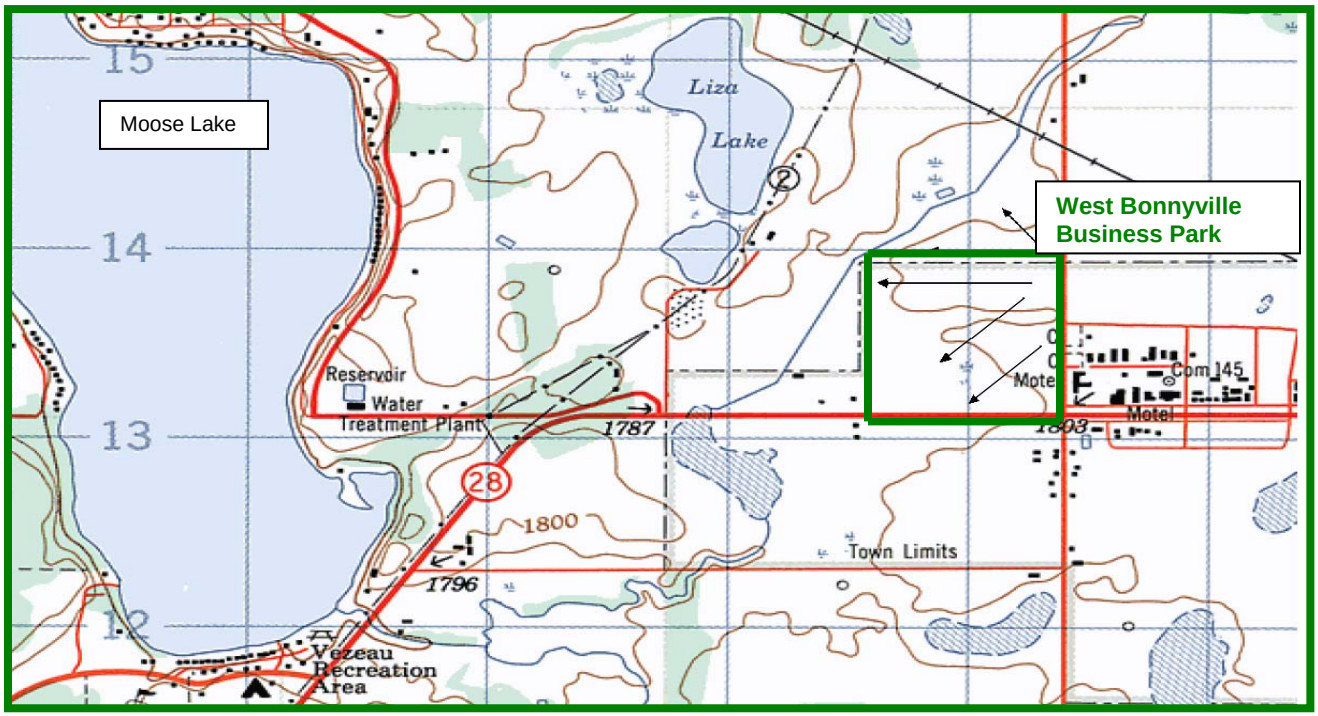


Figure 2: Expanded View of the Area Considered for Development

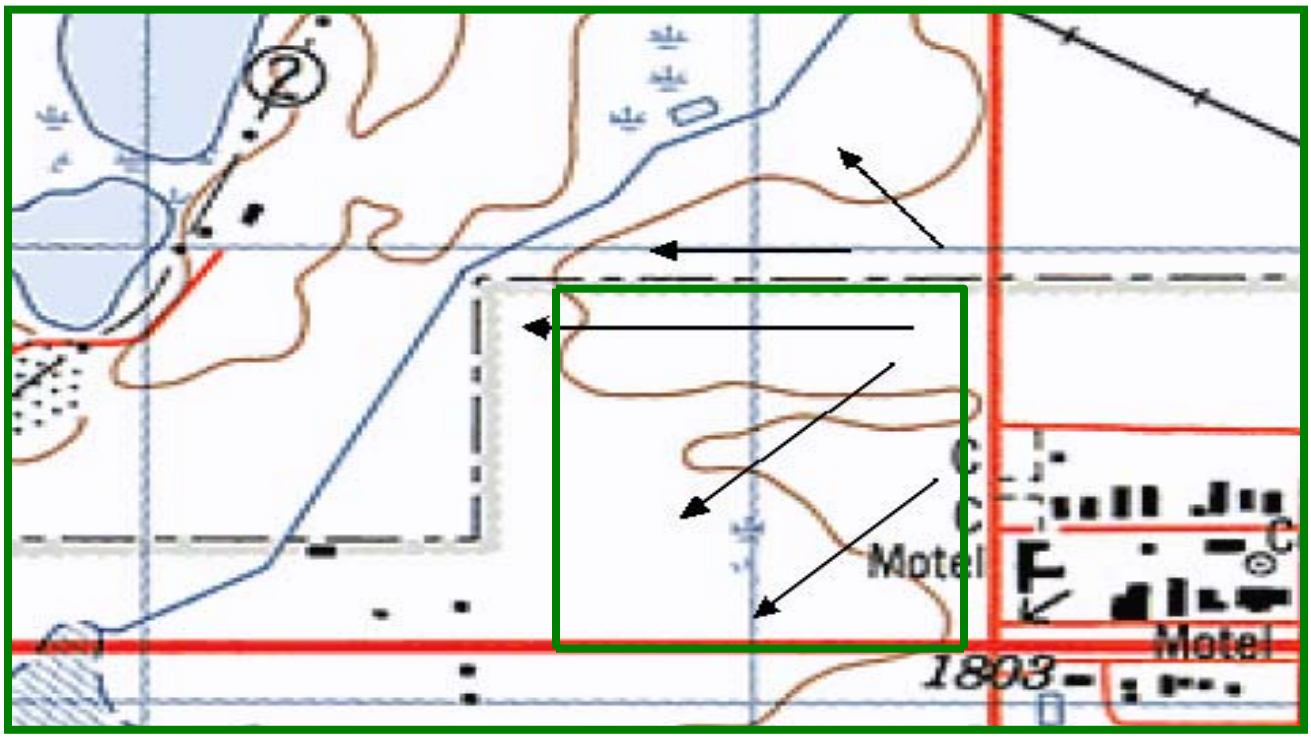


Figure 3: Orthographic View of the Area Being Considered for Development

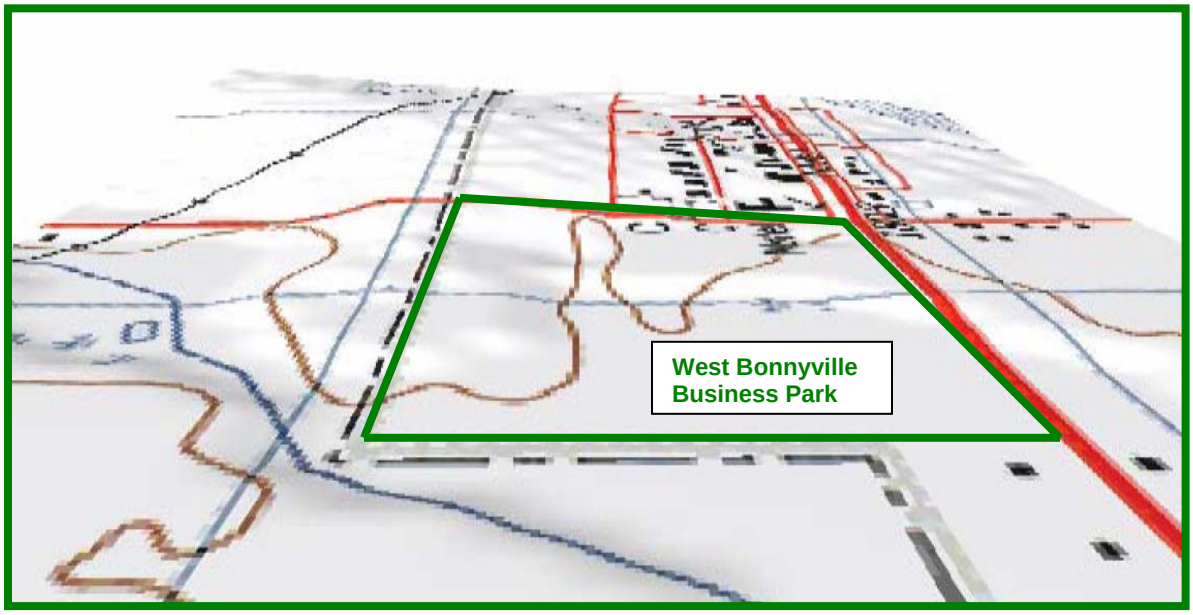


Figure 4: Colour Air Photo Identifying the Flow Storm Water to Moose Lake

3.0 Storm Water Management Flow Calculations

Storm water computer modelling was undertaken using a modelling program developed by the Environmental Protection Agency. The EPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from both rural and urban areas but primarily from urban areas. The runoff component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads. SWMM tracks the quantity and quality of runoff generated within each subcatchment area and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps. This model which was first developed in 1971 is now used internationally. The initial work involving the calculation of runoff from the proposed development area involved calculations for pre and post development runoff. It was concluded that a storm water management pond would address both quantity and quality issues for storm water runoff from the proposed development area.

Proposed design elevations were established to ensure that the superimposed topography would accommodate the flow off storm water runoff to a proposed retention pond. It is proposed that the retention pond be constructed in a natural low lying area of the proposed development area as shown on Figure 5.

The darker areas shown on Figure 5 indicate areas with higher elevations. The Town Engineer advised that there is a contributed off site drainage flow of approximately 0.14 m^3 per second that flows from the area to the north east of the proposed development. That additional flow was incorporated into the storm water runoff calculations.

Storm water runoff simulations were then undertaken for pre and post development 1 in 5 year rainfall events of 24 hours duration and pre and post development 1 in 100 year rainfall events of 24 hours duration. The actual rainfall intensity values were based on rainfall events that have been measured in Cold Lake. These values were used in the absence of measured rainfall statistics in Bonnyville on the advice offered by the Town Engineer.

