Regional Assessment of the Groundwater Quality in the Beverly Channel in the Fort Saskatchewan Area

Prepared for:

Northeast Capital Industrial Association

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1.0 Introduction

Stantec Consulting Ltd. (Stantec) has been retained by the Northeast Capital Industrial Association (NCIA) to develop and populate a database management system in support of the multi-phase Regional Groundwater Investigation project.

The Regional Groundwater Investigation project is intended to provide a framework for regional scale management of groundwater quality and quantity issues in the Fort Saskatchewan area. The focus of this project is to develop management tools to address groundwater quality issues, however many of these tools could be used to address groundwater quantity issues as well.

The project aligns well with the principles and recommendations outlined in the Provincial Government's water strategy, *Water for Life: Alberta's Strategy for Sustainability* (Alberta Environment, 2003). "Information and knowledge of our provincial water resource was clearly defined as the most critical element in our ability to manage water effectively" (Alberta Environment, 2003). Specifically, this project seeks to:

- Develop scientific knowledge of groundwater resources in the Fort Saskatchewan area;
- gain understanding of emerging groundwater issues in the Fort Saskatchewan area; and,
- provide tools required to make effective management decisions.

1.1 PROJECT OVERVIEW AND PHASE I SCOPE OF WORK

The NCIA Regional Groundwater Investigation project will provide a detailed characterization of the extent, thickness, and hydrochemistry of the Beverly Channel aquifer in the Fort Saskatchewan area. The Beverly Channel aquifer is a major preglacial buried valley aquifer that serves as a source of useable water for rural Albertans along its path.

The project has been subdivided into four phases to be completed over a four to five year span (NCIA, 2003). In brief summary, the four phases of the project are:

- **Phase I:** Development of a database for hydrogeological data storage and subsequent analysis. Spatial analysis of existing data to determine where the data gaps are. Recommendations for drilling locations required to address the aforementioned data gaps.

- **Phase II:** Development and implementation of a field drilling program to obtain lithological and hydrochemical information in areas where data gaps were identified. Interpretation of existing and new data to develop a regional hydrogeologic framework for the project area.

- **Phase III:** Development of a numerical groundwater flow and contaminant transport model. Calibration and verification of the model. Determination of strategic locations for the permanent regional groundwater monitoring system using the model.

- **Phase IV:** Development and implementation of the regional groundwater monitoring system, long term monitoring strategy, and response plan.

This report presents the work conducted under Phase I of the project. The scope of work for Phase I of this project included:

- Project initiation;

- Data compilation;

- Development of QA/QC Protocols;

- Development of the Database Management System (DMS);

- Population of the DMS;

- Preliminary Data Analysis and identification of data gaps; and

- Preparation of Documentation

1.2 NCIA MEMBER COMPANIES

At the time of commencement of the project, there were 18 NCIA member companies. Since then, three additional companies have become NCIA members, bringing the total membership to 21. Table 1.1 presents a list of all current NCIA member companies. Figure 1.1 presents a map indicating the location of the NCIA member companies for reference.

RGE 22

RGE 21

RGE 20

TWP 56

TWP 55

TWP 54

N

1
5
18
20
19
14
15b
15a
2
11
3
10
4
7
6
16
9a
12a
12b
9b
8

83H/11 NW

83H/11 NE

FORT SASKATCHEWAN

BRUDERHEIM

ASTOTIN

NCIA Member Companies

- Agrium Redwater (1)
- Agrium, Sherritt, Sulzer, Umicore, Westaim (16)
- Air Liquid Canada Inc. (2)
- BA Energy Inc. (19)
- BP Canada Energy Company (4)
- Degussa Canada Inc. (5)
- Dow Chemical Canada Inc. (6)
- EnerPro Midstream (7)
- Erco Worldwide (3)
- Guardian Chemicals Inc. (8)
- Marsulex Inc. (9a)
- Marsulex Sulphides (9b)
- Nexen Chemicals (10)
- Oxy Vinyls Canada Inc. (11)
- Praxair Canada Inc. Air Separation Plant (12a)
- Praxair Canada Inc. CO2 Plant (12b)
- Provident Energy Ltd. (18)
- Shell Canada Ltd. (15a)
- Shell Chemicals Canada (14)
- Shell Upgrader (15b)
- Terasen Pipelines Inc. (20)

Location of Beverly Channel (Stein, 1976)

Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

1.1

Title

Location of Member Companies

Table 1.1: NCIA Member Companies

NCIA Member Company	Map ID
Agrium	1,16
Air Liquide Canada Inc.	2
BA Energy Inc.	19
BP Canada Energy Company	4
Degussa Canada Inc.	5
Dow Chemical Canada Inc.	6
EnerPro Midstream	7
ERCO Worldwide	3
Guardian Chemicals Inc.	8
Marsulex Inc.	9a,9b
Nexen Chemicals	10
Oxy Vinyls Canada Inc.	11
Praxair Canada Inc.	12a,12b
Provident Energy Ltd.	18
Shell Canada Ltd.	15a,15b
Shell Chemicals Canada	14
Sherritt International Corp.	16
Sulzer Metco (Canada) Inc.	16
Terasen Pipelines Inc.	20
The Westaim Corporation	16
Umicore Canada Inc.	16

1.3 NCIA STUDY AREA

Figure 1.2 presents a hydrogeological map of the Fort Saskatchewan area (Modified from Stein, 1976) indicating the interpreted extent of the Beverly Channel. The NCIA Project Area boundary shown on the map begins immediately upgradient of the Agrium Fort Saskatchewan Plant site and ends immediately downgradient of the Shell Chemicals Scotford Plant site. The Project Area also includes the full expected width of the Beverly Channel, as per the request for proposal (NCIA, 2003).

The NCIA Study Area is also shown on Figure 1.2. Although the focus of this project is primarily the Beverly Channel and its associated tributary channels, an additional buffer zone was included to delineate the spatial limits of the study area. This buffer zone was included to ensure that enough data was imported into the database to support numerical groundwater modeling in latter phases of the project. The additional buffer extent is required to minimize the influence of model domain boundary effects during the hydrogeological numerical modeling to be conducted in Phase III of the project.

RGE 22

RGE 21

RGE 20

TWP 56

TWP 55

TWP 54

Cross Section Location

Study Area

Project Area

tudy Area

Stantec

NCIA Member Companies

- Agrium Redwater (1)
- Agrium, Sherritt, Sulzer, Umicore, Westaim (16)
- Air Liquid Canada Inc. (2)
- BA Energy Inc. (19)
- BP Canada Energy Company (4)
- Degussa Canada Inc. (5)
- Dow Chemical Canada Inc. (6)
- EnerPro Midstream (7)
- Erco Worldwide (3)
- Guardian Chemicals Inc. (8)
- Marsulex Inc. (9a)
- Marsulex Sulphides (9b)
- Nexen Chemicals (10)
- Oxy Vinyls Canada Inc. (11)
- Praxair Canada Inc. Air Separation Plant (12a)
- Praxair Canada Inc. CO2 Plant (12b)
- Provident Energy Ltd. (18)
- Shell Canada Ltd. (15a)
- Shell Chemicals Canada (14)
- Shell Upgrader (15b)
- Terasen Pipelines Inc. (20)

Location of Beverly Channel (Stein, 1976)

Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

1.2

Title

Location of Project Area and Study Area

2.0 Background Information

2.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The regional geology in the Fort Saskatchewan area has been influenced by preglacial, glacial, and postglacial events. The Beverly Channel is a major preglacial valley in the area which consists of sands and gravels on top of bedrock. The channel is roughly coincident with the present day North Saskatchewan River Valley. The Belly River Formation, which consists of alternating layers of bentonitic shales and sandstones, carbonaceous shales, mudstone or siltstone, and coal seams, forms the near-surface bedrock. The Lea Park Formation (shales) directly underlies the Belly River Formation (Stein, 1976). Figure 2.1 presents a typical geological cross section of the Beverly Channel in the Fort Saskatchewan area. Figure 2.1a presents the cross section location.

Glacial drift constitutes the bulk of the materials that overlie the sands and gravels of the Beverly Channel. The drift is comprised of till, fluviolacustrine and intertill deposits of clay, silt, and/or sand. Recent deposition in the North Saskatchewan River Valley has replaced the drift with fine to coarse-grained alluvial sediments.

Late Cretaceous bedrock of the Belly River Formation underlies the Project Area. The bedrock strata consist of nonmarine clay shales, siltstones, sandstones, and mudstones. Coal seams have been noted in the bedrock. Some fracturing of the bedrock may be present, but its extent has not been defined (Rescan, 1993).

Overlying the bedrock beneath the site are five unconsolidated units (Andriashek and Pawlowizc, 1995). The basal unit resting on bedrock consists of sands and gravels of the Tertiary Empress Formation. These are the fluvial deposits that have infilled the Beverly Channel. The stratified sequence overlying the Empress Formation consists of fluvial sediments in the river terrace area and glacial sediments in the uplands area of the Plant Site. The river terrace units are Recent alluvium, ranging from clay and silt to sand and gravel. The uplands units (from bottom to top) are Quarternary drift comprised of clayey till, sandy intertill, lacustrine clay, fluvial and aeolian sand.

