# STRATHCONA COUNTY
# SUBDIVISION AND DEVELOPMENT APPEAL BOARD
# AGENDA

| | |
|---|---|
| Date: | **February 9, 2023** |
| Call to Order: | **9:00 a.m.** |
| Location: | **Council Chamber** |
| | **401 Festival Lane** |
| | **Sherwood Park, AB** |

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# STRATHCONA COUNTY
# SUBDIVISION AND DEVELOPMENT APPEAL BOARD
# AGENDA

Date: **January 19, 2023**
Call to Order: **9:00 a.m.**
Location: **Microsoft Teams Meeting**

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**Pages**

STRATHCONA COUNTY

# Notice of Appeal
## Subdivision and Development Appeal Board



Legislative and Legal Services, 2001 Sherwood Drive, Sherwood Park, Alberta T8A 3W7
Phone 780-464-8140 Fax 780-464-8194
Email: sdab@strathcona.ca

**Site and appellant information** (fill out completely)

| | | | |
|---|---|---|---|
| **Site information** | | | |
| Municipal address of site | | | |
| Owner of site<br>Joburg Aggregates Ltd. | | Applicant<br>Joburg Aggregates Ltd. | |
| Legal description of site ('lot/block/plan' and/or 'quarter-section-township-range')<br>SW-25-54-22-W4, NW-25-54-22-W4 & SW 36-54-22-W4 | | | |
| Development permit number or subdivision application number<br>2022-0589-DP | | | |
| **Appellant information** | | | |
| Name of Appellant<br>Jim and Coralie Mohr | | | |
| Mailing address<br>54540 Range Road 220 | | | |
| City/Municipality<br>Fort Saskatchewan | Province<br>AB | Postal code<br>T9L 4C1 | Phone number<br>780-441-3236 |
| **Agent information and certification (if Appellant is represented by an Agent)** | | | |
| Name of Agent<br>Janice Agrios, KC | | | |
| Mailing address<br>1325, 10180 - 101 Street | | | |
| City/Municipality<br>Edmonton | Province<br>AB | Postal code<br>T5J 3S4 | Phone number<br>780-969-6911 |

The Appellant hereby authorizes the above named agent to act on the Appellant's behalf on matters pertaining to this Appeal.

Signature of Appellant     2022-12-19
Date

☒ By checking this box the Appellant or, if the Appellant is represented by an Agent, the Agent would like to receive all correspondence including the Appeal hearing notice and decision via the following e-mail address and understands no paper copies will be sent.

Email address: jagrios@kaolawyers.com

**Appeal against** (Check one box only)

| Development permit | Subdivision application | Order |
|---|---|---|
| ☒ Approval | ☐ Approval | ☐ Notice of order |
| ☐ Conditions of approval | ☐ Conditions of approval | |
| ☐ Refusal | ☐ Refusal | |

# Notice of Appeal
## Subdivision and Development Appeal Board


**Reasons for appeal** (Attach a separate page if required)

Sections 678 and 686 of the *Municipal Government Act* require that the written Notice of Appeal must contain specific reasons for the appeal.

Please refer to the attached.

**Collection and use of personal information**
Personal information is collected under the authority of section 33(c) of the Freedom of Information and Protection of Privacy Act and will be used to manage and administer the Subdivision and Development Appeal Board process. Information provided in your submission may be made available to the public. If you have questions regarding the collection, use or disclosure of this information contact the Coordinator, Secretariat Services at 780-464-8140.

| Signature of Appellant / Agent | Date YYYY | MM | DD |
|---|---|---|---|
| | 2022 | 12 | 20 |

**Office use only**

| SDAB appeal number | Appeal fee paid | Hearing date YYYY | MM | DD | Date Notice of Appeal Received |
|---|---|---|---|---|---|
| | ☐ Yes ☐ No | | | | |

KENNEDY AGRIOS OSHRY | LAW

1325 Manulife Place, 10180-101 Street
Edmonton, AB, Canada T5J 3S4
Phone: (780) 969-6900
Calgary: (403) 265-6899

**Janice A. Agrios, KC**
Direct Line: (780) 969-6911
jagrios@kaolawyers.com

***Delivered via E-mail***
***(sdab@strathcona.ca)***

December 20, 2022 Our File: 76092-2 JAA

**Strathcona County**
**Subdivision and Development Appeal Board**
3rd Floor, North Wing, Community Centre
401 Festival Lane, Sherwood Park

Dear Sirs/Mesdames:

**Re: Notice of Appeal**
**DPA#2022-0589 (the "Development Permit")**
**Joburg Aggregates Ltd.**
**Aggregate Extraction Use**
**SW-25-54-22-W4, NW-25-54-22-W4 & SW 36-54-22-W (the "Site")**

I act on behalf of James and Coralie Mohr, who own and reside on property adjacent to the Site. They wish to appeal the Development Authority's decision to issue the Development Permit. The grounds of appeal are as follows:

1. The Development Permit relates to an existing Aggregate Extraction development.

2. The existing development has created ongoing nuisances and adverse effects, which have not been mitigated, including excessive noise and dust.

3. In addition, the existing development has created safety concerns due to truck traffic related to the development as well as general traffic concerns due to hauling occurring on unapproved roads..

4. Conditions on the previous development permit that were designed to mitigate impacts have been continually breached and the County has not taken steps to enforce the conditions.

5. The existing development is an industrial use that is adjacent to a pre-existing residential use. The surrounding area is agricultural/ residential. The

development is incompatible with surrounding uses and is not suitable for the Site. Past experience has proven that the impacts cannot be mitigated through the imposition of conditions.

6. The Site is located within the Agricultural Large Holding Policy Area. The development does not comply with the policies for the Agricultural Large Holding Policy Area set out in the Strathcona County Municipal Development Plan.

7. Such further and other grounds as may be raised at the hearing of the Appeal.

I have enclosed a Notice of Appeal form and my office will contact you directly to provide a credit card number to pay the filing fee of $150.00. I look forward to hearing from you with respect to a hearing date. I would very much appreciate if you would check with me regarding my availability prior to scheduling an appeal date.

Yours truly,

**KENNEDY AGRIOS OSHRY LAW**

Per:

**JANICE A. AGRIOS, KC**
JAA/

cc: client

STRATHCONA COUNTY

# Notice of Appeal
## Subdivision and Development Appeal Board



Legislative and Legal Services, 2001 Sherwood Drive, Sherwood Park, Alberta T8A 3W7
Phone 780-464-8140 Fax 780-464-8194
Email: sdab@strathcona.ca

**Site and appellant information** (fill out completely)

**Site information**

Municipal address of site

| Owner of site | Applicant |
|---|---|
| Joburg Aggregates Ltd. | Joburg Aggregates Ltd. |

Legal description of site ('lot/block/plan' and/or 'quarter-section-township-range')
SW-25-54-22-W4, NW-25-54-22-W4 & SW 36-54-22-W4

Development permit number or subdivision application number
2022-0589-DP

**Appellant information**

Name of Appellant
Joburg Aggregates Ltd.

Mailing address
11610 151 Street NW

| City/Municipality | Province | Postal code | Phone number |
|---|---|---|---|
| Edmonton | AB | T5M 4E9 | 780-454-0700 |

**Agent information and certification (if Appellant is represented by an Agent)**

Name of Agent
Aspen Land Group Inc.

Mailing address
11213 Winterburn Road NW

| City/Municipality | Province | Postal code | Phone number |
|---|---|---|---|
| Edmonton | AB | T5S 2B2 | 780-809-8191 ext. 22 |

The Appellant hereby authorizes the above named agent to act on the Appellant's behalf on matters pertaining to this Appeal.

[signature] 2022-12-21

Signature of Appellant Date

☒ By checking this box the Appellant or, if the Appellant is represented by an Agent, the Agent would like to receive all correspondence including the Appeal hearing notice and decision via the following e-mail address and understands no paper copies will be sent.

Email address: lfoy@aspenlandgroup.com, pwall@gjconstruction.ca

**Appeal against** (Check one box only)

| Development permit | Subdivision application | Order |
|---|---|---|
| ☐ Approval | ☐ Approval | ☐ Notice of order |
| ☒ Conditions of approval | ☐ Conditions of approval | |
| ☐ Refusal | ☐ Refusal | |

# Notice of Appeal
## Subdivision and Development Appeal Board


**Reasons for appeal** (Attach a separate page if required)

Sections 678 and 686 of the *Municipal Government Act* require that the written Notice of Appeal must contain specific reasons for the appeal.

Joburg Aggregates Ltd. respectfully submit this Notice of Appeal as it pertains to Condition 5 and the expiration date of the issued Development Permit.

Condition 5 of the Development Permit allows activities associated with the aggregate extraction to take place between between 7:00 am to 7:00 pm, however, Joburg Aggregates Ltd. applied for the the aggregate processing activities (crushing, screening and washing) associated with the aggregate extraction to be 24 hours, seven days a week. Joburg Aggregates Ltd. wishes to appeal the condition to allow for 24 hour, seven day a week as applied for. The extended hours will allow for activity to be concentrated over a reduced period of time.