The results are shown by Figures 6 and 7 and the associated calculations. The following summarizes the results:

Event	Duration	Pre Dev. Flow (m^3)	Post Dev. Flow (m^3)	Difference (m^3)
1 in 5 Yr.	24 hours	6863	21,098	14,235
1 in100 Yr.	24 hours	11881	36,535	24,654

Off site contributions must also be accommodated in the overall storm water management system for the development. The Town Engineer has indicated that:

"The north western portion (20 ha) of the partially developed existing Commercial/Industrial area to the east of the plan area drains through a 450 mm culvert crossing under 66th Street, 40 m North of the intersection between 66th Street and 54th Avenue. This existing Commercial/Industrial area will contribute a flow of 0.14 m³/s through the culvert to the proposed area. The applicant, through the ASP, must demonstrate how this flow will be accommodated through the ASP lands."

Preliminary calculations related to this suggested contribution would indicate that the contribution was calculated on the basis of the amount of run off that would be contributed from undeveloped land. The land is presently partially developed and could be considered for development in the foreseeable future. Consequently, the decision was taken to incorporate the anticipated runoff for developed industrial land as opposed to undeveloped land.

The additional off-site contribution from a 1 in 5 year event that must be accommodated in flow channels and stored on-site was calculated for industrial development as follows:

$Q = 0.00278 \times CIA$

Where :

Q = Quantity of Runoff in m^3/second
C = Runoff Coefficient = 0.6
I = Rainfall Intensity in mm/hr = 53.9 mm/hr
A = Area in Hectares = 20

$Q = 0.00278 \times (0.6) \times (53.9) \times (20)$

$= 1.80\ m^3/s$
$= 107.88\ m^3/min$
$= 6473.17\ m^3/hr$

The additional off-site contribution from a 1 in 100 year event that must be accommodated in flow channels and stored on-site was calculated for industrial development as follows:

$Q = 0.00278 \times (0.6) \times (94.2) \times (20)$

$= 3.14\ m^3/s$
$= 188.55\ m^3/min$
$= 11313.04\ m^3/hr$

The off site contributions must be accommodated by the both the flow channels and the storage capacity in the retention pond that will be included in the proposed West Bonnyville Business Park development.