The regional hydrogeology for the Fort Saskatchewan area is presented in Stein (1976), which described the regional hydrogeology of the Edmonton area (northeast segment). The gravel and sand deposits of the Beverly Channel are regional aquifers that affect both groundwater availability and flow distribution. Figure 2.2 presents the general location of the Beverly Channel in the Fort Saskatchewan area (Modified from Stein, 1976). The Beverly Channel is in direct hydraulic connection with the North Saskatchewan River and water levels in the channel vary with river

stage fluctuations in the immediate vicinity of the river. Groundwater flow is generally toward the Beverly Channel and the North Saskatchewan River. Because of its high permeability, the Beverly Channel acts as a preferential channel for groundwater flow. In places, groundwater flow may be expected to be approximately parallel to the North Saskatchewan River, while in other places it is towards the river.

Local aquifers can be found in gravel, sand, and silt lenses within the till. Glacialfluvial deposits and aeolian dune fields are also present and may constitute local aquifers.

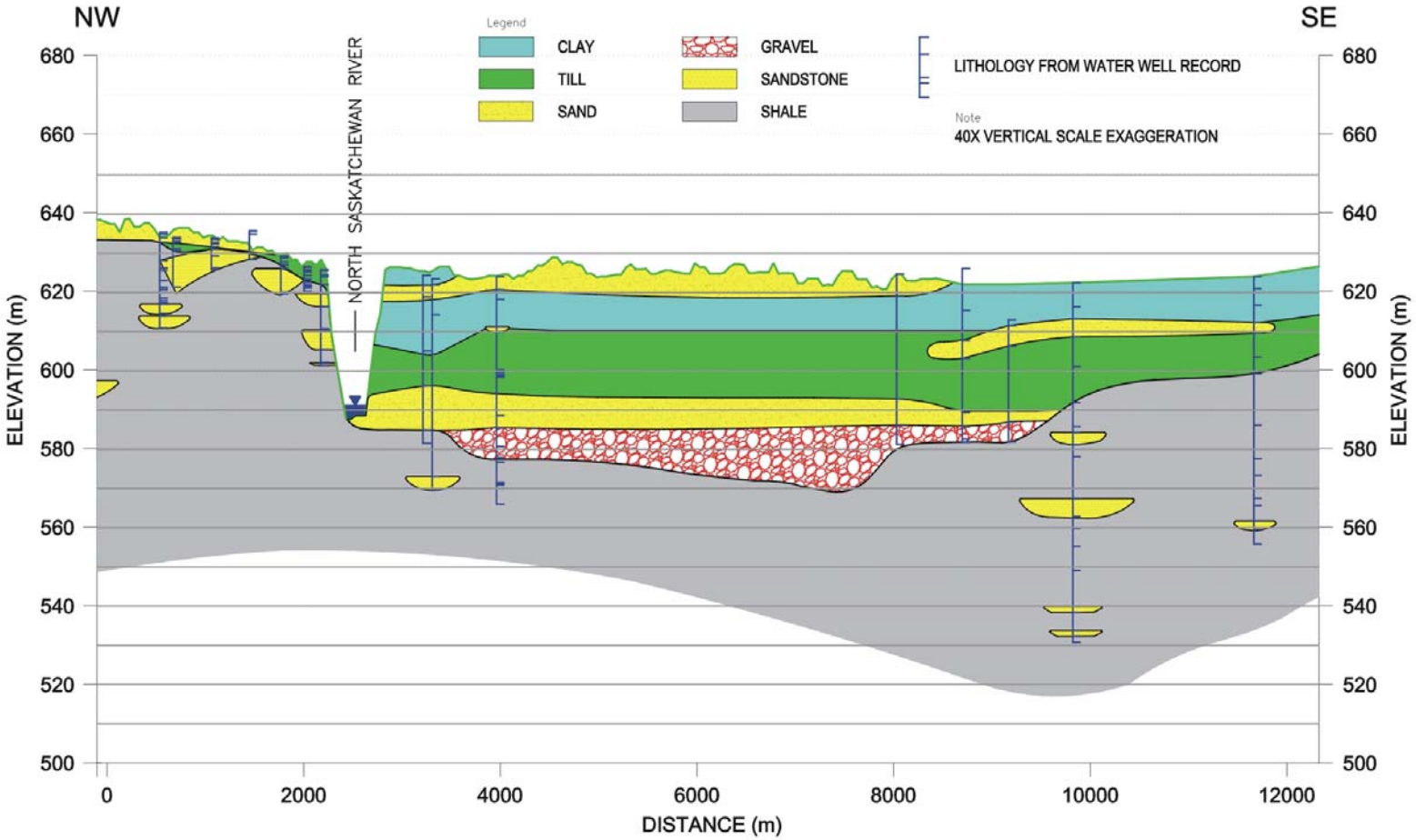
Stein (1976) reports that groundwater quality in drift aquifers is variable, with total dissolved solids ranging from less than 500 mg/L to more than 3,000 mg/L, and locally exceeding 6,000 mg/L. In some sand dunes, portions of near-surface outwash sands and gravels, and in the Beverly Channel, total dissolved solids generally range from less than 500 mg/L to approximately 1000 mg/L.

2.2 PROJECT INITIATION SURVEY

A Project Initiation Survey was prepared and distributed to all NCIA member companies during the initial stages of this project. The survey was developed in order to determine the needs of the NCIA member companies, and to estimate the amount and types of data which were available for the Project Area. A blank copy of the Project Initiation Survey is included in Appendix A for reference.

The results of the survey were compiled and summarized in order to initiate design of the database structure and functionality. Based on the surveys received, the total number of boreholes from NCIA member companies was 3,516. These boreholes were classed into three general depth ranges (0-10 m, 10-20 m, and >20 m) and percentages of the total were calculated for each depth class. Figure 2.3 presents the proportion of the total for each depth class.

The total number of monitoring wells from NCIA member companies was 1,236. These monitoring wells were also classed into three general depth ranges (0-10 m, 10-20 m, and >20 m) and percentages of the total were calculated for each depth class. Figure 2.4 presents the proportion of the total for each depth class.



Legend

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BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No. **2.1**

Title **Typical Geological Cross Section**

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RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56 | TWP 55 | TWP 54

Study Area

Study Area

Project Area

Cross Section Location

Stantec

NCIA Member Companies

- Agrium Redwater (1)
- Agrium, Sherritt, Sulzer, Umicore, Westaim (16)
- Air Liquid Canada Inc. (2)
- BA Energy Inc. (19)
- BP Canada Energy Company (4)
- Degussa Canada Inc. (5)
- Dow Chemical Canada Inc. (6)
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- Provident Energy Ltd. (18)
- Shell Canada Ltd. (15a)
- Shell Chemicals Canada (14)
- Shell Upgrader (15b)
- Terasen Pipelines Inc. (20)

Location of Beverly Channel (Stein, 1976)

Approximate Extent

Scale

5000 0 5000 Meters

1:150,000

Client / Project

NCIA Northeast Capital Industrial Association

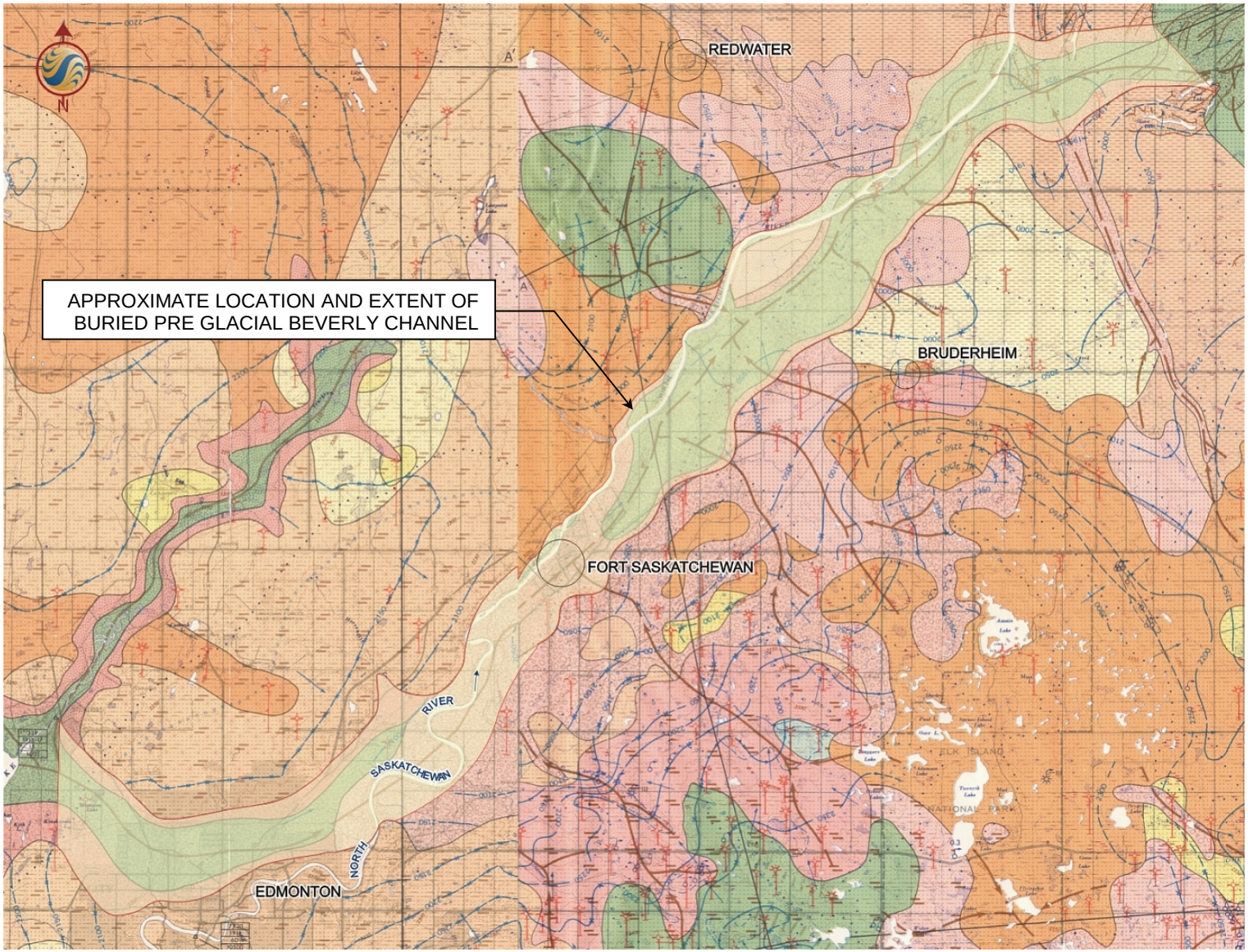
REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