Additionally, Joburg Aggregates Ltd. requests that the Development Permit Expiration Date is set 10 years from the date of the SDAB's decision.

**Collection and use of personal information**
Personal information is collected under the authority of section 33(c) of the Freedom of Information and Protection of Privacy Act and will be used to manage and administer the Subdivision and Development Appeal Board process. Information provided in your submission may be made available to the public. If you have questions regarding the collection, use or disclosure of this information contact the Coordinator, Secretariat Services at 780-464-8140.

| Signature of Appellant / Agent | Date YYYY | MM | DD |
|---|---|---|---|
| | 2022 | 12 | 21 |

| Office use only | | | | | |
|---|---|---|---|---|---|
| SDAB appeal number | Appeal fee paid ☐ Yes ☐ No | Hearing date YYYY | MM | DD | Date Notice of Appeal Received |
| | | | | | |

## NOTICE OF APPEAL SUBMISSION INFORMATION

To file a Notice of Appeal your completed Notice of Appeal and the $150.00 filing fee must both be received by the Subdivision and Development Appeal Board no later than the final date for appeal as specified in the *Municipal Government Act.*

## FILING INFORMATION

The Notice of Appeal may be submitted as follows:

| MAIL TO: | DELIVER TO: | EMAIL TO: |
|---|---|---|
| Subdivision and Development Appeal Board<br>2001 Sherwood Drive<br>Sherwood Park, Alberta T8A 3W7 | Subdivision and Development Appeal Board<br>3rd Floor, East Tower, Community Centre<br>401 Festival Lane, Sherwood Park | SDAB@strathcona.ca |

## METHOD OF PAYMENT

Payment of the filing fee may be made in person at the Subdivision and Development Appeal Board office by cash, cheque, debit, Visa or Mastercard. Payment may also be made by cheque payable to Strathcona County. Payment may be made by phone by Visa or Mastercard.

## FURTHER INFORMATION

If you require further information regarding an appeal or Subdivision and Development Appeal Board procedures, please contact the Coordinator, Secretariat Services, Legislative and Legal Services, Strathcona County at 780-464-8140 or sdab@strathcona.ca.

SENT TO PARTIES

**STRATHCONA COUNTY**
**Subdivision and Development Appeal Board**

2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Email: SDAB@strathcona.ca

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**NOTICE OF HEARING – Appeal #2023-01 and 2023-02**

December 23, 2022

**APPEAL 2023-01**

**APPELLANTS:**
Jim and Coralie Mohr
54540 Range Road 220
Fort Saskatchewan, AB T9L4C1

**RESPONDENT:**
Strathcona County
c/o Meghan Thompson
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7

**APPEAL 2023-02**

**APPELLANT/APPLICANT:**
Joburg Aggregates Ltd.
11610 151 St
Edmonton, AB T5M 4E9

**LANDOWNERS:**
1488098 Alberta Ltd.
11610 151 Street
Edmonton, AB T5M 4E9

Christopher Alan McEachern
22155 Township Road 455
Fort Saskatchewan, AB T8L 3Z8

**RE: APPEAL #2023-01 and 2023-02**
**PROPOSED AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use**
**(expires November 30, 2032)**
**Development Permit Number: 2022-0589-DP**
**Legal Description: W-25-54-22-W4, NW-25-54-22-W4, and SW-36-54-22-W4**

The SUBDIVISION AND DEVELOPMENT APPEAL BOARD ("SDAB") will hold a hearing to consider an appeal of the decision of the Development Officer of Strathcona County to issue a development permit for a proposed AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use (expires November 30, 2032), on the above described property as follows:

| | |
|---|---|
| DATE: | Thursday, January 19, 2023 |
| TIME: | 9:00 a.m. |
| LOCATION: | Via electronic means or Council Chambers<br>401 Festival Ln, Sherwood Park, AB T8A 3W7 |

The Subdivision and Development Appeal Board ("SDAB") has received two Notices of Appeal related to Development Permit 2022-0589-DP. A copy of each is enclosed.

The hearings of both appeals are scheduled for the same time, date, and location. It is the intention of the SDAB that they be heard together. The SDAB will provide direction on the order of presentations at the hearing.

You or any person acting on your behalf may present verbal, visual or written submissions to the SDAB at the hearing.

If you wish to submit visual or written material to the SDAB, please email your submissions to the clerk at SDAB@strathcona.ca **no later than 4:30 p.m. on January 11, 2023** Materials submitted will be included in the hearing package prepared for the SDAB and will be distributed to the SDAB and made available to the appeal participants prior to the hearing.

If you are unable to meet the above submission deadline, please contact the clerk at SDAB@strathcona.ca.

PLEASE BE ADVISED THAT YOUR ENTIRE SUBMISSION WILL FORM PART OF THE PUBLIC RECORD.

**IMPORTANT INFORMATION:**

1. any visual or written material received by the Clerk of the SDAB in advance of the hearing will form part of the public record and will be made available for public inspection pursuant to section 686(4) of the *Municipal Government Act*, RSA 2000, c M-26 as amended;

2. while the Clerk of the SDAB will accept visual or written material in advance of the hearing, the ultimate decision as to whether any or all of the materials will be considered by the SDAB remains with the SDAB; and

3. depending on the complexity and volume of the materials submitted, there may be requests for adjournments which the SDAB would consider on a case-by-case basis.

You may participate in this hearing either electronically or in person. If you wish to participate electronically, contact the clerk to receive the required instructions.

Relevant documents and materials respecting the appeal will be posted on the SDAB web page **after 1:00 p.m. on January 13, 2023.**

If you have any questions concerning this appeal, please contact Lana Dyrland, Clerk of the SDAB, at (780) 464-8140.

Sincerely,

Lana Dyrland
Clerk, Subdivision and Development Appeal Board
STRATHCONA COUNTY

*Enclosure*

SENT TO AFFECTED PERSONS

**STRATHCONA COUNTY**
**Subdivision and Development Appeal Board**

2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Email: SDAB@strathcona.ca

---

**NOTICE OF HEARING – Appeal #2023-01 and 2023-02**

December 23, 2022

**RE: APPEAL #2023-01 and 2023-02**
**PROPOSED AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use (expires November 30, 2032)**
**Development Permit Number: 2022-0589-DP**
**Legal Description: W-25-54-22-W4, NW-25-54-22-W4, and SW-36-54-22-W4**

The SUBDIVISION AND DEVELOPMENT APPEAL BOARD ("SDAB") will hold a hearing to consider an appeal of the decision of the Development Officer of Strathcona County to issue a development permit for a proposed AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use (expires November 30, 2032), on the above described property as follows:

| | |
|---|---|
| DATE: | Thursday, January 19, 2023 |
| TIME: | 9:00 a.m. |
| LOCATION: | Via electronic means or Council Chambers<br>401 Festival Ln, Sherwood Park, AB T8A 3W7 |

You may participate in this hearing either electronically or in person. If you wish to participate electronically, contact the clerk to receive the required instructions.

As a PERSON GIVEN NOTICE OF THIS HEARING, you or a person acting on your behalf may present verbal, visual or written submissions to the SDAB at the hearing.

If you wish to submit visual or written material to the SDAB, please email your submissions to the clerk at SDAB@strathcona.ca **no later than 4:30 p.m. on January 11, 2023**. Materials submitted will be included in the hearing package prepared for the SDAB and will be distributed to the SDAB and made available to the appeal participants on the SDAB web page prior to the hearing.

If you are unable to meet the above submission deadline, please contact the clerk at SDAB@strathcona.ca**.**

PLEASE BE ADVISED THAT YOUR ENTIRE SUBMISSION WILL FORM PART OF THE PUBLIC RECORD.

**IMPORTANT INFORMATION:**

1. any visual or written material received by the Clerk of the SDAB in advance of the hearing will form part of the public record and will be made available for public inspection pursuant to section 686(4) of the *Municipal Government Act*, RSA 2000, c M-26 as amended;

2. while the Clerk of the SDAB will accept visual or written material in advance of the hearing, the ultimate decision as to whether any or all of the materials will be considered by the SDAB remains with the SDAB; and

3. depending on the complexity and volume of the materials submitted, there may be requests for adjournments which the SDAB would consider on a case-by-case basis.

Relevant documents and materials respecting the appeal will be posted on the SDAB web page **after 1:00 p.m. on January 13, 2023.**

If you have any questions concerning this appeal, please contact Lana Dyrland, Clerk of the SDAB, at (780) 464-8140.