Figure 5: Proposed Elevations

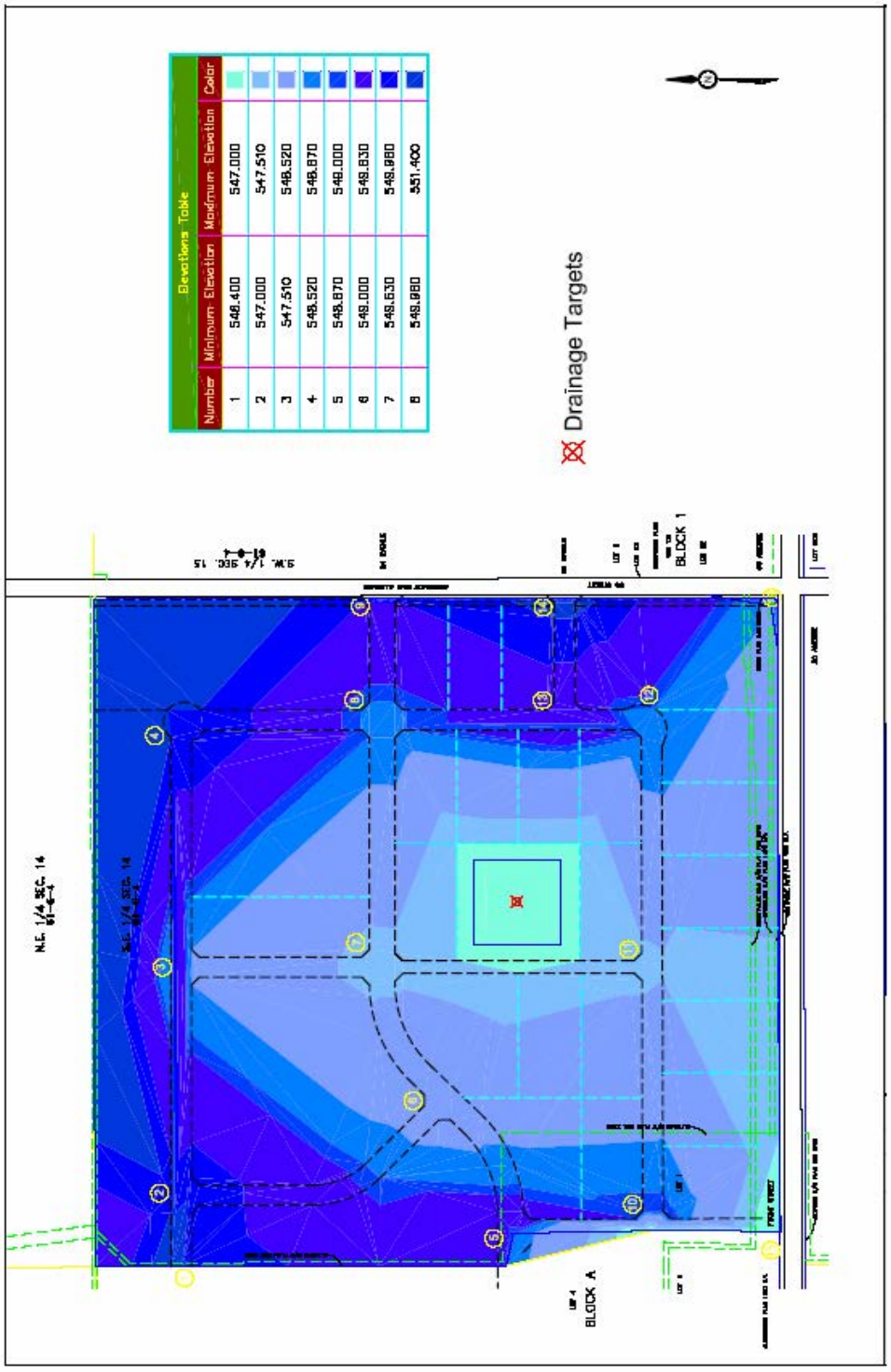
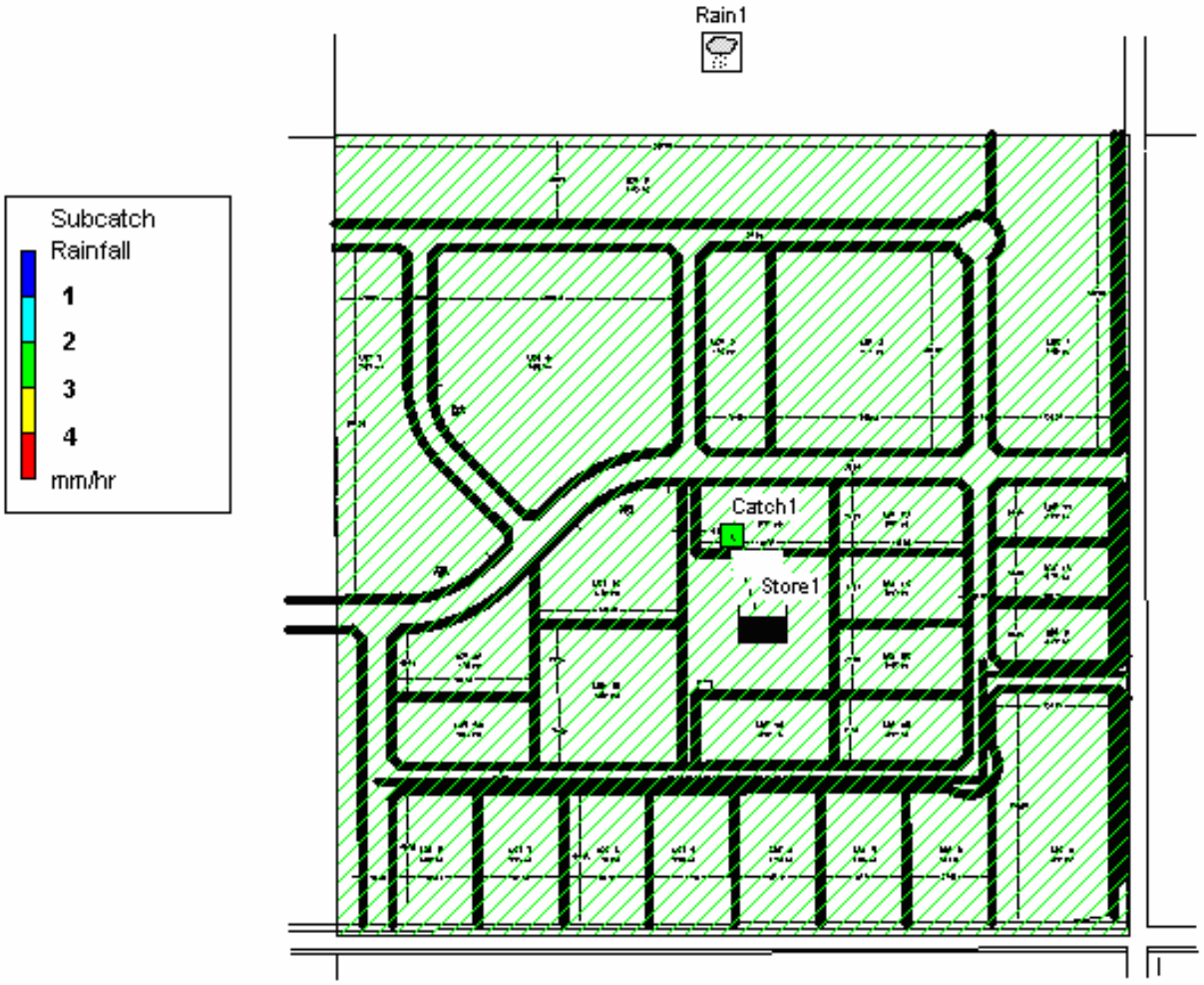