2.1a

Title

Location of Regional Geological Cross Section



Legend

Stantec

Client/Project

NCIA
Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.
2.2

Title
General Location of the Buried Pre-glacial Beverly Channel

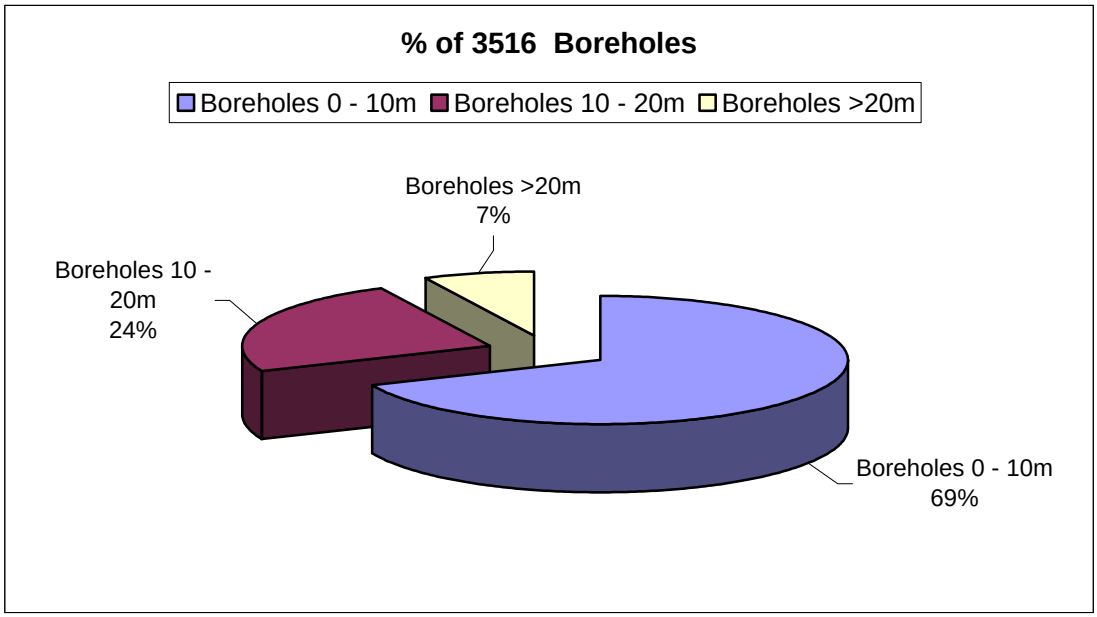


Figure 2.3: Depth classes of NCIA member companies' boreholes as a percentage of the total number.

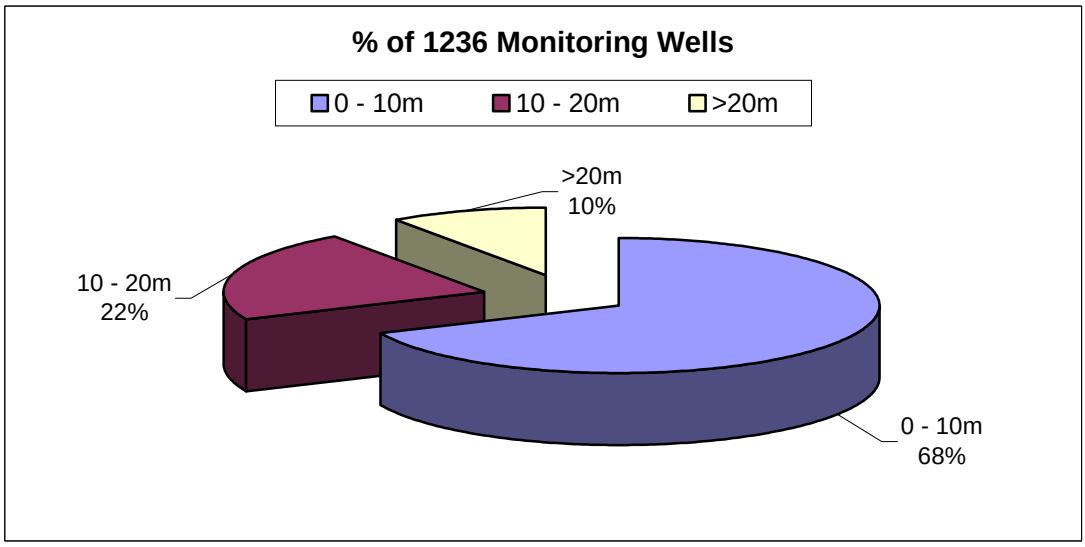


Figure 2.4: Depth classes of NCIA member companies' monitoring wells as a percentage of the total number.

3.0 Database Management System Development

The NCIA Groundwater Database Management System (DMS) has been developed with three key design objectives in mind:

- The development of broad data storage capabilities;
- The development of user friendly interfaces; and
- The development of internal data auditing and data quality control protocols.

3.1 GENERAL DATABASE STRUCTURE

The NCIA Groundwater DMS was developed using client server architecture with Microsoft Data Engine (MSDE) as the back end and Microsoft Access as the primary front end. MSDE possesses the data integrity and security features of Microsoft SQL Server, lacking only scalability to more than 10's of simultaneous users.

The DMS is compatible with Microsoft analysis tools (i.e. MSExcel), as well as non-Microsoft analysis tools (i.e. Crystal Reports). Careful analysis and categorization of the types of data to be stored has created a table structure that allows for clean queries that can easily extract the required information.

A more detailed discussion of the DMS structure can be found in the DMS Operations Manual (Access Resource Consulting, 2004).

3.2 DATA STORAGE CAPABILITIES

The NCIA Groundwater DMS allows for storage of a broad range of hydrogeological information. The following sections describe in general terms the types of information which can be stored in the DMS.

Other types of information regarding internal lookup codes, data auditing and tracking records, internal identifiers, and administrative functions are also stored in the DMS, however these are not included in the following discussion. A more detailed description of internally required information is presented in the DMS Operations Manual (Access Resource Consulting, 2004).

3.2.1 Borehole General and Spatial Information

The DMS associates a particular borehole name with a Owner Organization. In this manner, each borehole in the DMS can be uniquely identified even if the same

borehole name exists at several different sites. The DMS stores general information regarding the borehole, including the date it was drilled, the drilling method employed, who drilled the hole, and the diameter of the hole.

For each borehole location, the DMS can store spatial coordinates of the borehole in UTM NAD83 and/or local coordinate systems. For the UTM NAD83 system, the DMS stores the northing, easting, elevation, and UTM zone. For local coordinate systems, the DMS stores the northing, easting, elevation, and local zone (if applicable). The DMS can also store borehole locations in a legal land description format, including LSD, section, township, range, and meridian information.

3.2.2 Borehole Lithology Information

The DMS can store lithological information associated with a borehole, if available. The DMS stores the general information including the date that the borehole was logged and who logged the lithological descriptions in the field. The DMS can also store the top and bottom elevations of each lithological unit, the soil description (i.e. sand) for the unit as well as the geological process (i.e. fluvial), if available. A notes field is also available to store other types of field notes typically recorded on a borehole log.

3.2.3 Monitoring Well Completion Details

If a monitoring well was installed in the borehole, the DMS can store completion details for it. The organization who installed the well (i.e. Stantec) is stored along with construction details including the top of screen elevation, bottom of screen elevation, type of screen used, end of pipe elevation, top of casing elevation, static water level (at the time of installation), diameter of pipe, and stickup above ground level.

In some cases the top of casing elevation for a well changes over time, due to accidents, clearance adjustments, or conversion to flush mounted installations. Since many groundwater measurements are taken relative to the top of casing, the date of measurement also needs to be stored in the DMS. As such, the top of casing elevation is also stored in a separate DMS location, where it is associated with a date of measurement. This was implemented to allow for updated elevation measurements in situations where the well casing stickup is altered.

The DMS also stores the type of backfill used to fill the borehole annulus. The top and bottom elevations of well fill materials (i.e. bentonite, filter sand, grout, etc.) can be stored.

3.2.4 Groundwater Hydrochemistry

Groundwater analysis results from monitoring wells can be stored in the DMS. The name of the analytical laboratory, lab sample ID, date of sampling, date of analysis, analytical method, method detection limit, parameter name, and analysis result can all be stored.

The DMS also allows for particular analysis results to be flagged, should the analytical results be deemed to be an erroneous result or an outlier. By flagging particular results, they can be queried or filtered out of a particular analysis if required. It should be noted that individual member companies are required to identify analysis results that should be flagged according to their own internal QA/QC programs.

3.2.5 Pumping Tests

Pumping test and response test data can be stored in the DMS, if available. The DMS stores the organization conducting the test, the testing date, pumping rate, duration of test, top of casing elevation at the time of testing, static water level, diameter of well casing, and stickup above ground level.