Sincerely,

Sara McKerry
Clerk, Subdivision and Development Appeal Board
STRATHCONA COUNTY

POSTED ONLINE

**STRATHCONA COUNTY**
**Subdivision and Development Appeal Board**

2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Email: SDAB@strathcona.ca

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**NOTICE OF HEARING – Appeal #2023-01 and 2023-02**

December 23, 2022

**RE: APPEAL #2023-01 and 2023-2**
**PROPOSED AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use (expires November 30, 2032)**
**Development Permit Number: 2022-0589-DP**
**Legal Description: W-25-54-22-W4, NW-25-54-22-W4, and SW-36-54-22-W4**

The SUBDIVISION AND DEVELOPMENT APPEAL BOARD ("SDAB") will hold a hearing to consider an appeal of the decision of the Development Officer of Strathcona County to issue a development permit for a proposed AGGREGATE EXTRACTION USE – Sand, Gravel and Clay Extraction and Processing Operation – Temporary Use (expires November 30, 2032), on the above described property as follows:

| | |
|---|---|
| DATE: | Thursday, January 19, 2023 |
| TIME: | 9:00 a.m. |
| LOCATION: | Via electronic means or Council Chambers<br>401 Festival Ln, Sherwood Park, AB T8A 3W7 |

If you are affected by the above appeal, you **may** be entitled to make submissions to the SDAB. Here is what you can do:

1) you can provide visual or written submissions in advance of the hearing by sending an email to SDAB@strathcona.ca ; and

2) you can attend this hearing either electronically or in person means and make a presentation at the hearing.

If you wish to submit visual or written material to the SDAB, please email your submissions to the clerk at SDAB@strathcona.ca **no later than 4:30 p.m. on January 11, 2023**. Materials submitted will be included in the hearing package prepared for the SDAB and will be distributed to the SDAB and made available to the appeal participants prior to the hearing.

If you are unable to meet the above submission deadline, please contact the clerk at SDAB@strathcona.ca**.**

PLEASE BE ADVISED THAT YOUR ENTIRE SUBMISSION WILL FORM PART OF THE PUBLIC RECORD.

**IMPORTANT INFORMATION:**

1. any visual or written material received by the Clerk of the SDAB in advance of the hearing will form part of the public record and will be made available for public inspection pursuant to section 686(4) of the *Municipal Government Act*, RSA 2000, c M-26 as amended;

2. while the Clerk of the SDAB will accept visual or written material in advance of the hearing, the ultimate decision as to whether any or all of the materials will be considered by the SDAB remains with the SDAB; and

3. depending on the complexity and volume of the materials submitted, there may be requests for adjournments which the SDAB would consider on a case-by-case basis.

You may participate in this hearing either electronically or in person. If you wish to participate electronically, contact the clerk to receive the required instructions.

Relevant documents and materials respecting the appeal will be posted on the SDAB web page **after 1:00 p.m. on January 13, 2023.**

If you have any questions concerning this appeal, please contact Lana Dyrland, Clerk of the SDAB, at (780) 464-8140.

**From:** Janice Agrios <JAgrios@kaolawyers.com>
**Sent:** January 8, 2023 1:42 PM
**To:** SDAB
**Cc:** Lana Dyrland
**Subject:** RE: SDAB January 19, 2023 Notice of Hearing for Appeals 2023-01 and 2023-02

**CAUTION:** This email originated from outside the organization.

I have now received the notice of appeal.

As I have been away from the office, I will not be able to meet the submission deadline of January 11.

In addition, Coralie Mohr is not available on January 19 for the hearing. Both Ms. Mohr and I are available on January 26 and February 9. In the circumstances, I am requesting that the hearing be postponed to one of these dates (Note – I have only provided availability for Thursdays as I believe that the Board usually holds hearings on Thursdays. If the Board is prepared to hold the hearing on a day other than a Thursday, I will canvass Ms. Mohr and provide availability for other dates).

Janice Agrios

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**From:** SDAB <SDAB@strathcona.ca>
**Sent:** December 29, 2022 1:46 PM
**Subject:** SDAB January 19, 2023 Notice of Hearing for Appeals 2023-01 and 2023-02

Good afternoon,

Please see the attached Notice of Hearing for Appeals 2023-01 and 2023-02 regarding Development Permit number 2022-0589-DP.

Please confirm receipt of this email to
SDAB@strathcona.ca.

Regards,

**Thomas Kassian** (he/him)
Governance Services Administrator
Legislative and Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8135
thomas.kassian@strathcona.ca

STRATHCONA COUNTY

**From:** Lana Dyrland
**To:** SDAB
**Cc:**
**Subject:** Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment
**Date:** Tuesday, January 10, 2023 9:29:48 AM
**Attachments:**

**Importance:** High

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Good morning,

The Subdivision and Development Appeal Board(SDAB) has received an adjournment request. The January 19, 2023 date does not work for the Appellant and a request has been made to postpone in order for them to attend.

On January 19, 2023, the SDAB will open the hearing to consider this adjournment request.

**The SDAB asks all parties to reply to this email as to your availability on January 26 and February 9, 2023.**

Thank you for your attention to this matter,
Lana

**Lana Dyrland**
Coordinator, Boards, Committees, and Tribunals
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca
**www.strathcona.ca**

STRATHCONA COUNTY

Find us on:

**From:** Janice Agrios <JAgrios@kaolawyers.com>
**Sent:** January 10, 2023 11:39 AM
**To:** Lana Dyrland; SDAB
**Cc:** Sara McKerry; Thomas Kassian
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment



Hi Lana – Ms. Mohr and I are available on both dates.

Janice Agrios

---

**From:** Lana Dyrland <Lana.Dyrland@strathcona.ca>
**Sent:** January 10, 2023 9:30 AM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Sara McKerry <Sara.McKerry@strathcona.ca>; Thomas Kassian <Thomas.Kassian@strathcona.ca>
**Subject:** Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment
**Importance:** High

Good morning,

The Subdivision and Development Appeal Board(SDAB) has received an adjournment request. The January 19, 2023 date does not work for the Appellant and a request has been made to postpone in order for them to attend.

On January 19, 2023, the SDAB will open the hearing to consider this adjournment request.

**The SDAB asks all parties to reply to this email as to your availability on January 26 and February 9, 2023.**

Thank you for your attention to this matter,
Lana

**Lana Dyrland**
Coordinator, Boards, Committees, and Tribunals
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca
**www.strathcona.ca**

STRATHCONA COUNTY

Find us on:

**From:** Jana Jedlic
**Sent:** January 10, 2023 4:00 PM
**To:** Lana Dyrland; SDAB
**Cc:** Thomas Kassian; Sara McKerry
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

Good afternoon,

Thank you for your email. The development authority does not make any submission and does not take any position with respect to the adjournment request from the Applicant. If the adjournment request is granted by the board, the development authority is available to attend the hearing on January 26th or February 9th, 2023.

Thank you,

Jana

**Jana Jedlic M.U.P., B.A., RPP, MCIP** (she/her)
Manager, Permitting, Inspections & Customer Service
Planning & Development Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8159
jana.jedlic@strathcona.ca
**www.strathcona.ca**

STRATHCONA COUNTY

Find us on:

---

**From:** Lana Dyrland <Lana.Dyrland@strathcona.ca>
**Sent:** Tuesday, January 10, 2023 9:30 AM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Sara McKerry <Sara.McKerry@strathcona.ca>; Thomas Kassian <Thomas.Kassian@strathcona.ca>
**Subject:** Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment
**Importance:** High

Good morning,

The Subdivision and Development Appeal Board(SDAB) has received an adjournment request. The January 19, 2023 date does not work for the Appellant and a request has been made to postpone in order for them to attend.

On January 19, 2023, the SDAB will open the hearing to consider this adjournment request.

**The SDAB asks all parties to reply to this email as to your availability on January 26 and February 9, 2023.**

Thank you for your attention to this matter,
Lana

## Thomas Kassian

**From:** Wachowicz, Ian <ian.wachowicz@dentons.com>
**Sent:** January 10, 2023 11:11 AM
**To:** Lana Dyrland
**Cc:** jagrios@kennedyagrios.com; Lesley Foy; Peter Wall
**Subject:** FW: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment



Good Morning:

I have been retained by Joburg Aggregates Ltd. ("Joburg") to represent them in both Appeal #2023-01 and #2023-02.

Joburg can and will make itself available on either **January 26 or February 9, 2023.** We request that the date be the **January 26, 2023** date.

Joburg is agreeing to this as a courtesy to opposing counsel, and to ensure that all sides in this appeal can have a fair hearing. The filing of the appeal by Ms. Agrios' client has the effect of suspending the permit that was granted to Joburg. Joburg did file it's own appeal of one of the conditions of the permit, but only after Ms. Agios' client had already filed an appeal and triggered the SDAB's jurisdiction in this matter. Every day that the permit is suspended represents a significant financial loss to Joburg.

As you are aware, s. 686(2) of the MGA requires the SDAB to hold the hearing within 30 days after receipt of the notice of appeal. This adjournment request therefore requires Joburg's consent. Joburg is giving it's consent, in order to avoid the suggestion that Joburg was preventing Ms. Agrios' client from having a fair hearing. However, we wish it to be known that Joburg will not consent to any day past February 9, 2023. Joburg is requesting January 26 both because it is the closer of the two dates, and also because it fits better with our consultant's schedule.

Thank you.