Figure 6

Storm Water Management Model for a 1 in 5 Year Rainfall Event – 24 Hour Duration



COMPUTER SIMULATED STORM WATER MANAGEMENT MODEL

For a 1 in 5 Year Rainfall Event on Undeveloped Land – 24 Hour Duration

(Runoff Coefficient = 0.197; Time of Duration = 24 Hours)

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	3.490	53.900
Evaporation Loss	0.000	0.000
Infiltration Loss	1.713	26.457
Surface Runoff	0.686	10.599
Final Surface Storage	0.000	0.000

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Runoff Coeff
Catch1	53.900	0.000	0.000	26.457	10.599	0.197
Totals	53.900	0.000	0.000	26.457	10.599	0.197

Area = 647,500 m^2 ;

Runoff = 10.60 mm = 0.0106 m/24 hours

Volume = (Area) x (Runoff)

= (647,500) x (0.0106) = 6863.5 m^3

Approximately 6863.5 m^3 of water will be generated during a 1 in 5 year storm, over 24 hours, on undeveloped industrial land.

COMPUTER SIMULATED STORM WATER MANAGEMENT MODEL

For a 1 in 5 Year Rainfall Event on Developed Industrial Land

(Runoff Coefficient = 0.605; Time of Duration = 24 Hours)

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	3.490	53.900
Evaporation Loss	0.000	0.000
Infiltration Loss	1.713	26.457
Surface Runoff	2.110	32.584
Final Surface Storage	0.000	0.000

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Runoff Coeff
Catch1	53.900	0.000	0.000	26.457	32.584	0.605
Totals	53.900	0.000	0.000	26.457	32.584	0.605

Area = 647,500m^2

Runoff = 32.584 mm = 0.0326 m

Volume (m^3) = (Area) x (Runoff)