The DMS stores the elapsed time and dynamic water level measurements in separate locations for response testing and pump testing. Many different techniques and formulae exist for the analysis of pump test data. Local conditions and assumptions will govern selection of the analysis method. As such, raw data can be exported from the DMS in spreadsheet format to allow for external data analysis.

3.2.6 Geophysical Results

The results from geophysical logging of a borehole can be stored in the DMS. The logging date, method employed, and parameter name can be stored if available. The DMS stores the depth and associated parameter measurements in a separate location to allow for data export in spreadsheet format to allow for external visualization of the logging results.

3.2.7 Interpreted Geology

The DMS has the ability to store interpreted geology information. Interpreted geology refers to the process of assigning lithological descriptions (i.e. sand and gravel) to stratigraphic units (i.e. Empress Formation – Unit 1) known to be present in the study area. This analysis is intended to be conducted by an experienced hydrogeologist familiar with the study area.

Once the analysis has been conducted, the DMS can store the name of the interpreter, the date of interpretation, the top and bottom elevations of the unit, and the geological unit that is being assigned.

3.3 DATABASE FEATURES

The NCIA Groundwater DMS has been developed to meet the needs of users with little database experience. Users familiar with Microsoft Windows operating environments should be comfortable with the 'look and feel' of the DMS interfaces.

The primary interface for the DMS users will be the "Browse Database" form. Here, users can select various search parameters by selecting appropriate search filters from drop down boxes. The DMS will then automatically create a query that searches the database for matching records. Matching records are displayed in a "tree view" format, where expanding a particular result will reveal sub branches of available data, as described in Section 3.2.

Several reports are automatically generated by the DMS by selecting a sub branch of a particular record. An "Installation Details" report for a borehole/well presents the general and spatial information (Section 3.2.1), the borehole lithology information (Section 3.2.2), and the monitoring well completion details (Section 3.2.3) on a single form similar to a typical borehole log.

A "Sample Results" report presents the hydrochemistry information (Section 3.2.4) for a particular well on a particular sampling date. The DMS can also generate cross tab reports, where the variation in analytical parameter concentrations over time can be displayed.

In addition, the DMS can generate a "Pump Test" report presenting pumping test or response test data (Section 3.2.5). Dynamic water level measurements are presented in a raw format, and in addition, several parameters required for external pump test analysis (i.e. drawdown, t/t') are automatically calculated by the DMS.

The DMS automatically creates a data auditing trail during import events. The DMS will store information regarding the date of import, user who conducted the import, and other internal identifiers that allow the DMS to track import events. All of the original data is stored in compacted form outside of the DMS. In the future, if problems are discovered with data residing within the DMS, the user will be able to track and find the original source of the data.

3.4 QA/QC PROTOCOLS

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Many QA/QC checks are automatically conducted by the DMS during the data import procedure. The DMS first loads the import data into temporary working tables to

conduct the QA/QC tests. If a particular record fails one of these QA/QC tests, the DMS flags the data inconsistency and does not allow the data to be imported. The user can then access an import error report, view the data inconsistency, and fix the problems in the source data, or edit DMS lookup table values so that the data record can be imported into the DMS. In this manner, data residing within the DMS is of consistent quality. Specific data checks are outlined in the following sections.

3.4.1 Owner Organization

The DMS checks each borehole/well record to confirm that an Owner Organization has been associated with it. The Owner Organization is required to uniquely identify borehole/well records in the DMS, since several member companies may be using the same borehole naming convention. Owner Organizations are designated as the NCIA member companies for their respective boreholes/wells, and AENV for well records originating from the AENV Water Well Database.

3.4.2 All Given Borehole Owners in DMS

The DMS automatically checks each borehole/well record during import to confirm that the Owner Organization is recognized by the DMS. Owner Organizations recognized by the DMS include the NCIA member companies and AENV.

3.4.3 Which Boreholes are Already in DMS

The DMS checks the name of each borehole/well record in the temporary import data against borehole/well names already populated within the DMS. If a particular borehole/well name already exists in the DMS, the temporary import data is appended to the existing record. In this manner, duplicate entries for the same borehole/well name (for a particular Owner Organization) are rejected from the import. If a particular borehole/well name does not already exist in the DMS, a new record is created in the database.

3.4.4 Borehole Spatial Control

The DMS checks each borehole/well record for northing, easting, and ground elevation information. Northing and easting coordinates are required by GIS software to conduct mapping and spatial analysis, and ground elevation information is required to allow for calculation of groundwater elevations. As such, these parameters were deemed to be minimum requirements for data import and records lacking any one of these three parameters are rejected from the import.

3.4.5 Driller Organization and Drilling Methods

Driller Organization refers to the company who owns and operates the drilling equipment. The DMS checks each borehole/well record to confirm that the Driller Organization and Drilling Method is recognized by the DMS. For example, if the standard name recognized by the DMS is “Mobile Augers and Research Ltd.” and a NCIA Member Company calls them “Mobile Augers” or “Mobile” in their source data, then the DMS will reject the record from the import.

If this test fails, the user must edit the lookup tables in the DMS to associate the names they have used (“Mobile Augers” and “Mobile”) to the standard name (“Mobile Augers and Research Ltd.”). In this manner, the DMS will consistently report “Mobile Augers and Research Ltd.” as the Driller Organization, even if the original source data contained several variations of the same name. The user is not required to make changes in the source data once this association has been established.

The DMS also checks each borehole/well record to confirm that the Drilling Method (i.e. rotary, auger, etc.) stated in the source data is recognized by the DMS.

3.4.6 Installer Organization

Installer Organization refers to the company who directed and supervised the drilling program in the field. In many instances, the Installer Organization is an engineering consulting company acting of behalf on the Owner Organization (i.e., Stantec). The DMS checks each borehole/well record to confirm that the Installer Organization is recognized by the DMS.

If this test fails, the user must edit the lookup tables in the DMS to associate the names they have used (i.e., “Stantec”) to the standard name (i.e., “Stantec Consulting Ltd.”). In this manner, the DMS will consistently report “Stantec Consulting Ltd.” as the Installer Organization, even if the original source data contained several variations of the same name. The user is not required to make changes in the source data once this association has been established.

3.4.7 Laboratory Organization

Laboratory Organization refers to the company providing analytical services for groundwater samples. The DMS checks each borehole/well record to confirm that the Laboratory Organization is recognized by the DMS.

If this test fails, the user must edit the lookup tables in the DMS to associate the names they have used (i.e., “ETL”) to the standard name (i.e., “Enviro-Test Laboratories”). In this manner, the DMS will consistently report “Enviro-Test Laboratories” as the Laboratory Organization, even if the original source data

contained several variations of the same name. The user is not required to make changes in the source data once this association has been established.

3.4.8 Analytical Parameters

The DMS checks each chemistry record to confirm that the analytical parameter names used in the source data can be recognized by the DMS. If this test fails, the user must edit the lookup tables in the DMS to associate the analytical parameter names they have used (i.e., "TDS") to the standard name (i.e., "Total Dissolved Solids"). In this manner, the DMS will consistently report "Total Dissolved Solids" as the analytical parameter name, even if the original source data contained a variation of the same name. The user is not required to make changes in the source data once this association has been established.

The DMS also checks the analytical parameter units that were used in the source data to confirm that they are consistent with the units used in the DMS. If this test fails, the user must edit the lookup values in the DMS to associate the units they have used (i.e., "µg/L") to the standard units (i.e., "mg/L"). The user must also specify the formula used to convert from the units they have used to the standard units. Once the association and unit conversion has been specified in the lookup tables, the DMS will consistently report analytical parameter results in the standard unit (mg/L), and automatically convert parameters according to the conversion formula specified. The user is not required to make changes in the source data once the conversion formula has been established.

3.4.9 Lithology Types and Interface Depths

Lithology type refers to the lithological description assigned to a geological unit by the field logger. The DMS checks each borehole/well record to confirm that the descriptions provided by the field logger can be recognized by the DMS. If this test fails, the unrecognized records are flagged in the error report. The user must then determine if the flagged records refer to lithological descriptions that are reasonable and exist within the Project Area. The user must then edit the lookup tables in the DMS to create a new lithological description so that it will be recognized by the DMS during import.

3.5 SITE SURVEYS

A common coordinate system was required for this study in order to enable spatial analysis of the hydrogeological information collected. The projected coordinate system used for this study is the Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83), Zone 12. This coordinate system was chosen as it

is compatible with the 1:20,000 provincial maps. UTM NAD83 coordinates are also compatible with Global Positioning System (GPS) measurements.

Many of the member companies' Plant sites use a local system of coordinates with a local benchmark utilized as the datum. In order to conduct spatial analysis of all the member companies' data, it was necessary to convert local coordinates into the UTM NAD83 system. Site surveys were conducted at several Plant sites where conversion to UTM NAD83 coordinates was required. Site surveys were conducted at the following Plant sites:

- Agrium Redwater
- Air Liquide Canada Inc.
- Albchem Industries Ltd.
- BP Canada Energy Company
- Degussa Canada Inc.
- EnerPro Midstream
- Guardian Chemicals Inc.
- Marsulex Inc.
- Nexen Chemicals
- Oxy Vinyls Canada Inc.
- Praxair Canada Inc.
- Shell Chemicals Canada
- Williams Energy Canada

UTM NAD83 coordinates were established for the local benchmarks, and transformation equations for individual Plant sites were derived. The transformation equations were then applied to the borehole local coordinates in order to obtain UTM NAD83 coordinates for the boreholes. Details of the transformation equation calculations are presented in Appendix B.