Ian L. Wachowicz
Partner

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**From:** SDAB
**To:** SDAB
**Cc:**

**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment
**Date:** Tuesday, January 17, 2023 3:09:34 PM
**Attachments:**

---

Good afternoon,

The SDAB has now received responses from all parties and will consider the written submissions of the parties regarding the adjournment request on January 19, 2023.

Once the Board has considered the written submissions from the parties regarding the adjournment request, the Board will send an email to the parties with their decision on this preliminary matter.

Should you have questions about the hearing process please feel free to contact me.
Thank you,
Lana

**Lana Dyrland**
Clerk, Subdivision and Development Appeal Board
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca

## Thomas Kassian

**From:** Wachowicz, Ian <ian.wachowicz@dentons.com>
**Sent:** January 17, 2023 3:23 PM
**To:** SDAB
**Cc:** Janice Agrios
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

**CAUTION:** This email originated from outside the organization.

Thank you for your email. As a result I will not attend on January 19, 2023.

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Partner


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---

**From:** SDAB <SDAB@strathcona.ca>
**Sent:** Tuesday, January 17, 2023 3:10 PM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Sara McKerry <Sara.McKerry@strathcona.ca>; Thomas Kassian <Thomas.Kassian@strathcona.ca>; Janice Agrios <JAgrios@kaolawyers.com>; Wachowicz, Ian <ian.wachowicz@dentons.com>; Meghan Thompson

<Meghan.Thompson@strathcona.ca>; Chris Gow <Chris.Gow@strathcona.ca>; developmentpermitting <developmentpermitting@strathcona.ca>; Jana Jedlic <Jana.Jedlic@strathcona.ca>; Kendra Andrew <Kendra.Andrew@strathcona.ca>; Lesley Foy <lfoy@aspenlandgroup.com>
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

**[WARNING: EXTERNAL SENDER]**

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Good afternoon,

The SDAB has now received responses from all parties and will consider the written submissions of the parties regarding the adjournment request on January 19, 2023.

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Should you have questions about the hearing process please feel free to contact me.
Thank you,
Lana

**Lana Dyrland**
Clerk, Subdivision and Development Appeal Board
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca

---

**From:** Lana Dyrland
**Sent:** Tuesday, January 10, 2023 9:30 AM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Sara McKerry <Sara.McKerry@strathcona.ca>; Thomas Kassian <Thomas.Kassian@strathcona.ca>
**Subject:** Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment
**Importance:** High

Good morning,

The Subdivision and Development Appeal Board(SDAB) has received an adjournment request. The January 19, 2023 date does not work for the Appellant and a request has been made to postpone in order for them to attend.

On January 19, 2023, the SDAB will open the hearing to consider this adjournment request.

**The SDAB asks all parties to reply to this email as to your availability on January 26 and February 9, 2023.**

Thank you for your attention to this matter,
Lana

**From:** Janice Agrios <JAgrios@kaolawyers.com>
**Sent:** January 17, 2023 5:04 PM
**To:** Wachowicz, Ian; SDAB
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

**CAUTION:** This email originated from outside the organization.

Hi Lana – I agree with what Ian has set out. It would be difficult to meet submission deadlines for a hearing next week.

Janice Agrios

---

**From:** Wachowicz, Ian <ian.wachowicz@dentons.com>
**Sent:** Tuesday, January 17, 2023 3:23 PM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Janice Agrios <JAgrios@kaolawyers.com>
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

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Ian L. Wachowicz
Partner


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## Lana Dyrland

**From:** SDAB
**Sent:** Wednesday, January 18, 2023 1:14 PM
**To:** Wachowicz, Ian; SDAB
**Cc:** Janice Agrios
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

Thank you for your email. The email will be provided to the Board.

Lana

**Lana Dyrland**
Coordinator, Boards, Committees, and Tribunals
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca
**www.strathcona.ca**

STRATHCONA COUNTY

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**From:** Wachowicz, Ian <ian.wachowicz@dentons.com>
**Sent:** Tuesday, January 17, 2023 3:23 PM
**To:** SDAB <SDAB@strathcona.ca>
**Cc:** Janice Agrios <JAgrios@kaolawyers.com>
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

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## Lana Dyrland

**From:** SDAB
**Sent:** Wednesday, January 18, 2023 1:15 PM
**To:** Janice Agrios; Wachowicz, Ian; SDAB
**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

Thank you for your email Janice. This email will also be provided to the Board.

Lana


**Lana Dyrland**
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**Subject:** RE: Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02 - Request for Adjournment

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Should you have questions about the hearing process please feel free to contact me.
Thank you,
Lana

STRATHCONA COUNTY

# Development Permit

Decision

2001 Sherwood Drive
Sherwood Park, Alberta
T8A 3W7
Phone: (780) 464-8080
Fax: (780) 464-8142

## DEVELOPMENT PERMIT NUMBER: 2022-0589-DP

### PROPERTY DESCRIPTION

| | |
|---|---|
| | **4225300005** |
| *Civic Address* | *Roll Number* |
| **SW-25-54-22-W4, NW-25-54-22-W4 & SW 36-54-22-W4** | **No subdivsion name found** |
| *Legal Description* | *Subdivision Name* |
| | **AG - Agriculture: General** |
| *Additional Description* | *Land Use District* |

### APPLICANT

**Joburg Aggregates Ltd.**
11610 151 Street NW
Edmonton, Alberta
T5M4E9

**Contact:** Peter Wall
**Phone:** 780-233-3588, 780-454-0700

### LANDOWNER

Joburg Aggregates Ltd.
11610 151 St
Edmonton, AB
T5M 4E9

### PROPOSED DEVELOPMENT

*The development proposed is described as follows:*

**Aggregate Extraction Use - Sand, Gravel and Clay Extraction and Processing Operation (167.93 ha) - Temporary Use Expires November 30, 2032**

### DECISION

*The proposal has been reviewed by Planning and Development Services and the following decision was rendered pursuant to the Land Use Bylaw:*

**APPROVED**

*Please see below or Schedule A for the conditions of Approval.*

*The decision on this application was made by:* **Meghan Thompson**, *Development Officer* — **November 30, 2022** (*Date*)

This permit has been issued on a TEMPORARY basis and will expire in approximately 10 Years on November 30, 2032.
Please contact Planning and Development Services at least one month prior to the expiry date for information regarding reapplication, extension or renewal of this permit.

### APPEAL

*The decision and/or conditions of this permit are subject to a twenty one (21) day appeal period.*

**Decision Date: NOVEMBER 30, 2022** **Appeal Expiry Date: DECEMBER 21, 2022**

*Appeals must be submitted to the Subdivision and Development Appeal Board prior to the Appeal Expiry Date. For further information, contact the clerk to the Subdivision and Development Appeal Board at (780) 464-8140.*

**LAND USE BYLAW 6-2015** **When Ready:** ● **Phone** ○ **Mail** ○ **Email**

***EDMS#: 4200***

STRATHCONA COUNTY

November 30, 2022

DP#2022-0589-DP

Joburg Aggregates Ltd.
11610 – 151 Street NW
Edmonton, AB
T5M 4E9

Attention: Lucas Bodnar

**RE: PROPOSED AGGREGATE EXTRACTION USE (TEMPORARY USE)**
**Applicant:** Joburg Aggregates Ltd.
**Site Description:** SW-25-54-22-W4, NW-25-54-22-W4, and SW-36-54-22-W4
**Zoning District:** AG - Agriculture: General
**Use Type:** Temporary Discretionary Use
**Development Description:** Aggregate Extraction - sand, gravel, and clay extraction and processing operation
**Development Permit Number:** 2022-0589-DP
**Development Permit Expiration Date:** November 30, 2032

Please be advised that on November 30, 2022, the Strathcona County Development Authority **APPROVED** your development permit application for an Aggregate Extraction Use (sand, gravel, and clay extraction and processing operation) on the site identified above and issued a temporary use development permit with conditions that expires on November 30, 2032.

The **conditions of this development permit** are as follows:

1. Development and operation of the Aggregate Extraction Use must be in conformance with the plans and information submitted by the Applicant and approved by the Development Authority as part of the development permit application. Without limiting the generality of the foregoing, this includes the 'Aspen Land Group Joburg Pit Summary and Supporting Documents' dated November 2022.

2. That this development permit is valid for a temporary period expiring **November 30, 2032**. In this regard, a new development permit application is required to be submitted to Planning & Development Services for any proposed development and operations intended after the expiry date.

3. No sales of raw material or product associated with the Aggregate Extraction Use shall be conducted on the site.

4. All aggregate extraction and processing operations taking place as part of the Aggregate Extraction Use shall be carried out so as to create a minimum of dust and environmental disturbance.

5. All activities associated with the Aggregate Extraction Use taking place on the site may only take place between 7:00 a.m. to 7:00 p.m., Monday through Saturday (inclusive), excepting statutory holidays. For clarity, no such activities shall take place on Sundays or on statutory holidays.

6. Despite condition #5, loading and hauling associated with the Aggregate Extraction Use taking place on the site may only take place between 6:00 a.m. to 7:00 p.m., Monday through Saturday (inclusive), excepting statutory holidays. For clarity, no such activities shall take place on Sundays or on statutory holidays.