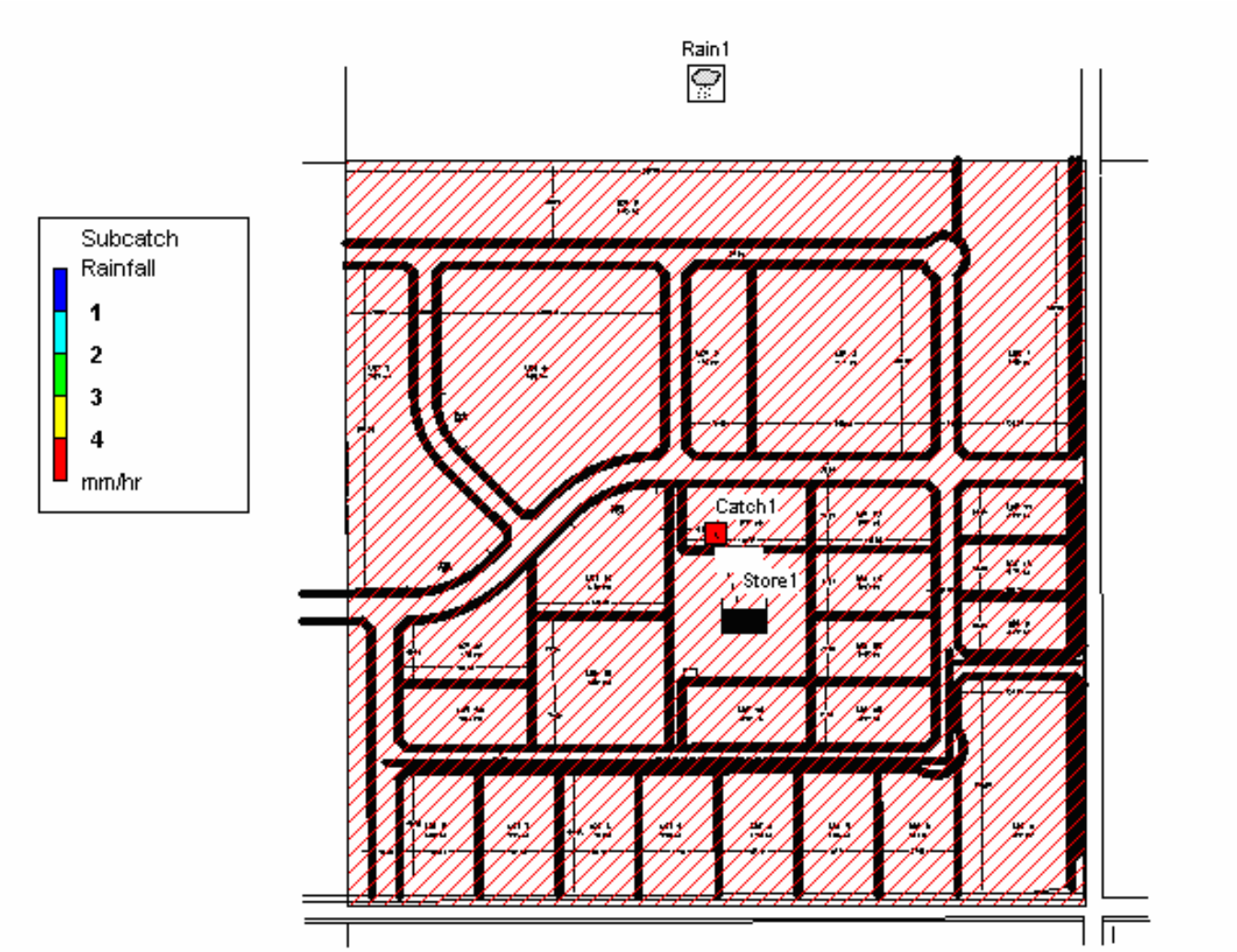
= 647,500 x 0.0326

= 21,108.5 m^3

Approximately 21,108.5 m^3 of runoff will be generated during a 1 in 5 year Rainfall Event, over 24 hours, on developed industrial land.

Figure 7

Storm Water Management Model for a 1 in 100 year Rainfall Event – 24 Hour Duration



COMPUTER SIMULATED STORM WATER MANAGEMENT MODEL

For a 1 in 100 Year Rainfall Event on Undeveloped Industrial Land

(Runoff Coefficient = 0.195; Time of Duration = 24 Hours)

************************ Runoff Quantity Continuity ************************	Volume hectare-m	Depth mm
Total Precipitation	6.099	94.200
Evaporation Loss	0.000	0.000
Infiltration Loss	1.751	27.038
Surface Runoff	1.188	18.350
Final Surface Storage	0.000	0.000

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Runoff Coeff
Catch1	94.200	0.000	0.000	27.038	18.350	0.195
Totals	94.200	0.000	0.000	27.038	18.350	0.195

Area = 647,500 m^2;

Runoff = 18.35 mm = 0.0184m/24 hours

Volume = (Area) x (Runoff)

= (647,500) x (0.0184) = 11,881.6 m^3

Approximately 11,881.6 m^3 of water will be generated during a 1 in 100 year Rainfall Event, over 24 hours, on undeveloped industrial land.

COMPUTER SIMULATED STORM WATER MANAGEMENT MODEL

For a 1 in 100 Year Rainfall Event on Developed Industrial Land

(Runoff Coefficient = 0.599; Time of Duration = 24 Hours)

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	6.099	94.200
Evaporation Loss	0.000	0.000
Infiltration Loss	1.751	27.038
Surface Runoff	3.654	56.426
Final Surface Storage	0.000	0.000
Continuity Error (%)	11.397	

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Runoff Coeff
Catch1	94.200	0.000	0.000	27.038	56.426	0.599
Totals	94.200	0.000	0.000	27.038	56.426	0.599

Area = 647,500 m^2

Runoff = 56.43 mm = 0.05643 m

Volume (m^3) = (Area) x (Runoff)

= 647,500 x 0.05643

= 36,538.4 m^3

Approximately 36,538.4 m^3 of runoff will be generated during a 1 in 100 year Rainfall Event, over 60 minutes, and developed industrial land.

The retention pond must be designed to accommodate the storm water contributions as outlined by the *Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems.* Selected Sections of that document have been attached to this report as Appendix “A”.

4.0 Proposed Retention Pond

The criteria used for the design of the storm water retention pond is as follows:

- The volume of the pond must accommodate the volume of storm water runoff generated by a 1 in 5 year rainfall event in a permanent pool,
- The volume of the storm water runoff generated by a 1 in 100 year rainfall event in the detention zone and additional freeboard area.

Then the volume of storm water that the retention pond must be able to accommodate is as follows:

21,108.5 m^3	(1 in 5 year in a permanent pool)
6,473.17 m^3/hr	(Additional off-site contribution from 1 in 5 year event)
36,538.40m^3	(Rainfall generated in a 1 in 100 year Rainfall)
11,313 m^3/hr	(Additional off-site contribution from 1 in 100 year event)

Total = 75,433 m^3

The proposed retention pond must accommodate 75,433 m^3 of water during a 1 in 100 year rainfall event.

5.0 Mitigation of Downstream Impacts

The incorporation of a retention pond is an acceptable effective way to control runoff discharges and enhance storm water quality prior to release into a receiving flow channel.

Section s 4, 5 and 6 of the *Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems, Best Management Practices (BMP's) for Removal of Pollutants from Storm Water*, states"

"**4. Effectiveness**

Wet ponds are probably the most common end-of-pipe management facility for the control of peak runoff discharges and the enhancement of water quality. Wet ponds are very effective in controlling runoff and improving water quality when proper design considerations are made for those two objectives.

5. Water Quantity

As a detention facility, a wet pond typically flattens and spreads the inflow hygrograph, thus lowering the peak discharge. Wet ponds are effective in controlling the post-development peak discharge rate to the desired

predevelopment levels for design storms. Watershed/sub watershed analyses should be performed to coordinate subcatchment/pond release rates for regional flood control. Wet ponds are relatively ineffective for volume reduction, although some infiltration and/or evaporation may occur. Wet ponds are generally effective in controlling downstream erosion if designed such that the duration of post development "critical impulses" does not exceed a pre-determined erosive threshold.

6. Water Quality

Wet ponds have been cited as providing the most reliable end-of-pipe BMP in terms of water quality treatment. This reliability is attributed to a number of actors including:

- Performance does not depend on soil characteristics
- Permanent pool prevents resuspension
- Permanent pool minimizes blockage of outlet
- Promotes biological removal of pollutants
- Permanent pool provides extended settling

Wet ponds have a moderate to high capacity to remove most urban pollutants depending on how large the volume of the permanent pool is in relation to the runoff produced from the contributing drainage area. The establishment of vegetative zones in and around a wet pond can enhance its pollutant removal capability."