4.0 Database Population

4.1 MEMBER COMPANY DATA

NCIA member companies were formally requested to submit their relevant data to Stantec on 04 December 2003. The 04 December 2003 memo describing data submission guidelines is included in Appendix C for reference. Table 4.1 presents a summary of the member company data received to date.

Table 4.1: NCIA Member Company Data Recieved

NCIA Member Company	Borehole Data	Monitoring Well Data
Agrium	Y	Y
Air Liquide Canada	Y	Y
BA Energy Inc.	Y	Y
BP Canada Energy Company	Y	Y
Degussa Canada Inc.	Y	Y
Dow Chemical Canada Inc.	Y	Y
EnerPro Midstream	Y	Y
ERCO Worldwide	Y	Y
Guardian Chemicals Ltd.	N	N
Marsulex Inc.	Y	Y
Nexen Chemicals	Y	Y
Oxy Vinyls Canada Inc.	Y	Y
Praxair Canada Inc.	Y	Y
Provident Energy Ltd.	Y	Y
Shell Canada Ltd.	Y	Y
Shell Chemicals Canada	Y	Y
Sherritt International Corp.	Y	Y
Sulzer Metco (Canada) Inc.	Y	Y
Terasen Pipelines Inc.	Y	Y
The Westaim Corporation	Y	Y
Umicore Canada Inc.	Y	Y

4.2 OTHER SOURCES OF DATA

The Alberta Environment (AENV) Groundwater Information System database was queried using GIS software in order to determine how many water well drillers'

reports were available for the study area. The study area boundary was overlaid on a plot of water well locations, and the database was queried for records falling within the study area boundary. A total of 1,950 water well records were determined to lie within the study area. Of the 1,950 records, 1,019 have lithology information, 1,013 have hydrochemistry information, 112 have pump test data, and 1,262 have short term response test data. These records were then exported from the AENV Groundwater Information System database for inclusion in the NCIA Groundwater DMS.

PFRA regional groundwater assessments for Sturgeon (Hydrogeological Consultants Ltd., 2001a), Strathcona (Hydrogeological Consultants Ltd., 2001b), and Lamont County (Hydrogeological Consultants Ltd., 1998) were reviewed for comparison with the AENV water well records. Where available, water well location coordinates were obtained from these reports. This was implemented since the water well locations given in the PFRA reports were corrected for horizontal coordinates using orthorectified air photos, resulting in a more accurate location of the water well (i.e., by the homestead, instead of at the center of the quarter section).

Ground level elevations for the AENV water well records were obtained from the 1:20,000 digital elevation model (DEM) for the Province (AltaLIS, 2004).

4.3 MINIMUM DATA REQUIREMENTS

The minimum data requirements for a particular borehole record include its northing, easting, and ground elevation coordinates. Boreholes records lacking any one of these three fields were not imported into the database. Subsequent analysis of data requires, at a minimum, knowledge of the spatial position of the data.

5.0 Analysis of Well Locations

5.1 LOCATION OF EXISTING WELLS EXPECTED TO BE COMPLETED IN THE BEVERLY CHANNEL AQUIFER

Many of the monitoring wells/boreholes populating the NCIA DMS are located in areas that do not directly overly the interpreted extent of the Beverly Channel. Although the DMS stores hydrogeological data related to these wells/boreholes, they are not useful in characterizing the Beverly Channel Aquifer. Further, many of the wells/boreholes populating the DMS are completed in surficial deposits that are too shallow to enable characterization of the Empress Formation sands and gravels. As such, several queries were developed to filter out the extraneous information contained within the DMS.

5.1.1 NCIA Member Companies' Data

The NCIA member companies' data was reviewed to determine which groundwater monitoring wells or boreholes may be of value to characterize the extent of the Beverly Channel. Member companies who own monitoring wells/boreholes completed within the Empress Formation sands and gravels included:

- Agrium
- Sherritt
- EnerPro Midstream
- Dow Chemical
- Shell Canada
- BA Energy

The location of the wells/boreholes completed within the Empress Formation sands and gravels is presented in Figure 5.1. Inspection of Figure 5.1 reveals that the majority of the NCIA member companies' wells/boreholes are situated on the southwestern half of the Project Area. Very little information from NCIA member companies is available for the northeastern half of the Project Area

5.1.2 AENV Water Well Data

Data that originated from the AENV Water Well database were reviewed to determine which water well records would be of value in characterizing the extent of the Beverly

Channel. Data were screened using various queries to create subsets of data points that possessed the required information.

The AENV Water Well data were queried to determine which water well records had lithological information. Figure 5.2 presents the spatial distribution of AENV data with lithological information within the Study Area.

Although the AENV Water Well records presented in Figure 5.2 all possess lithological information, not all of the water wells were completed at a depth within or below the Empress Formation sands and gravels. As such, the water well records presented in Figure 5.2 were queried to determine which records contained "gravel" or "sand and gravel" within their lithological description, which could potentially indicate completion within the Empress Formation sands and gravels. A query of the data indicated that 436 water well records met that condition. Figure 5.3 presents the spatial distribution of AENV Water Well records that contained "gravel" or "sand and gravel" within their lithological descriptions.

Although the query returned records containing "gravel" or "sand and gravel" within the lithological descriptions, it did not specifically determine if the records were for wells completed within the Empress Formation. Information regarding correlation between lithological descriptions and stratigraphic units are not available in the AENV Water Well database. As such, water well records in Figure 5.3 were also classed by completion elevation to assess if it was likely for the water well to be completed within the Empress Formation sands and gravels. A more detailed analysis of the well lithologies is to be conducted in Phase II of the project during development of the conceptual geological framework.

5.2 IDENTIFICATION OF DATA GAPS

Figures 5.1 to 5.5 summarizes the available hydrogeologic data that are available for the study area. Company lithologic data for the Beverly Channel, shown in Figure 5.1, shows basically one large cluster where the Dow, Enerpro and Sherritt/Agrium/Umicore/Westaim/Sulzer facilities are located. Additional company data are available for Shell Canada, BA Energy, and Terasen Pipelines. There is clearly a large gap in data between Dow and Shell and Between Shell and BA Energy/Terasen Pipelines.

Data from Alberta Environment within the Beverly Channel are sparse and few of them are located in the gap area between Dow and BA Energy/Terasen Pipelines. There are a few water wells in the area south of the Agrium facility and a few to the east/northeast of the BA Energy/Terasen Pipelines location. These data have the disadvantage that they lack survey control and are likely inaccessible. The information from these water well records will be of benefit for the geological interpretation.

RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56

TWP 55

TWP 54

Study Area

83H/11 NW

83H/11 NE

Stantec

Location of Test Holes / Monitoring Wells
with completion into the Beverly Channel

- Agrium, Sherritt, Sulzer, Umicore, Westaim
- BA Energy, Terasen
- Dow Chemical, Enerpro
- Shell Canada

Location of Beverly Channel (Stein, 1976)

- Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

5.1

Title

Location of Test holes by Member Companies

RGE 23

RGE 22

RGE 21

RGE 20

TWP 56

TWP 55

TWP 54

Study Area

Stantec

Location of Water Wells with Lithologic Information

- Alberta Environment Data

Location of Beverly Channel (Stein, 1976)

- Approximate Extent

Scale

5000 0 5000 Meters

1:150,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

5.2

Title

Location of AENV Water Wells with Lithologic Information

RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56

TWP 55

TWP 54

Study Area

AENV Water Wells with Sand and Gravel Units Classed by Elevation (m AMSL)

- 560 - 570
- 570 - 580
- 580 - 590
- 590 - 600
- 600 - 610
- 610 - 620
- 620 - 630
- 630 - 640
- 640 - 690

Location of Beverly Channel (Stein, 1976)

Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

5.3

Title

AENV Water Wells w/ Sand & Gravel Classed by Elevation

RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56

TWP 55

TWP 54

Study Area

83H/11 NW

83H/11 NE

1 2 3 4 5 6 7 8 9a 9b 11 12a 12b 14 15a 15b 18 19 20

GIBBONS

BRUDERHEIM

FORT SASKATCHEWAN

Stantec

Location of Monitoring Wells
with completion into the Beverly Channel

- Agrium, Sherritt, Sulzer, Umicore, Westaim
- BA Energy, Terasen
- Dow Chemical, Enerpro
- Enerpro

Location of Beverly Channel (Stein, 1976)

- Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA
Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

5.4

Title

Locations of Existing Monitoring Wells

RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56

TWP 55

TWP 54

Study Area

Stantec

Location of Monitoring Wells
with completion into the Beverly Channel

- Agrium, Sherritt, Sulzer, Umicore, Westaim
- BA Energy
- Dow Chemical, Enerpro
- Enerpro

Location of Test Holes / Monitoring Wells
with completion into the Beverly Channel

- Agrium, Sherritt, Sulzer, Umicore
- BA Energy, Terasen
- Dow Chemical, Enerpro
- Shell Canada

Location of AENV Water Wells with
Sand and Gravel Units

- Alberta Environment Data

Location of Beverly Channel (Stein, 1976)

- Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

5.5

Title

Location of All Available Data

In terms of available water level data, there are only two clusters of monitoring wells: the first at the location of the Dow, Enerpro and Sherritt/Agrium/Umicore/Westaim/Sulzer facilities and the second at the location of the BA Energy/Terasen Pipelines site. These data, shown in Figure 5.4 will definitely allow the determination of the groundwater flow direction in the area of the two clusters, but they are insufficient to determine the groundwater flow direction in the area of the Beverly Channel that is part of this study.