7. All hauling activities associated with the Aggregate Extraction Use may only occur on the approved haul route. In this regard, the approved haul route is indicated in the plans and information in the 'Aspen Land Group Joburg Pit Summary and Supporting Documents' dated November 2022.

8. Vehicles attending the site related to the Aggregate Extraction Use shall only park (including idling while waiting to load and transport aggregate materials) in a parking area on the site. Such vehicles shall not park on any municipal road.

9. Prior to the commencement of any activity on the site related to the Aggregate Extraction Use, the Applicant shall enter into a Road Use Agreement with Strathcona County.

10. Any required outdoor lighting shall be in accordance with Land Use Bylaw 6-2015 (Part 3, Section 3.11–Outdoor Lighting) and Strathcona County's Light Efficient Community Policy unless otherwise required under provincial or federal regulation.

11. All site access and/or alterations to site access shall be to the satisfaction of the County Engineer with respect to location, design, and construction standards. In this regard, the applicant is to contact Nazia Ahsan at 780-416-6775 for any site access that requires upgrading.

12. The Applicant is required to make an Access Approach Permit Application for the removal of accesses through County Connect. Please see the following link for additional information regarding the Property Access Approach Permit and access construction specifications at https://www.strathcona.ca/transportation-roads/roads/permits/access-guidelines/. In this regard, there are a number of existing field accesses to the subject properties which are required to be removed to the County's satisfaction.

13. Failing to conform to the aforementioned conditions would render this permit invalid.

The Applicant is advised of the following:

a. Information regarding the process for a Road Use Agreement with Strathcona County is located at https://www.strathcona.ca/countyconnect/service/road-use-agreement/ and questions can be directed to the Strathcona County Transportation Engineering and Operations department at 780-417-7100.

b. A new development permit application will be required for any expansion or intensification of the Aggregate Extraction Use, and for any proposed development and operations of the Aggregate Extraction Use intended to take place after the expiration date of the development permit identified above.

c. It is the Applicant's responsibility to ascertain and ensure compliance with, and obtain and maintain all required approvals pursuant to, all applicable federal, provincial, and municipal laws and regulations, which include but are not limited to:
   - *Code of Practice For Pits* (made under the *Environmental Protection and Enhancement Act*, RSA 2000, c, E-12);
   - *Conservation and Reclamation Regulation*, Alta Reg 115/1993;
   - *Environmental Protection and Enhancement Act*, RSA 2000, c E-12;
   - *Migratory Birds Convention Act, 1994*, SC 1994, c 22;
   - National Fire Code - 2019 Alberta Edition;
   - *Water Act*, RSA 2000, c W-3;
   - *Weed Control Act*, SA 2008, c W-5.1;
   - *Wildlife Act*, RSA 2000, c W-10;
   - Strathcona County Noise Control Bylaw (Bylaw 66-99); and
   - Strathcona County Traffic Bylaw (Bylaw 16-2015).

d. The Applicant shall ensure the proper reclamation and restoration of the site after completion of extraction activities. The Applicant shall:
   a. obtain development and reclamation approval from Alberta Environment, including the provision of security to the satisfaction of Alberta Environment, and
   b. upon satisfactory completion of reclamation on-site, the applicant shall obtain a Reclamation Certificate from Alberta Environment.

e. This development permit is not a building permit, plumbing permit, gas permit, or electrical permit. It is the Applicant's responsibility to obtain and maintain any such required permits. Information regarding building, plumbing, gas, and electrical permits is located at https://www.strathcona.ca/council-county/administration/departments/planning-development-services/ and questions can be directed to the Strathcona County Planning and Development Services department at 780-464-8080.

f. It is the Applicant's responsibility to ascertain and ensure compliance with any easement, right-of-way, restrictive covenant, or development agreement affecting the site. We advise that the applicant/developer is responsible for maintaining authorization from ATCO Electric and AltaLink L.P. as well as any other parties with an interest in rights-of-way registered on the title of the subject properties. Please also note that access to transmission tower right-of-ways it to be maintained during operation of the aggregate extraction operation.

g. It is the Applicant's responsibility to contact utility companies to ascertain and ensure compliance with any applicable regulations or requirements related to underground and overhead utilities located on or in proximity to the site.

This decision may be appealed to the Subdivision and Development Appeal Board within 21 days after the decision date pursuant to Section 686 of the *Municipal Government Act*, RSA 2000, c M-26. For inquiries regarding the appeal process, please contact the Subdivision and Development Appeal Board at 780-464-8140.

Sincerely,
**STRATHCONA COUNTY**

Meghan Thompson
Development Officer
Permitting, Inspections & Customer Service
Planning & Development Services
:mt:

pc: Diana Charleson, Land Development Engineering
Karolina Haggerty, Land Development Engineering
Dawn Prosper, Transportation Engineering and Operation
Ryan Wilson, Transportation Engineering and Operation
Garry Johnston, Transportation Engineering and Operation
Fire Prevention, Emergency Services
Cody Nahirniak, Alberta Environment & Parks

# Joburg Pit

## Referral Comment Letter Response & Development Permit Application

Revision 1

W 1/2 25 & SW 36-054-22-W4M

November 2022

Prepared for

JOBURG
Aggregates Ltd.

STRATHCONA COUNTY
AGGREGATE EXTRACTION USE
APPROVED FOR DEVELOPMENT PERMIT ONLY
DEVELOPMENT OFFICER
DEVELOPMENT PERMIT No 2022-0589-DP DATE Nov. 30 2022

Aspen LAND GROUP

11213 Winterburn Rd NW
Edmonton, AB T5S 2B2

**Office** (780) 809 8191
**Fax** (780) 809 8190
**Site** aspenlandgroup.com

11213 Winterburn Rd NW
Edmonton, AB T5S 2B2

**Office** (780) 809 8191
**Fax** (780) 809 8190
**Site** aspenlandgroup.com

November 1, 2022

Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7

Sent via email: meghan.thompson@strathcona.ca

Attention: Megan Thompson
Industrial Planning Officer

Reference: Referral Comments Letter
Proposed Aggregate Extraction Use – Sand, Gravel, and Clay Extraction (167.93 ha)
SW 36-54-22-W4, NW 25-54-22-W4 & SW 25-56-22-W4
Strathcona County

Dear Ms. Thompson:

Aspen Land Group Inc. (Aspen) has been retained by Joburg Aggregates Ltd. (Joburg) to prepare a response to the Referral Comments Letter received on October 11, 2022 regarding the proposed aggregate extraction development within SW 36-54-22-W4, NW 25-54-22-W4 & SW 25-56-22-W4. We have prepared a response to the Referral Letter questions below, with the questions in italics and the corresponding answer directly below. Responses to the below items have been integrated into the revised Development Permit Application package which is included as an Attachment. A revision table is available on Page iv of the package to easily reference the revisions that have been made to the original application. If a section or appendix is not referenced in the revision table, it remains the same as the original September 2022 submission.

***Development Permitting Comments:***

1. *Please provide a copy of the noise study that was being completed by ACI Acoustical Consultants Inc., including the recommendations.*

A copy of the ACI Acoustical Consultants Inc. (ACI) Noise Impact Assessment Report has been included in the revised Development Permit Application package as Appendix M and is discussed within the revised Section 5.13

2. *Land Use Bylaw 6-2015 Section 2.15 Discretion Exercised by the Development Authority*

*Land Use Bylaw 6-2015 Section 2.15.5 states that the Development Authority may consider, but not be bound by, any known concerns and opinions of affected residents, landowners, and adjacent municipalities.*

*Adjacent Landowners:*

*As a result of circulation, the following is a summary of the comments received from adjacent landowners:*

*A) The conditions of development permit approval 2015-1108-DP were continually breached:*

> *Condition #7: All aggregate extraction processing/operations shall be carried out so as to create minimum of dust and environmental disturbance.*

- *We have complained about the dust issues for the past 5 years. Joburg has not acknowledged nor addressed our concerns. In October 2021 Strathcona County sent out enforcement officers to deal with the unbearable amount of dust coming from the gravel pit. This is the first and only time that Strathcona County has addressed our concerns. The dust has not abated in the last year.*
- *Stockpiles are not covered with clay overburden and grass. In addition to the dust coming directly from the gravel pit, the road is a dusty, hazy mess on a regular basis. There are records of the complaints*

Joburg Aggregates has employed and will continue to employ a number of dust mitigation measures during operations and hauling at the pit. All trucks leaving the pit will be tarped and drivers are expected to adhere to posted speed limits on internal and external haul routes. During site activities, active areas and internal access roads are watered to mitigate dust generated from the pit. Additionally, Range Road 221 is watered regularly during hauling. All watering is done is accordance with *Water Act* Licence No. 00286978-00-00. All long-term berms or stockpiles comprised of reclamation are vegetated in order to mitigate dust as well as prevent wind and water erosion.