The incorporation of a wet pond or retention addresses the issues associated with both storm water quality and flow control.

The proposed wet pond that will be included in this development will incorporate a wet well and pumping system for removal of excess storm water. The pumps will be designed to ensure that post development flow rates will not be exceeded. An outfall structure will also be constructed at the end of the pipe to ensure that erosion and scouring of the soil does not occur.

6.0 Summary

The approach taken to address the flow of storm water onto and over the proposed development ensures that predevelopment rates of storm water flow are maintained and that the quality of storm water contributions to existing receiving bodies of water is maintained at a high standard. The system has been developed on the basis of "Best Management Practices" throughout the course of the work undertaken to prepare this report.

Appendix "A"

Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems

Best Management Practices (BMP's) for Removal of Pollutants from Storm Water

Best Management Practices (BMP's) for Removal of Pollutants from Storm Water

From

The Province of Alberta's

Standards for Municipal Waterworks, Wastewater and Storm Drainage Systems

August 15, 2005

Grassed Swales and Water Quality

8.3.4.6. Water Quality

Grassed swales can be effective in filtering and detaining storm water runoff from a variety of catchment types. Grassed swales are effective for storm water treatment as long as minimum channel slope is maintained and a wide bottom width is provided. Many storm water contaminant particulates are effectively filtered by grassed swales including heavy metals, COD, nitrate nitrogen, ammonia nitrogen, and suspended solids. Other contaminant nutrients such as organic nitrogen, phosphorus, and bacteria have been reported to bypass grass swales.

Water Quality Enhancement in Wet Ponds and Wetlands

8.3.5 End-of-Pipe Storm Water BMPs

End-of-pipe storm water BMPs provide water quality enhancement to storm water prior to discharge into a receiving water body. A number of end-of-pipe alternatives are available for application depending on the characteristics of the upstream catchment and the requirements for water quality enhancement. Eight general categories of end of pipe BMP facilities are discussed:

- Wet ponds
- Dry ponds
- Wetlands
- Infiltration trenches
- Infiltration basins
- Filter strips
- Sand filters
- Oil/grit separators

All references to "wet ponds", "wetlands", or "dry ponds" assume that extended detention storage is provided. Extended detention refers to the dry or active storage provided by these facilities. Extended detention ponds reduce the rate of storm water discharge by storing the storm water runoff temporarily and releasing it at a controlled rate. Water quality treatment is provided through enhanced settling and biological processes. As such, extended detention storage provides benefits related to water quality, erosion protection, and flooding potential.

8.3.5.1 Wet Ponds

1. Purpose

The purpose of wet ponds is to temporarily store storm ater runoff in order to promote the settlement of runoff pollutants and to restrict discharge to predetermined levels to reduce downstream flooding and erosion potentials.

2. Description

Wet ponds can be created as an impoundment by either constructing an embankment or excavating a pit. They are often designed as a two-stage (dualpurpose) facility, where the upper stage (flood fringe area) is designed to store large, infrequent storms, and the lower stage (extended detention stage) is designed to store, and promote sedimentation, of smaller, more frequent storms. The deep, permanent pond is the wet pond's primary water quality enhancement mechanism. Runoff entering the retention basin is designed to displace water already in the permanent pool and remain there until another storm event. Runoff entering the basin is slowed by the permanent pool and suspended pollutants are allowed to settle. Biologic processes, such as nutrient uptake by algae, are established in the permanent pool and help reduce concentrations of soluble contaminants. A vegetative planting strategy should provide shading, aesthetics, safety, and enhanced pollutant removal.

3. Applicability

A reliable source of runoff or groundwater discharge must be available to maintain the permanent pool of a wet pond. As such, wet ponds are generally considered for drainage areas greater than 5 ha. Because of a wet pond's ability to reduce soluble pollutants, it is generally applicable to residential, commercial, or industrial areas where nutrient loadings may be expected to be relatively high. Wet ponds may not be appropriate, or may require specialized design, where receiving water temperatures are a concern.

4. Effectiveness

Wet ponds are probably the most common end-of-pipe management facility for the control of peak runoff discharges and the enhancement of water quality. Wet ponds are very effective in controlling runoff and improving water quality when proper design considerations are made for those two objectives.

5. Water Quantity

As a detention facility, a wet pond typically flattens and spreads the inflow hygrograph, thus lowering the peak discharge. Wet ponds are effective in controlling the post-development peak discharge rate to the desired predevelopment levels for design storms. Watershed/subwatershed analyses should be performed to coordinate subcatchment/pond release rates for regional flood control. Wet ponds are relatively ineffective for volume reduction, although some infiltration and/or evaporation may occur. Wet ponds are generally effective in controlling downstream erosion if designed such that the duration of post evelopment "critical impulses" does not exceed a pre-determined erosive threshold.

6. Water Quality

Wet ponds have been cited as providing the most reliable end-of-pipe BMP in terms of water quality treatment. This reliability is attributed to a number of factors including:

- Performance does not depend on soil characteristics
- Permanent pool prevents resuspension
- Permanent pool minimizes blockage of outlet
- Promotes biological removal of pollutants
- Permanent pool provides extended settling

Wet ponds have a moderate to high capacity to remove most urban pollutants depending on how large the volume of the permanent pool is in relation to the runoff produced from the contributing drainage area. The establishment of vegetative zones in and around a wet pond can enhance its pollutant removal capability.

Some water quality control design parameters for Wet Ponds are:

- Permanent pool sized to store the volume of runoff from a 25-mm storm over the contributing area

- Detention time of 24 hours

- Length to width ratio shall be from 4:1 to 5:1

- Minimum permanent pool depth of 2.0 m

- Maximum permanent pool depth of 3.0 m The maximum water level should be below adjacent house basement footings.

- Maximum active detention storage depth of 1.5 m

- 1-in-100-year storm stored within 2 m above the permanent pool (Alternatively, the 2 m can be used to store the 1-in-25-year storm. In such cases an emergency overflow drainage system should be constructed with the capacity to carry storm runoff from the 1-in-100-year storm event to receiving streams or downstream storm water management facilities.)