Groundwater quality data will be available for those monitoring wells and also for 28 different Alberta Environment water wells within the expected extent of the Beverly Channel. It would be expected that these data would allow a reasonable characterization of the groundwater quality in the Beverly Channel.

Figure 5.5 shows all of the available data points. All of them have lithologic information, but only selected datapoints will have chemistry and water level information. In order to fill in the gaps, determine the extent and thickness of the Beverly Channel deposits, and obtain piezometric elevations to determine groundwater flow direction, a number of test holes and monitoring wells are required. These requirements are described in Section 6.

6.0 Recommendations

The review of the data has indicated that basically, there are two clusters of data in the Beverly Channel, one where the Dow, EnerPro, and Sherritt/Agrium/Umicore/Westaim/Sulzer facilities are located, and another where the BA Energy and Terasen Pipelines sites are located. These clusters have data for lithology, water levels, and hydrochemistry. Data gaps have been identified between Dow and BA Energy/Terasen Pipelines, northwest of BA Energy/Terasen Pipelines, and south of the Dow, EnerPro, and Sherritt/Agrium/Umicore/Westaim/Sulzer facilities.

Stantec makes the following recommendations for future phases of the Project:

1. In order to address the data gaps a number of test holes should be drilled and monitoring wells should be installed in the Project Area, as shown in Figure 6.1. Table 6.1 identifies the test holes and monitoring wells and provides a rationale for the site selections.

Table 6.1: Test Hole and Monitoring Well Rationale

Rationale	Identification
▪ Obtain lithological information to refine the interpreted extent of the Beverly Channel	TH-01; TH-02; TH-03; TH-04; TH-05; TH-08; TH-09; TH-10
▪ Obtain lithological information to refine the interpreted Beverly Channel geometry and location of thalweg. ▪ Enable well testing to characterize aquifer hydraulic parameters. ▪ Enable characterization of groundwater quality upgradient of the industrial area.	MW-01; MW-02; MW-03
▪ Obtain lithological information to refine the interpreted Beverly Channel geometry and location of thalweg. ▪ Enable well testing to characterize aquifer hydraulic parameters. ▪ Enable characterization of groundwater quality upgradient of the industrial area and downgradient of the City of Fort Saskatchewan.	MW-04; MW-05

Table 6.1 (Continued): Test Hole and Monitoring Well Rationale

Rationale	Identification
▪ Obtain lithological information to refine the interpreted Beverly Channel geometry and location of thalweg.	TH-06; TH-07
▪ Obtain lithological information to refine the interpreted Beverly Channel geometry and location of thalweg. ▪ Enable well testing to characterize aquifer hydraulic parameters. ▪ Enable characterization of groundwater quality in the Project Area	MW-06; MW-07; MW-08; MW-09; MW-10; MW-11
▪ Obtain lithological information to refine the interpreted Beverly Channel geometry and location of thalweg. ▪ Enable well testing to characterize aquifer hydraulic parameters. ▪ Enable characterization of groundwater quality downgradient of all NCIA member companies.	MW-12; MW-13

The final location and number of monitoring wells/boreholes to be installed should be revisited following a field reconnaissance of the proposed installation locations. Field conditions, pipeline corridors, and/or site accessibility may dictate the final location of the monitoring wells/boreholes.

It should be noted that some of the proposed monitoring well/borehole locations are likely situated on private land. As such, the public communication strategy for this Project should highlight the need for groundwater monitoring on private lands. It would be advantageous for NCIA to engage landowners whom are willing to have permanent monitoring wells installed on their property.

2. The extent of the Project Area (and in turn, the Study Area) should be revisited in consideration of the additional companies which have become NCIA members since initiation of this project. The current Project Area (refer to Figure 1.2) does not extend far enough northeast to encompass the BA Energy and Terasen sites.

RGE 23 | RGE 22 | RGE 21 | RGE 20

TWP 56

TWP 55

TWP 54

Study Area

MW-13
MW-12
MW-11
MW-10
MW-09
MW-08
MW-07
MW-06
MW-05
MW-04
MW-03
MW-02
MW-01

TH-10
TH-09
TH-08
TH-07
TH-06
TH-05
TH-04
TH-03
TH-02
TH-01

Stantec

Proposed Lcations for Further Investigations

- Test Hole
- Monitoring Well

Location of Test Holes / Monitoring Wells with completion into the Beverly Channel

- Agrium, Sherritt, Sulzer, Umicore, Westaim
- BA Energy, Terasen
- Dow Chemical, Enerpro
- Shell Canada

Location of Water Wells with sand & gravel intervals and possible completion into the Beverly Channel

- Alberta Environment Data

Location of Beverly Channel (Stein, 1976)

- Approximate Extent

Scale

3000 0 3000 Meters

1:100,000

Client / Project

NCIA Northeast Capital Industrial Association

REGIONAL ASSESSMENT OF THE GROUNDWATER QUALITY
BEVERLY CHANNEL, FORT SASKATCHEWAN, AB

Figure No.

6.1

Title

Proposed Locations of Test Holes and Monitoring Wells

3. Master copies (with full Administrator access) of the DMS should reside on computers at the NCIA office, AENV, and Stantec. User distributions (with limited access to administrative functions) will be made available to all NCIA member companies on CD for installation on their respective computers.

4. Maintenance of the DMS will be required on an ongoing basis to update the data following subsequent groundwater monitoring events. It is recommended that in the future, all of the member companies' data be submitted to a single party, who in turn will update the Master copies of the DMS. If available, updated versions of the AENV Water Well Database could also be re-imported at that time. When updates to the master copies of the DMS are completed, updates to user distributions of the DMS should be implemented by restoring backups of the master copies. Further details regarding administration of the DMS can be found in the DMS Operations Manual (Access Resource Consulting, 2004).

5. Two stations for water level measurements in the North Saskatchewan river should be established to further understand the interrelations between river stage and piezometric pressures in the Beverly Channel. One station should be established upstream of the Project Area, and another station should be established downstream of the Project Area. Information gathered from these stations will provide further insight into the extent of hydraulic communication between the North Saskatchewan river and the Beverly Channel.

6. Data regarding groundwater diversions should be collected from the NCIA member companies. Details including the rate of pumping and cumulative volumes should be included. This data is required for latter phases of the project when numerical modeling of the hydrogeological system in the Study Area is conducted. Groundwater diversions will influence the natural groundwater flow directions. These effects need to be considered during model development.

7.0 Stantec Quality Management Program

This report, entitled **"Regional Assessment of the Groundwater Quality in the Beverly Channel in the Fort Saskatchewan Area"** was produced by:

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This report was reviewed by:

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Senior Hydrogeologist

Stantec

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APPENDIX A

PROJECT INITIATION SURVEY

NCIA Regional Groundwater Investigation

Project Initiation Survey

Prepared by:

Stantec Consulting Ltd.

July 2003
1-02-15741

Stantec Contact

Should you have any questions about this survey, please contact:

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Phone: (780) 917-7497
Cell: (780) 995-9370
Fax: (780) 917-7249
dyoshisaka@stantec.com

Contact and General Information

Company _____

Name _____

Phone Number _____

Cellular Number _____

Fax Number _____

eMail Address _____

Mailing Address _____

_____

_____

Objective of Survey

The objective of this survey is to assist initiation of the development of the database for the NCIA Regional Groundwater Investigation Project. The information provided by your company, although estimates, should be as accurate as practically possible so that the project team can gain an understanding of the amount and type of data that your company will be providing. Depending on the volume of data it may be necessary to have a meeting with your company to determine what information would be considered relevant for this project.

Computer Experience

Please indicate your level of experience with the following applications:

	Low				High
Rate your level of experience with computer databases in general	1	2	3	4	5
Rate your level of experience with Microsoft Access	1	2	3	4	5
Rate your level of experience with Graphical Information Systems	1	2	3	4	5
Rate your level of experience with web based applications	1	2	3	4	5

Geological Data

This section of the survey will assist in the estimation of the number of geological data points at your site.

Borehole Information

	No. between 0 – 10 m deep	No. between 10 - 20 m deep	No. greater than 20 m deep
Approximately how many borehole logs are available for your site?			
Approximately how many of the boreholes have been geophysically logged?			

Approximate the proportion of boreholes (in %) used for various functions (foundation design, geotechnical, siting of facilities, contaminant delineation) _____

_____

_____

Has there been laboratory testing completed to determine physical properties of the geological material beneath your site (i.e. grain size analysis, hydrometers, Atterberg Limits, permeability testing)? Estimate the number of physical tests that have been conducted. _____

Has the location of the boreholes been surveyed. If so, what coordinate system was used? (Local benchmark, UTM, other) _____

Of the available boreholes, approximately what proportion (in%) are considered public information? _____

What format is your geological information in?(i.e. paper, electronic, other). If in electronic format, what type of software is used? _____

_____

Comments: _____

_____

_____

Hydrogeological Data

This section of the survey will assist in the estimation of the number of hydrogeological data points and type of hydrogeological data at your site.

Approximately how many monitoring wells are on your site? _____

Of the available monitoring wells, approximately what proportion (in%) are considered public information? _____

Of the available monitoring wells, approximately what proportion (in%) are the following age ranges:

0 - 5 Years _____

6 - 10 Years _____

11 - 15 years _____

16 - 20 Years _____

21 - 25 Years _____

25+ Years _____

Of the available monitoring wells, approximately what proportion (in %) are completed in the following depth ranges?

0 – 10 metres _____

10 – 20 metres _____

20+ metres _____

Of the available monitoring wells, approximately what proportion (in %) are sampled at the following frequencies?