It is to be noted that Item 21 (k) of the Subdivision and Development Appeal Board (SDAB) Decision for Appeal File No. 8-2017 and 9-2017 may have been misprinted as covering aggregate (product) stockpiles in clay is not operationally feasible as these types of stockpiles are typically short term. In order to address the concern of dust from aggregate stockpiles, Joburg has will water aggregate stockpiles if dust observed coming from the piles. Section 5.11 has been revised within the Development Permit Application Package to clearly outline dust mitigation measures employed within the pit and on the haul route.

> *Condition #10.1: All on-site activities associated with the proposed extraction operation shall be limited to 7:00 a.m. to 7:00 p.m. Monday through Saturday inclusive, except that there shall be no such activities on statutory holidays.*

- *We have complained about trucks/equipment starting up (with their lights pointed directly at our home) prior to 7:00 a.m. Joburg's response was a denial that this has ever happened. Further, in the winter, Joburg runs generators all night that can be heard loud and clear in our backyard. In our recent meeting with Joburg on September 30, 2022, we raised this issue with them and their response was "oh, you can hear that?".*

Joburg Aggregates is compliant with the hours of operation approved under Item 24 (10.1) of the SDAB Decision for Appeal File No. 8-2017 and 9-2017. The gate of the pit remains locked until precisely 7 AM on days where the pit is operational. In some instances, trucks may wait outside of the locked gate prior to 7AM, however no entrance into the site is made. To ensure operations are compliant, security cameras were installed at the entrance to the site that are monitored to ensure compliance with the permitted hours of operation.

It is to be noted that Joburg's primary operational season is from spring to fall where daylight at 7 AM is most common. However, to reduce light impacting residents to the east when it is dark, a large stockpile of reclamation material is positioned in the northeast corner of the pit which shields residents to the east from any truck or equipment headlights. Section 5.3 of the Development Permit Application package has been updated to include these insurances that Joburg is compliant with hours of operation.

All generators on site are WhisperWatt type generators which are extremely quiet machines meant for residential construction sites, neighbourhoods and hospitals. The manufacturer indicates the WhisperWatt produces 66 decibels of noise at a distance of 23 feet. Generators only run at night during certain circumstances. These generators are used when equipment is on site and the temperature is colder than -15 but warmer than -25 degrees Celsius, in order to plug in equipment. At temperatures cooler than -25 degrees Celsius, Joburg ceases operations. Over the past couple of years, it is estimated that generators were used 4 to 5 nights annually.

In order to facilitate removal of aggregate from the pit, dewatering occurs continuously during operation. The pump used for dewatering is housed in a silent pack and placed below original ground level and behind a berm in order the limit the noise produced.

All noise mitigation measures and the results of the ACI Noise Study are discussed in Section 5.13 of the Revised Development Permit Application Package.

> <u>*Condition #10.2:*</u> *That hauling activities associated with the proposed aggregate extraction shall occur only on the approved haul route.*

- *Joburg has advised that sometimes trucks travel north on 830. This is not an approved route and there has been no traffic impact assessment done for this route that we are aware of.*

All aggregate hauling has been in compliance with the approved Development Permit and Road Use Agreements. This includes the primary route of trucks heading south on Highway 830 (which is under the jurisdiction of Alberta Transportation). The haul route proposed in the original development permit application indicated that trucks would occasionally travel north on Highway 830 and the primary haul route would be south on Highway 830. This is primarily to serve customers in the Fort Saskatchewan area as the current development permit does not allow for travel westward on Township Road 550. During the upgrades to Township Road 550, intersection improvements were completed at the intersection of Township Road 550 and Highway 830. Section 5.2 of the Development Permit Application package has been updated to clarify the primary and alternate haul routes and are shown on Drawing No. 13-13 (located in Appendix L).

> *Condition #11: That prior to commencement of any activity on the site related to the proposed aggregate extraction development, the applicant shall enter into a Road Use Agreement with Strathcona County.*

- *Joburg commenced activity on site related to the development in January 2018. Joburg and Strathcona County did not enter into the Road Use Agreement until July 31, 2018.*

Joburg initially applied for a road use agreement with the County in January 2018 to bring equipment onto the site, as a result, Road Use Agreement No. RUA-2018-0116-011 was issued on January 16, 2018. Since then, Joburg has entered into multiple road use agreements with the County and are currently hauling under Road Use Agreement No. RUA-2022-005. Should the road use agreement need to be updated or renewed at any time, Joburg will do so in order to remain in compliance with the County. Information regarding the road use agreements has been added to Section 5.2 of the revised Development Permit Application package.

B) *Nuisance is generated from the aggregate extraction use:*

- *Peace and Enjoyment*
  - *Joburg has invaded the peace and enjoyment of this designated agricultural land. They are the exception and as part of the exception, primary consideration should be given to the citizens and the detrimental effects this large operation has on people trying to raise their crops, their livestock and their children in an agricultural setting*

Joburg has implemented several mitigation measures to ensure the peace and enjoyment of the surrounding residents is maintained during operations at the pit. Berms and stockpiles have been strategically placed in order to create a visual and sound barrier between the pit and adjacent residences. Further mitigation measures to noise, dust and traffic are discussed below and in Sections 5.2, 5.11 and 5.13 of the revised Development Permit Application Package.

- *Traffic and General Safety Concerns*
    - *Gravel trucks not stopping and missing the stop signs*
    - *Contractors disregarding basic safety for drivers and residence of Range Road 220*
    - *Witnessed a single vehicle rollover of a gravel truck that could seemingly only be caused by distracted driving*

Joburg is committed to ensuring safety of the local residents and drivers on haul routes from the pit. All contractors and truckers complete a safety orientation, review the Pit Hauling Regulations and are required to sign a copy of the Joburg Trucking Form (acknowledging the Pit Hauling Regulations) daily when hauling from the pit. Safety checks are conducted weekly on the haul route. Additionally, to ensure an additional level of safety for drivers on the haul route, Joburg has contracted a local resident to monitor the stop sign to ensure all truck drivers are coming to a complete stop.

Joburg has completed the necessary road upgrades to Township Road 550, therefore there are no anticipated impacts to drivers on Range Road 220 resulting from Joburg contractors moving forward.

The specific single vehicle incident referenced was investigated and addressed in accordance with Joburg's Pit Hauling Regulations. A copy of the Pit Hauling Regulations and Joburg Trucking Form are included in Appendix N and are discussed in Section 5.2 of the revised Development Permit Application package.

- *Dust*
    - *Joburg's operation covers 145 acres, which is too large to be able to mitigate noise and dust for a residence that is only 800 meters away. Any mitigation efforts, if any, have been useless.*

As previously mentioned in the response to Item 2 (A) regarding Condition #7 of the existing development permit, Joburg has implemented a variety of dust mitigation measures and will continue to implement these measures within the pit and on the haul route. Section 5.11 of the revised Development Permit package has been updated to reflect all dust mitigation methods used by Joburg to limit impacts to nearby residents.

- *Noise*
    - *Constant and repetitive over last 5 years*
    - *Back-up beepers, which are loud and clear within our residence has created mental anguish to have to listen to the repetitive sound*
    - *White noise beepers are a major irritant, as it sounds like a piece of equipment is not running properly.*
    - *On-going noise of the equipment that can be heard in our home*

As previously mentioned in the response to Item 2 (A) in regard to Condition 10.1 of the existing development permit, Joburg has implemented a variety of noise mitigation measures and will continue to do throughout the lifespan of the operation. Back-up beepers are an essential part of safety within the pit and are required by provincial safety regulations. In response to resident complaints regarding conventional back-up beepers, Joburg switched all of their equipment to white noise back up beepers. The sound from these beepers is extremely directional and is only prominent when located directly behind the machinery. On occasion, vehicles equipped with conventional back-up beepers may enter the site (such as delivery trucks and fuel trucks) however these vehicles will only be on site temporarily to complete their designated task. It is Joburg's intention to ensure all long-term equipment is outfitted with white noise back up beepers.

Joburg has taken additional efforts to limit noise travelling to residents located east of the pit by orienting mining, stripping and reclamation material replacement to be primarily travelling in a forward direction while facing east and backward while facing west, away from the residents to the east. Directionality of stationary equipment will also be considered, where possible to be positioned facing away from the most impacted residents. Stockpiles may be strategically placed around stationary equipment such as crushers to reduce noise impacts to residents.

To limit cumulative effects of equipment noise, Joburg will reduce the number of pieces of equipment to the minimum number required to do the given task or activity and where possible, smaller pieces of equipment will be utilized where large equipment is not necessary. Joburg has chosen to use rock trucks instead of tandem trucks in their operation to mitigate noise generated from tailgates opening and closing.

Section 5.13 of the revised Development Permit Application package has been updated to reflect all noise mitigation measures being taken by Joburg.