- Detention time of 24 hours. Also, a wet ponds water quality control performance can be improved by providing a pretreatment sump or forebay and a backup water supply to maintain the minimum storage volume. During the design process, other design considerations should be evaluated that relate to ease of maintenance. The forebay should be designed with the following parameters:

- Length to width ratio of 2:1 or greater

- Forebay surface area not to exceed one-third of the permanent pool surface Area

- Forebay length, L_{fb} as follows:

$$L_{fb} = [rQ_p/V_s]_{0.5}$$

where:

r = Length to width ratio of forebay

Q_p = Peak flow rate from the pond during the design quality storm (m_3/s)
V_s = Settling velocity (dependent on the desired particle size to settle)

- Dispersion length, L_{dis} as follows:

  $L_{dis} = (8Q)/(dV_f)$

  where:

  Q = inlet flow rate (m_3/s)
  d = depth of permanent pool in the forebay (m)
  V_f = desired velocity at the end of the forebay

- Forebay Bottom Width, $W = L_{dis}/8$

- Forebay berm should be 0.15 to 0.3 metres below the permanent pool elevation

Constructed Wetlands

8.3.5.3

6. Water Quality
In general, wetland water treatment systems have been found to lower BOD, TSS, and total nitrogen concentrations to 10 to 20 percent of the concentrations entering the systems. For total phosphorus, metals, and organic compounds, removal efficiencies vary widely, typically from 20 to 90 percent. Removal of these latter constituents appears to be limited by substrate type, the form of the constituents, the presence of oxygen, and the entire chemical makeup of the water to be treated.

TABLE 8-2

BMP ADVANTAGES AND DISADVANTAGES

BMP	Advantages	Disadvantages
Wet pond	• Capable of removing soluble as well as solid pollutants • Provides erosion control • Habitat, aesthetic, and recreation opportunities provided • Relatively less frequent maintenance schedule	• More costly than dry ponds • Permanent pool storage requires larger land area • Could have negative downstream temperature impacts • Could be constrained by topography or land designations • Sediment removal relatively costly when required
Dry pond	• Batch mode has comparable effectiveness to wet ponds • Not constrained by land area required by wet ponds • Can provide recreational benefits	• Potential resuspension of contaminants • More expensive O&M costs than wet ponds (batch mode)
Wetlands	• Pollutant-removal capability similar to wet ponds • Offers enhanced nutrient-removal capability • Potential ancillary benefits, including aviary, terrestrial, and aquatic habitat	• Requires more land area than wet ponds • Could have negative downstream temperature impacts • Could be constrained by topography or land designations • Potential for some nuisance problems
Infiltration trenches	• Potentially effective in promoting recharge and maintaining low flows in small areas • May be appropriate as secondary facility where maintenance of groundwater recharge is a concern • No thermal impact • No public safety concern	• Appropriate only to small drainage areas (<2 ha) and residential land uses • Constrained by native soil permeabilities • Usually requires pretreatment device • Potential contamination of groundwater must be investigated • Generally ineffective for water quantity control • High rate of failure due to improper siting and design, pollutant loading, and lack of maintenance
Infiltration basins	• Potentially effective in promoting recharge and maintaining low flows in small areas • May be appropriate as secondary facility where maintenance of groundwater recharge is a concern • No thermal impact • No public safety concern	• Appropriate only to relatively small drainage areas (<5 ha) and residential land uses • Constrained by native soil permeabilities • Pretreatment is recommended • Potential contamination of groundwater must be investigated • Generally ineffective for water quantity control • High rate of failure due to improper siting and design, pollutant loading, and lack of maintenance

TABLE 8-2

BMP ADVANTAGES AND DISADVANTAGES

BMP	Advantages	Disadvantages
Filter strips	• Water quality benefits may be realized if part of overall SUM plan (i.e., as secondary facility) • Effective in filtering out suspended solids and intercepting precipitation • May reduce runoff by reducing overland flow velocities, increasing time of concentration, and increasing infiltration • Can create wildlife habitat • No thermal impact	• Limited to small drainage areas (<2 ha) with little topographic relief • Uniform sheet flow through vegetation difficult to maintain • Effectiveness in freeze/thaw conditions questionable
Sand filters	• Generally effective in removing pollutants, are resistant to clogging and are easier/less expensive to retrofit compared to infiltration trenches	• Not suitable for water quantity control • Generally applicable to only small drainage areas (<5 ha) • Do not generally recharge groundwater system • May cause aesthetic/odour problems • O&M costs generally higher than other end-of-pipe facilities
Oil/Grit Separators (3-Chamber Separator)	• Offline, 3-chamber (oil, grit, discharge) separators may be appropriate for commercial, industrial, large parking, or transportation-related areas less than 2 ha	• Scour and resuspension of trapped pollutants in heavy rainfall events • Difficult to maintain • Relatively high O&M costs • Online design of 3-chamber separators has resulted in poor pollutant removal performance
Oil/Grit Separators (Bypass Separator)	• Bypass prevents the scouring and resuspension of trapped pollutants in heavy rainfall events • Effective in removing sediment load when properly applied as a source control for small areas • Effective in trapping oil/grease from run off	• Relatively high capital costs compared to manholes • Applicable for drainage areas less than 5 ha