Once per year _____

Twice per year _____

Four times per year _____

Greater than four times per year _____

Of the available monitoring wells, approximately what proportion (in %) are analyzed for the following number of chemical parameters?

0 – 25 _____

25 – 50 _____

50 – 75 _____

More than 75 _____

Approximately what proportion (in %)of your monitoring wells are used ONLY for water level measurements? _____

Approximately how many monitoring wells are completed as piezometer nests (i.e. multi level wells)? _____

Approximately how many monitoring wells are completed in the Beverly Channel? _____

Has hydraulic conductivity testing or pumping test been conducted on some of the monitoring wells? If Yes on approximately how wells? _____

Do any of the monitoring wells at your site have devices such as pressure transducers to measure water level fluctuations? If yes how many and at what depths are the monitoring wells? _____

Comments: _____

Database Needs

This section of the survey will help determine the level of functionality of the database and specific requirements required by your Company.

What format is your geological and hydrogeological data in? (paper, spreadsheets, ASCII, database, other digital) If data is in more than one format, please specify approximate proportions (in %) of each respective data type. _____

How would you like to provide the data to the project team? Ideally the data should be provided in electronic format. _____

For information that is in paper format, how would you like to provide it to the project team? (submit originals, submit paper copies, submit originals to be copied and returned) _____

Who is the custodian of your data, and who is responsible for maintenance of your data? (environmental group, IT group, if other please specify)

If you have had previous experience with computer databases, list three items you particularly **disliked** about them.

1.

2.

3.

If you have had previous experience with computer databases, list three items you particularly **liked** about them.

1.

2.

3.

List any features and functionalities that you would like to see in the NCIA database. (Consider what groundwater related questions you commonly need to answer, what type of output you need, what type of analysis tools you would like, etc.)

Other Sources of Information:

If there are other sources of geological / hydrogeological information such as EIA's conducted for proposed facilities (does not have to be a member of NCIA) that you or your colleagues are aware of please provide as much information (location, company name, reason for investigation) as possible so if available this information can be included in the Regional Study.

Questions and Comments

Please feel free to write any other questions or comments that you may have:

APPENDIX B
COORDINATE TRANSFORMATIONS

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Agrium Redwater***

Local and UTM coordinates at Agrium Redwater

Source: Surveyed by Stewart Weir & Co.

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.9997374

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
Agrium Redwater	**PT06**	363298.533	5969813.008	629.846	5511.19	10871.08	Surveyed 2002, plant control pt.
Agrium Redwater	**PT16**	361936.090	5967356.940	624.414	1275.04	2685.06	Surveyed 2002, plant control pt.
Agrium Redwater	**PT17**	362184.323	5967349.738	622.500	2090.00	2685.00	Surveyed 2002, plant control pt.

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$ $Xo = 361524.06$ $f = 0.30471996$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$ $Yo = 5966550.33$ $\alpha = -1.657250°$

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan *Air Liquide Canada*

Local and UTM coordinates at Air Liquid

Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.999866

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
AIR LIQUIDE	NW	362543.546	5963189.810	623.023	-798.741	337.526	0.22x0.41 AGL
AIR LIQUIDE	SE	362624.199	5963051.382	623.336	-714.199	201.413	0.22x0.96 Steel Pipe

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$ $Xo = 363332.33$ $f = 0.999866$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$ $Yo = 5962829.91$ $\alpha = -1.618528°$

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***BA Energy Inc.***
Local and UTM coordinates at BA Energy
Source: Surveyed by Stewart Weir & Co. in 2004

UTM Coordinates =	NAD83, Zone 12	**Monitoring network already in the UTM system.**
Central Meridian =	111 °	**- No need for transformation**
Combined scale factor =	0.999729	

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
BA Energy	**04-2-4**	365879.410	5965336.740	621.360			Already in UTM system
BA Energy	**04-4-7**	365096.030	5965950.430	624.190			Already in UTM system

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***BP Canada Energy Company***
Local and UTM coordinates at BP Canada
Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates = NAD83, Zone 12
Central Meridian = 111 °
Combined scale factor = 0.9997456

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
BP CANADA	**825-575 cp 8**	357777.816	5958939.936	625.744	-1886.48	2706.69	Square metal plate on steel pipe BP
BP CANADA	**SW4**	357427.962	5958565.705	625.456	-2953.13	1407.21	Brass Cap on Steel Pipe BP

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$ $Xo = 358298.37$ $f = 0.304722$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$ $Yo = 5958079.84$ $\alpha = -3.691712°$

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Degussa Canada Inc.***

Local and UTM coordinates at Degussa

Source: Surveyed by Stewart Weir & Co. in 2004

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.999743

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
DEGUSSA	**90-1-9**	359603.580	5967563.538	630.871	9395.17	10549.68	0.73 AGL Degussa - Observation Well
DEGUSSA	**95-3-10**	359792.974	5967289.078	631.782	9591.78	10280.26	0.51 AGL Degussa - Observation Well
DEGUSSA	**DEGMW-1**	359547.524	5967454.272	631.101	9342.02	10438.94	0.14 BGL - Monitoring Well
DEGUSSA	**DEGMW-6**	359847.033	5967481.196	631.150	9640.75	10473.79	0.10x0.06 AGL - Monitoring Well

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 349935.59

Yo = 5957268.27

f = 0.999743

α = -1.513146°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan

Dow Chemical Canada Inc. - Main Plant

Local and UTM coordinates at Dow Chemical - Main Plant

Source: Dow's coordinate transformation

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.99975075

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
Main Plant	**Origin**	356427.135	5954974.601		0.00	0.00	
Main Plant	**DP1**	356605.355	5955762.097		1680.07	2048.90	

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Main_Xo = 356427.13

Main_Yo = 5954974.601

Main_f = 0.304724

*Main_* α = 26.599325°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Dow Chemical - HCP Plant
Source: Dow's coordinate transformation

Dow Chemical Canada Inc. - HCP Plant

UTM Coordinates = NAD83, Zone 12
Central Meridian = 111 °
Combined scale factor = 0.99975075

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
HCP Plant	**Origin**	355121.638	5953501.503		0.00	0.00	
HCP Plant	**HCP 1**	358488.877	5957675.860		10600.01	14050.00	

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

HCP_Xo = 355121.64
HCP_Yo = 5953501.50
HCP_f = 0.304724
*HCP_*α = -1.858630°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Enerpro Midstream***
Local and UTM coordinates at Enerpro Midstream
Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	NA

Surveyed Points/Benchmarks/Monuments

Site	PT. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
ENERPRO	CV-1	357591.487	5957539.809	631.200			0.20 AGL
ENERPRO	CV-2	357775.263	5957512.064	629.574			0.18 AGL
ENERPRO	RA1D	357999.577	5957321.539	631.985	534.960	31.810	0.70 AGL
ENERPRO	RA4S	357524.634	5957773.491	630.783	39.280	459.140	1.00 AGL

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

$Xo =$ 357462.75 $f =$ 1.001775

$Yo =$ 5957316.02 $\alpha =$ -2.814201°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***ERCO Worldwide***

Local and UTM coordinates at ERCO Worldwide

Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates =	NAD83, Zone 12	Local is pre-1998 system of coordinates
Central Meridian =	111 °	Could not resolve 1998 system of coordinates into UTM
Combined scale factor =	0.999603	

Site	PT. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	pre-1998* LOCAL EASTING (m)	pre- 1998* LOCAL NORTHING (m)	Comment
ALBCHEM	CONTROL-1	374770.849	5962504.020	637.93	0.00	0.00	I. Bar with M.P. Albchem
ALBCHEM	CONTROL-3	374795.750	5962703.390	637.00	20.00	200.00	I. Bar C.S. Albchem
ALBCHEM	98-4-12	374841.440	5962690.410	635.30	66.01	188.14	0.67x0.06 AGL Monitoring Well
ALBCHEM	3-4	374895.310	5962815.100	635.14	116.82	314.16	
ALBCHEM	97-7-11	375158.730	5962729.900	637.35	382.36	235.43	
ALBCHEM	4-5	374841.520	5962692.390	635.30	66.05	190.12	

*As surveyed by Stewart Weir in 2003

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$ $\quad Xo = 374770.85$ $\quad f = 0.999603$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$ $\quad Yo = 5962504.03$ $\quad \alpha = -1.408627°$

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Guardian Chemicals Ltd.***

Local and UTM coordinates at Guardian

Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates = NAD83, Zone 12
Central Meridian = 111 °
Combined scale factor = 0.99969

Monitoring network already in the UTM system.
- No need for transformation

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
GUARDIAN	GUARDIAN-FDI	352759.582	5958113.598	645.71			Already in UTM system
GUARDIAN	GUARDIAN-FDL	352755.207	5958260.293	647.67			Already in UTM system
GUARDIAN	GUARDIAN-MW	352768.522	5958218.845	648.20			0.97 AGL Monitoring Well

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Marsulex (Sulphides) Inc.***
Local and UTM coordinates at Marsulex (Sulphides)
Source: Stantec (1997)

Monitoring network in the 3TM system.
- Transformation done via software

UTM Coordinates =	NAD83, Zone 12	3TM Coordinates =	NAD83
Central Meridian =	111 °	Central Meridian =	114 °
Scale factor =	0.9996	Scale factor =	0.9999
False Easting =	500,000	False Easting =	0

Note: The coordinates for the monitoring network are provided in both grid and ground reference levels.
The combined scale factor from grid to ground for the 3TM system is 0.99984

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Marsulex Inc.***
Local and UTM coordinates at Marsulex
Source: Stantec (2001)

Monitoring network in the 3TM system.
- Transformation done via software

UTM Coordinates =	NAD83, Zone 12	3TM Coordinates =	NAD83
Central Meridian =	111 °	Central Meridian =	114 °
Scale factor =	0.9996	Scale factor =	0.9999
False Easting =	500,000	False Easting =	0

Note: The coordinates for the monitoring network are provided in both grid and ground reference levels.
The combined scale factor from grid to ground for the 3TM system is 0.99984

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Nexen Chemicals***

Local and UTM coordinates at Nexen Inc.

Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.99969

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
Nexen	NEXMON-1	376310.464	5962063.706	625.534	950.00	982.50	0.50x0.45 AGL
Nexen	NEXMON-2	376184.958	5961880.066	626.118	950.00	760.00	0.55x0.45 AGL
Nexen	NEXMON-6	375854.822	5962105.680	625.560	550.00	760.00	0.37x0.48 AGL

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 374972.19

Yo = 5961788.63

f = 0.999690

α = -34.348418°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Oxy Vinyls Canada Inc.***

Local and UTM coordinates at Oxy-Vinyls

Source: Surveyed by Stewart Weir & Co. in 2003

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.999737

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
OXY-VINYLS	14 oxy vinyl	363290.037	5961240.473		0.00	0.00	
OXY-VINYLS	15 oxy vinyl	363265.717	5960410.742		0.00	-2724.10	

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 363290.04

Yo = 5961240.47

f = 0.304720

α = 1.678861°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Praxair Air Separation Plant
Source: Surveyed by Stewart Weir & Co. in 2003

Praxair Canada Inc.
Air Separation Plant

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.999758

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
PRAXAIR	**Datum**	356427.215	5954974.651		0.00	0.00	
PRAXAIR	**RALF-BAR-1**	356481.733	5954967.896	628.775	150.00	-100.00	
PRAXAIR	**PRAXAIR-BAR_**	356536.316	5954892.989	628.271	200.00	-400.00	
PRAXAIR	**RALF-BAR-3**	356590.705	5955022.512	628.548	550.00	-100.00	
PRAXAIR	**PRAXAIR-MW-1**	356520.360	5954978.263	628.678	*	*	Man Hole

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 356427.21

Yo = 5954974.65

f = 0.304726

α = 26.622583°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Praxair Air Separation
Source: Surveyed by Stewart Weir & Co. in 2003

Praxair Canada Inc.
CO_2 Plant

UTM Coordinates = NAD83, Zone 12
Central Meridian = 111 °
Combined scale factor = 0.999756

Monitoring network already in the UTM system.
- No need for transformation

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
Praxair-CO2	**186791**	355211.644	5954152.401	623.438			Already in UTM system
Praxair-CO2	**93278**	361588.989	5958448.035	631.331			Already in UTM system
Praxair-CO2	**TH92-1**	356177.406	5954708.564	627.803			Already in UTM system
Praxair-CO2	**TH92-2**	356230.759	5954775.283	628.034			Already in UTM system
Praxair-CO2	**TH92-3**	356208.226	5954884.077	628.673			Already in UTM system
Praxair-CO2	**TH92-4**	356178.195	5954845.606	629.173			Already in UTM system

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Provident Energy
Surveyed by Stewart Weir & Co.

Provident Energy Ltd.

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.999744

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
PROVIDENT	**92-10A**	359867.533	5964771.255	632.978	No Local	No Local	0.78 AGL
PROVIDENT	**FD-I-55**	360131.470	5965016.472	633.745	-0.023	-346.116	0.11 AGL
PROVIDENT	**FD-I-CS-15**	360139.665	5965324.532	630.734	0.024	-37.868	Fd. I. C.S. Not 15 but post 2.86 North
PROVIDENT	**98-BR-2**	359774.947	5964992.374	636.986	No Local	No Local	

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 360140.64

Yo = 5965362.38

f = 0.999744

α = -1.515084°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Shell Chemicals
Source: Surveyed by Stewart Weir & Co. in 2003; Usher Canada Ltd.

Shell Chemicals Canada
Styrene Plant

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.9997366

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
SHELL	CM-801shell	362195.718	5964020.228	622.947	-1169.97	1158.00	10" I-Beam with metal plate (0.6m)
SHELL	CM-806shell	363279.306	5963647.543	622.949	-76.00	815.98	10" I-Beam with metal plate (0.5m)
SHELL	CM-904shell	362925.904	5963422.507	623.962	-423.00	580.97	
SHELL	CM-905shell	362921.848	5963278.617	624.335	-423.00	436.99	

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$ Xo = 363332.22 f = 0.999737

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$ Yo = 5962829.97 α = -1.618333°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Shell Scotford Refinery
Source: Usher Canada Limited

Shell Canada Ltd.
Scotford Refinery / Upgrader

UTM Coordinates =	NAD83, Zone 12
Central Meridian =	111 °
Combined scale factor =	0.9997366

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
Scotford Ref.	**M11**	362208.161	5962259.249	623.423	2522.018	2190.005	Usher Canada Ltd. data
Scotford Ref.	**U3**	361113.180	5962964.076	624.042	1405.002	2860.036	Usher Canada Ltd. data
Scotford Ref.	**U11**	362411.575	5963059.966	624.228	2700.06	2996.968	Usher Canada Ltd. data
Scotford Ref.	**UCL16**	361034.765	5964474.572	619.340	1278.833	4367.698	Usher Canada Ltd. data

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 359618.84

Yo = 5960150.64

f = 0.9997366

α = -1.812222°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan
Local and UTM coordinates at Agrium, Sherritt, Sulzer, Umicore, Westaim
Source: Surveyed by Stewart Weir & Co.

Agrium Fort Saskatchewan
Sherritt International Corporation
Sulzer Metco (Canada) Inc.
Umicore Canada Inc.
The Westaim Corporation

UTM Coordinates = NAD83, Zone 12
Central Meridian = 111 °
Combined scale factor = 0.999763

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (ft)	LOCAL NORTHING (ft)	Comment
	N1	355822.141	5953982.023		-2709.33	3702.46	Surveyed 2002
	P9	355463.524	5955634.234		-6504.9	7747.56	Surveyed 2002
	P18	355725.970	5955746.550		-5955.69	8506.24	Surveyed 2002
	15-3-5C	356348.070	5954964.430		-2885.91	7354.21	Surveyed 2002
SHERRIT	**566 sherrit**	356470.591	5954903.670		-2438.64	7389.84	Surveyed 2003
SHERRIT	**571 sherrit**	355737.737	5955643.242		-5748.36	8235.34	Surveyed 2003

Coordinates Conversion Table

$x_{utm} = x_0 + (x_{local} * f) * \cos\alpha - (y_{local} * f) * \sin\alpha$

$y_{utm} = y_0 + (x_{local} * f) * \sin\alpha + (y_{local} * f) * \cos\alpha$

Xo = 355950.08

Yo = 5952590.05

f = 0.304727762

α = -30.938200°

NCIA - Groundwater Study of the Beverly Channel in Fort Saskatchewan ***Terasen Pipelines Inc.***

Local and UTM coordinates at Terasen

Source: Surveyed by Stewart Weir & Co. in 2004

UTM Coordinates =	NAD83, Zone 12	**Monitoring network already in the UTM system.**
Central Meridian =	111 °	**- No need for transformation**
Combined scale factor =	0.999729	

Surveyed Points/Benchmarks/Monuments

Site	Point. I.D.	UTM EASTING (m)	UTM NORTHING (m)	Ground Elevation (m AMSL)	LOCAL EASTING (m)	LOCAL NORTHING (m)	Comment
Terasen	**04-3-04**	365897.970	5966038.640	620.850			Already in UTM system
Terasen	**04-9-06**	364313.530	5966782.670	624.570			Already in UTM system

APPENDIX C

04 DECEMBER 2003 MEMO

Memo

Stantec

To:	David Onuczko NCIA	From:	Dan Yoshisaka, M.Sc., E.I.T. Edmonton, AB
File:	Regional Groundwater Investigation	Date:	04 December 2003

Reference: Submission of Member Companies' Data to Stantec

David,

As was discussed during our meeting of 03 December 2003, we are nearing the stage where we would like to begin importing data into the NCIA database. We would like to request that member companies submit their relevant data to Stantec as soon as possible. All data submitted in electronic format will be imported into the database. Data submitted in paper format or *.pdf format will be screened by Stantec, and only relevant data will be entered into the database.

Several guidelines for data submission should be followed as much as possible to ensure efficient population of the database:

- Data should be in electronic form whenever possible. Historical data that are only available in paper format should be copied and submitted in binders. (Companies should retain their originals)

- MSExcel files, MSAccess database files, *.txt files, *.csv files, and *.dbf file formats are the preferred file types. In general it will be more efficient for Stantec to deal with large files with many records, rather than a large number of small files.

- Stantec can manipulate electronic data if required. In order to minimize data handling, it is requested that companies submit their data in the present format. If required, Stantec will contact the company for further clarification.

- Table names, field names, or column headings should clearly depict their meaning. Use of alias names or acronyms should be minimized for clarity.

- Individual companies are responsible for the data quality checks on their data, prior to submission to Stantec. All data submitted to Stantec will be considered to have passed the QA/QC programs of the respective companies.

Reference: **Submission of Member Companies' Data to Stantec**

If any questions regarding these guidelines arise, member companies are encouraged to contact me directly to discuss any issues or questions.

Should you require anything further to this, please let me know.

Best regards,

STANTEC CONSULTING LTD.

Dan Yoshisaka, M.Sc., E.I.T.
GeoEnvironmental Engineer
dyoshisaka@stantec.com

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