C) *We are located within the Agricultural Large Holding Policy Area which requires that new aggregate extraction mitigate nuisance impacts resulting from the aggregate extraction in the adjacent agricultural lands and operations with buffering, site orientation and other techniques. Joburg has not mitigated the nuisance. Nuisance is defined in the Land Use Bylaw as "anything that in the opinion of the Development Authority may cause adverse effects to the amenities of the neighbourhood or interfere with the normal enjoyment of adjacent land or buildings. This includes noise, dust and any other hazard to health or safety. Joburg is the very definition of a nuisance that has had detrimental effects on the use and enjoyment of our property for the last 5 years.*

As stated above in the responses to Item 2 (B), Joburg has employed multiple nuisance impact mitigation measures throughout operations and the pit. These ongoing dust and noise mitigation measures as well as the safety precautions mentioned in the above response will continue to be a priority for Joburg throughout the lifespan of the operation of the pit.

D) *Joburg has not upheld the proposed efforts to mitigate extreme noise and dust that our property and family have been subject to for the last 5 years. We have 5 years of evidence that any mitigation efforts by Joburg have been a failure and that given the magnitude of their operation it is impossible to mitigate the extreme adverse effects of noise and dust.*

As stated above in the responses to Item 2 (B), Joburg has employed multiple noise and dust mitigation measures to limit impacts to adjacent residents of the operation. Sections 5.11 and 5.13 of the revised Development Permit Application package reference all mitigation measures in place at the pit and along the haul road.

E) *The new application contains proposed hauling hours of 6:00 a.m. to 7:00 p.m. 6 days per week and aggregate crushing 7 days a week, 24 hours a day. This is egregious. If the Development Authority is considering granting this application, we request that all operations (hauling, crushing, generators running, and anything that makes a noise or creates a disturbance) be restricted to 9:00 a.m. to 3:00 p.m. 5 days per week. This is the only potential reprieve from the significant nuisance and safety issues created by Joburg.*

A six-hour day is not operationally feasible at the pit, Joburg will continue to employ mitigation measures to mitigate noise, dust and traffic impacts for adjacent residents. As stated above in the responses to Item 2 (B), Joburg has employed multiple noise and dust mitigation measures to limit impacts to adjacent residents of the operation.

*Land Development Engineering – Transportation Comments:*

*T1.* *No concerns with utilizing existing pit access to improved Range Road 221 for the expanded mining activities. Please note that any changes to access location and/or geometry require prior approval of the County and may trigger further road upgrades.*

The current operational plan is to keep the existing access onto Range Road 221 for the lifespan of the operation. Should it be decided that the access point is to be moved or an additional access location is required, the necessary applications will be made to the County at that time.

T2. *There are a number of other existing field accesses to subject lands noted which are required to be removed to County's satisfaction, inclusive of ditch restoration and seeding. As a condition of the Development Permit the applicant is required to make an Access Approach Permit Application for removal of the accesses through County Connect. Please see following link for additional information regarding the Property Access Approach Permit and access construction* *specifications at https://www.strathcona.ca/transportation-roads/roads/permits/access-guidelines/.*

Joburg will apply to remove additional access along Range Road 221 as requested by the County. Prior to removal, Joburg will apply for the appropriate permit as described.

*Transportation and Agriculture Services Comments:*

*TAS1. A Road Use Agreement must be in place prior to the commencement of your program or project. Please ensure the Transportation and Agriculture Services office is provided a minimum of five (5) business days notice to make the appropriate arrangements. Please apply for a Road Use Agreement (RUA) through County Connect on the Strathcona County website. Please note that a Bond will be required.*

Joburg currently hauls under Road Use Agreement No. RUA-2022-005. Joburg will ensure to maintain a road use agreement with the County for the lifetime of hauling activities at the pit. Details of the road use agreement have been incorporated into Section 5.2 of the revised Development Permit Application package.

*TAS2. Clubroot is present in Strathcona County, clubroot protocol must be followed. Clean equipment pre and post fields for clubroot. A detailed clubroot management plan may be required. See Alberta Clubroot Management Plan, available on website for further information or contact Sarah Rice, Transportation and Agriculture Services, at 780-417-7100.*

As mentioned in Section 5.16 of the Development Permit Application package, the current pit area was previously tested for the presence of clubroot with negative results. Additionally, any fill material imported to the pit will be tested for clubroot if it is sourced from a location that has been used for agriculture in the past 10 years. To prevent the spread of clubroot to the pit, the preventative measures and best management practices detailed in the *Alberta Clubroot Management Plan* will be implemented.

TAS3. *Clean equipment pre and post sites to reduce the spread of weeds and pests. Please contact Sarah Rice at Sarah.Rice@strathcona.ca if you require further details.*

As mentioned in Section 5.15 of the Development Permit Application package, all equipment will be cleaned prior to arriving onsite to prevent the introduction of weeds.

*Land Development Engineering – Utilities Comments:*

*U1. Figure 2-13- Current Conditions; We recommend that the applicant update the figure as follows to more clearly identify aspects as noted in the application.*

a) *Identify that the long-term safety and erosion protection berms complete with seeded native grass mix have been completed; and*

b) *As wetland soils are to be utilized in inoculating the reclaimed end pit waterbody and shoreline, identify wetland soils stockpile location(s) separate from regular stripping and grading.*

Drawing No. 2-13 (within Appendix L of the Development Permit Application package) has been updated to identify the long-term safety and erosion protection berms. Stockpiles 1, 7,9 and 12 serve this purpose. No major wetlands have been stripped to date, therefore no stockpiles of wetland soil are currently onsite. As mining progresses and the wetlands within the NW and SW 25 are stripped, wetland soils will be salvaged and stockpiled separately, as detailed in Section 6.1 of the Development Permit Application package.

*Strathcona County Emergency Services Comments*

*Strathcona County Emergency Services has reviewed the project and has the following comments:*

1. *Ensure access is available and maintained for fire department vehicles at all times. Means must be provided to allow firefighters to perform their duties.*

2. *Ensure the site personnel can provide location information should a 911 service be requested. A single point of contact is highly recommended.*

Access through the main gate in the northwest corner of the SW 36 will be available for emergency services to utilize throughout the lifespan of the pit. Joburg has a rigorous Emergency Response Plan for the site this includes designated emergency site contacts. Additionally, Joburg has a designated STARS Remote Site Landing Zone in case of serious emergency. Details of Joburg's emergency response plan for the site has been added to the Development Permit Application package in Section 5.17 and the Emergency Response Plan and STARS Remote Site Landing Zone Information Card are included in Appendix O.

*ATCO Gas*

*The Engineering Design Department of ATCO Gas has reviewed the above named plan and has the following conditions:*

> *There is an existing ATCO Gas facility in this area. If it should be necessary to lower, relocate or make any alterations to the existing pipelines and/or appurtenances due to this project, contact Dustin Evangelista (Dustin.Evangelista@atco.com, (780)-218-2429). Allow at least 4 months if facilities are required to be lowered, relocated, or altered.*

*Please hydrovac ATCO Gas facilities that are in direct conflict with the proposed construction to determine depths from final grade. If further clarification on locations is required contact Dustin Evangelista (Dustin.Evangelista@atco.com, (780)-218-2429), otherwise report hydrovac depths to engineer prior to construction. Allow at least 4 months if facilities are required to be lowered, relocated, or altered.*

*Deep Utilities: Maintain a minimum of 0.3m vertical clearance and a 2.0m horizontal clearance between ATCO Gas distribution gas lines and your facilities.*

*All Other Facilities: Maintain a minimum of 0.3m vertical clearance and a 1.0m horizontal clearance between ATCO Gas distribution gas lines and your facilities.*

*Above Ground Facilities: Maintain a 1.5m horizontal clearance between ATCO Gas distribution gas lines and your above ground facilities.*

Prior to mining activities proceeding into Mining Blocks 14A, 15A and 16A, Joburg will contact Alberta One Call to have the gas lines located. All appropriate buffers will be maintained and if it is determined that any facilities require relocation or realignment, Joburg will reach out to ATCO at that time. Pipeline proximity agreements will be maintained with all pipeline operators throughout the lifespan of the operation. Details on pipeline interactions have been added to the revised Development Permit Application package within Section 4.0.

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If you require further information, please contact the undersigned.

Sincerely,

Keira Nystrom

Keira Nystrom, AIT
Aspen Land Group Inc.

cc: Peter Wall, Joburg Aggregates Ltd.
Lucas Bodnar, Joburg Aggregates Ltd.
Lesley Foy, Aspen Land Group Inc.

Attachment A: Development Permit Application Package (Revised November 2022)

# Joburg Pit

## Development Permit Application

## Revision 1

W 1/2 25 & SW 36-054-22-W4M

November 2022

Prepared for

JOBURG Aggregates Ltd.