TABLE 8-5

EFFECTIVENESS OF BEST MANAGEMENT PRACTICES FOR CONTROL OF RUNOFF FROM NEWLY DEVELOPED AREAS

Management Practice		Removal Efficiency (%)						Factors	References
		TSS	TP	TN	COD	Pb	Zn		
Vegetated Filter Strip	Average:	65	40	40	40	45	60	Runoff volume Slope Soil infiltration rates Vegetative cover Buffer length	IEP, 1991 Casman, 1990 Glick et al, 1991 VADC, 1987 Minnesota PCA, 1989 Scheuler, 1967 Hartigan et al 1969
	Reported Range:	20-80	0-95	0-70	0-60	20-90	30-90		
	Probable Range:	40-90	30-80	20-60	-	30-80	20-50		
	No. of Values Considered:	7	4	3	2	3	3		
Grass Swale	Average:	60	20	10	25	70	60	Runoff volume Slope Soil infiltration rates Vegetative cover Swale length Swale geometry	Yousel et al, 1965 Dupuls, 1985 Washington State, 1968 Schuerer, 1967 British Columbia Res. Corp, 1991 EPA, 1983 Whelen et al, 1988 PIN, 1966 Caeman, 1990
	Reported Range:	0-100	0-100	0-40	25	3-100	50-80		
	Probable Range:	20-40	20-40	10-30	-	10-20	10-20		
	No. of Values Considered	10	8	4	1	10	7		
Porous Pavement	Average:	35	5	20	5	15	5	Maintenance Sedimentation storage volume	Pitt, 1965 Field, 1985 Schueler, 1967
	Reported Range:	0-95	5-10	5-55	5-10	10-25	5-10		
	Probable Range:	10-25	5-10	5-10	5-10	10-25	5-10		
	No. of Values Considered:	3	1	2	1	2	1		

TABLE 8-5

EFFECTIVENESS OF BEST MANAGEMENT PRACTICES FOR CONTROL OF RUNOFF FROM NEWLY DEVELOPED AREAS

Management Practice		Removal Efficiency (%)						Factors	References
		TSS	TP	TN	COD	Pb	Zn		
Wet Pond	Average:	60	45	35	40	75	80	Pond volume Pond shape	Wotzka and Oberta, 1966 Yousel et al, 1968 Cullum, 1985 Driscoll, 1983 Driscoll, 1986 MWCOG, 1963 OWML, 1963 Yu and Benemouflok, 1986 Hother, 1989 Martin, 1966 Dowman et al, 1969 OWML, 1962 City of Austin, 1990
	Reported Range:	(-30)-91	10-85	5-85	5-90	10-85	10-95		
	Probable Range:	50-90	20-90	10-90	10-90	10-95	20-95		
	No. of Values Considered:	18	18	9	7	13	13		
Extended-Detention Wet Pond	Average:	80	65	55	NA	40	20	Pond volume Pond shape Detention time	Ontario Ministry of the Environment, 1991 cited in Schueler et al 1992
	Reported Range:	50-100	50-60	55	NA	40	20		
	Probable Range:	50-95	50-90	10-90	10-90	10-95	20-95		
	No. of Values Considered:	3	3	1	0	1	1		

TABLE 8-5

EFFECTIVENESS OF BEST MANAGEMENT PRACTICES FOR CONTROL OF RUNOFF FROM NEWLY DEVELOPED AREAS

Management Practice		Removal Efficiency (%)						Factors	References
		TSS	TP	TN	COD	Pb	Zn		
Constructed Stormwater Wetlands	Average:	65	25	20	50	65	35	Storage volume Detention time Pool shape Wetlands biota Seasonal variation	Harper et al, 1966 Brown, 1985 Wotzka and Oberta, 1966 Hickock et al, 1977 Burten, 1967 Martin, 1966 Morris et al, 1961 Sherberger and Davis, 1962 ABAG, 1979 Oberts et al, 1969 Rushton and Dye, 1990 Hay and Barrett, 1991 Martin and Smool, 1986 Ralnelt et al, 1990 cited in Woodward and Clyde, 1991
	Reported Range:	(-20)-100	(-120)-100	(-15)-40	20-80	30-95	(-30)-60		
	Probable Range:	50-90	(-5)-80	0-40	-	30-95	-		
	No. of Values Considered:	23	24	6	2	10	8		

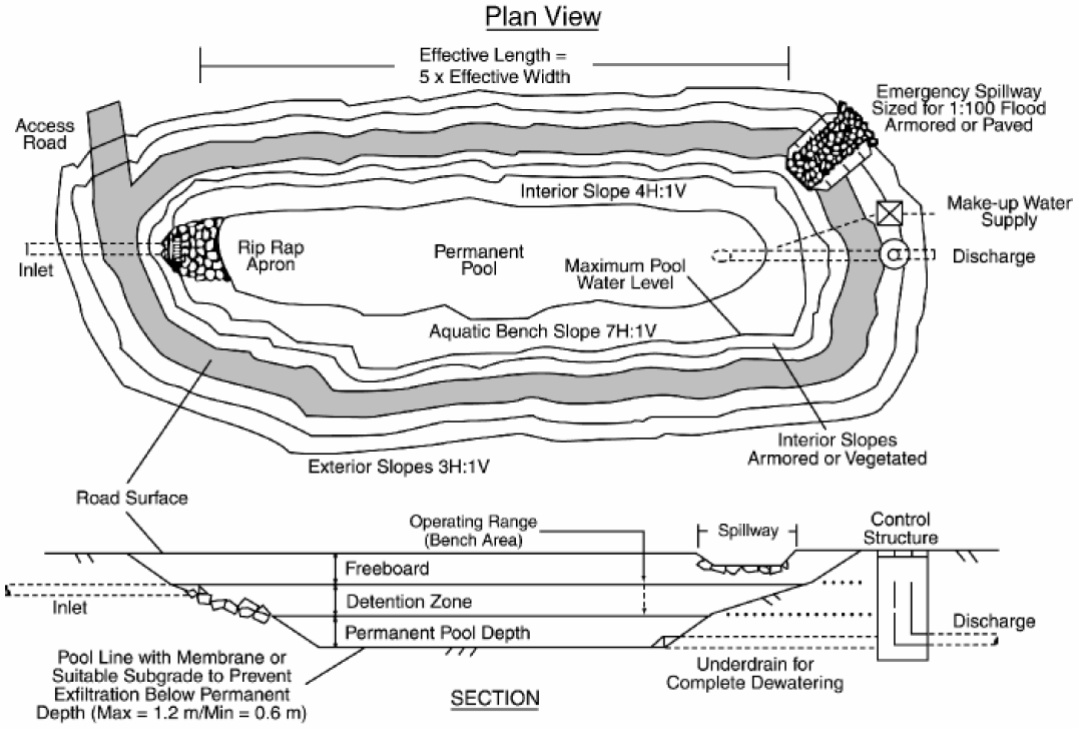


Figure 8.10
Wet Detention Pond Plan and Sections