STRATHCONA COUNTY
AGGREGATE EXTRACTION USE
APPROVED FOR DEVELOPMENT PERMIT ONLY

DEVELOPMENT OFFICER

DEVELOPMENT PERMIT No 2022-0589-DP DATE NOV. 30 2022

Aspen LAND GROUP

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Table of Contents

List of Tables:

List of Appendices:

| | |
|---|---|
| Appendix A: | Certificates of Title |
| Appendix B: | Development Permit No. 2015-1108-DP, SDAB Decision (December 28, 2017) & Development Permit Application Form |
| Appendix C: | EPEA Registration No. 395091-00-00 |
| Appendix D: | *Water Act* Approval No. 00286979-00-00 and 00286977-00-00 & *Water Act* Licence No. 00286978-00-00 |
| Appendix E: | *Historical Resources Act* Letter of Clearance |
| Appendix F: | Pipeline Proximity Agreements |
| Appendix G: | Hydrogeological Consultants Ltd. (HCL) Groundwater Review |
| Appendix H: | Alberta Conservation Information Management System (ACIMS) & Fish and Wildlife Internet Mapping Tool (FWIMT) Reports |
| Appendix I: | Spencer Environmental Management Services Ltd. Biophysical & Wetland Assessment |
| Appendix J: | Bunt & Associates Transportation Impact Assessment |
| Appendix K: | Soil Importation Management Plan |
| Appendix L: | Conservation and Reclamation Drawings |
| Appendix M: | ACI Acoustical Consultants Noise Impact Assessment Report |
| Appendix N: | Joburg Pit Hauling Regulations and Trucking Form |
| Appendix O: | Emergency Response Plan and STARS Remote Landing Site Card |

List of Drawings:

| | |
|---|---|
| Drawing No. 1-13: | Location Plan |
| Drawing No. 2-13: | Current Conditions |
| Drawing No. 3-13: | Pre-Development Contours |
| Drawing No. 4-13: | May 2022 UAV Contours |
| Drawing No. 5-13: | Proposed Mine Sequencing Plan |
| Drawing No. 6-13: | Cross Section A-A' Existing and Reclaimed Conditions |
| Drawing No. 7-13: | Cross Section B-B' Existing and Reclaimed Conditions |
| Drawing No. 8-13: | Cross Section C-C' Existing and Reclaimed Conditions |
| Drawing No. 9-13: | Cross Section D-D' Existing and Reclaimed Conditions |
| Drawing No. 10-13: | Cross Section E-E' Existing and Reclaimed Conditions |
| Drawing No. 11-13: | Cross Section F-F' Existing and Reclaimed Conditions |
| Drawing No. 12-13: | Conceptual Reclamation Plan |
| Drawing No. 13-13: | Haul Route |

| Revision History for Joburg Aggregates Development Permit Application Package (DP No. 2022-0589-DP) | | | |
|---|---|---|---|
| Revision No. | Date | Section No. | Details |
| 1 | October 31, 2022 | 5.2 Pit Access and Haul Routes | - Clarification of primary and alternate haul routes.<br>- Added reference to Road Use Agreements with the County<br>- Added discussion of safety measures related to trucks hauling on the haul route |
| 1 | October 31, 2022 | 5.3 Hours of Operation | - Clarification on when operations at the pit commence |
| 1 | October 31, 2022 | 5.4 Equipment and Facilities | - Revisions on equipment to be used on site. |
| 1 | October 31, 2022 | 5.11 Dust Control | - Clarification of dust mitigation measures |
| 1 | October 31, 2022 | 5.13 Noise Control | - Added information on white noise back-up beepers<br>- Added information on generators<br>- Added information on water pump<br>- Added additional mitigation measures and reference to the Noise Impact Assessment Report |
| 1 | October 31, 2022 | 5.17 Emergency Response Plan | - Added in response to County referral letter comments |
| 1 | October 31, 2022 | Appendix L- Conservation and Reclamation Drawings | - Updated Drawing No. 2-13 to label long-term safety and erosion protection berms.<br>- Updated Drawing No. 5-13 to include gas line locations |
| 1 | October 31, 2022 | Appendix M- ACI Acoustical Consultants Noise Impact Assessment Report | - Added in support of noise control measures discussed in Section 5.13 |

| Revision History for Joburg Aggregates Development Permit Application Package (DP No. 2022-0589-DP) | | | |
|---|---|---|---|
| Revision No. | Date | Section No. | Details |
| 1 | October 31, 2022 | Appendix N- Joburg Pit Hauling Regulations and Trucking Form | - Added in support of hauling safety measures discussed in Section 5.2 |
| 1 | October 31, 2022 | Appendix O- Emergency Response Plan and STARS Remote Landing Site Card | - Added in support of Emergency Response plan discussed in Section 5.17 |

# 1.0 Introduction

## 1.1 Overview and Pit History

Aspen Land Group Inc. (Aspen) has been retained by Joburg Aggregates Ltd. (Joburg) to prepare a Development Permit application for Strathcona County (the County) for the continued operation and development of the Joburg Pit (the pit). The development is a sand and gravel extraction operation located within the SW 36 & W 1/2 25-054-22-W4M.

Currently, Joburg holds Development Permit No. 2015-1108-DP for aggregate extraction and processing at the pit which expires on October 27, 2022. This report serves to provide information to support the issuance of a development permit for an additional 10 years of operations. Additionally, this report includes information on the historical operations, existing conditions of the pit and proposed operational changes since the previous application to the County.

Aggregate extraction operations began at the pit in 2018 and have been ongoing since. Alberta Environment and Parks (AEP) issued Registration No. 395091-00-00 under the *Code of Practice for Pits* (the Code) on December 5, 2017. Additionally, Joburg currently holds *Water Act* Approval No. 00286979-00-00 and 00286977-00-00 for the disturbance of wetlands and interception of the groundwater table, respectively. Joburg also holds *Water Act* Licence No. 00286978-00-00 for aggregate washing and dust control.

The pit area is comprised of 167.93 ha, which includes buffers and extraction areas. Operations to date of the pit have resulted in approximately 59.30 ha being developed for extraction. The current disturbance of 59.30 ha includes areas for stockpiling of reclamation material (including sight and sound berms), associated pit infrastructure (scale house, internal road network, groundwater recharge pond and laydown areas), processing and product stockpile areas, and open and partially reclaimed mining blocks. The remaining 108.63 ha of the pit is undisturbed and is used for agriculture purposes. Following the initiation of operations, it was determined the previous sizing for mining blocks was not operational feasible and that mine sequencing and mining blocks needed to be revised to ensure efficiency and cohesive reclamation within the operation. Additionally, it was discovered that the quantity of available aggregate underneath the wetlands was lower than expected, which has allowed Joburg to reconsider the disturbance of wetland features along the edge of the pit development. As such, the operations and reclamation plan require revisions to incorporate these changes. The pit will still be reclaimed to an agricultural end land use with three end pit waterbody complexes and one seasonal wetland with as discussed within Section 6.3 and shown on the attached Drawing No. 12-13.

### 1.2 Location and Land Ownership

The pit is located within the SW 36 & W 1/2 25-054-22-W4M to the south of Township Road 550 and east of Range Road 221 (Drawing No. 1-13). The pit is approximately 4 kilometers west of the Hamlet of Josephburg and 5 km east of the City of Fort Saskatchewan. The NW 25 is owned by Joburg Aggregates Ltd., the SW 25 is owned by Christopher Alan McEachern and the SW 36 is owned by 1488098 Alberta Ltd. Copies of the Certificates of Title are included in Appendix A.

## 2.0 Municipal Requirements

### 2.1 Development Permit

Development Permit No. 2015-1108-DP (the development permit) was issued to Joburg on October 27, 2017 for aggregate extraction and processing at the pit which expires on October 27, 2022. On December 28, 2017, the County's Subdivision and Development Appeal Board (SDAB) upheld the County's decision to issue the development permit, but modified Condition 10 and including additional condition of the October 27, 2017 development permit. Under the County's Land Use Bylaw, Joburg is required to maintain a development permit for the continued operations at the pit. As indicated in the development permit, Aspen on behalf of Joburg reached out to Planning and Development Services to discuss the next steps for continued operation and permitting of the pit. A meeting was held with representatives from the County, Joburg and Aspen on August 10, 2022, to discuss the historical operations at the pit and application requirements for permitting. The purpose of this application report is to provide historical operations, confirmation of operational plans and to highlight any changes to the previously permitted operations in order to permit the pit for an additional 10 years. A copy of Development Permit No. 2015-1108-DP, the December 2017 SDAB Decision and a development permit application form are included in Appendix B.

## 3.0 Provincial Requirements

### 3.1 Alberta Environment and Parks

#### 3.1.1 Registration under the *Code of Practice for Pits*

Under the Code, all pits that result in a disturbance of 5.0 ha or larger require a registration. Joburg currently holds Registration No. 395091-00-00 for the operations and reclamation of the pit. Currently Joburg has $1,083.121.75 of financial security posted within AEP's Environmental Protection Security Fund. Given Joburg will be making changes to the operations and reclamation plan an updated activities plan is being prepared in coordination with this Development Application. A copy of the current registration is in Appendix C.

### 3.1.2 Authorizations under the *Water Act*

Joburg currently holds *Water Act* Approval No. 00286979-00-00 and 00286977-00-00 for the disturbance of wetlands, interception of the groundwater table, diversion of water off-site and construction of end pit waterbodies, respectively. Given some of the proposed modification to the operation and reclamation plan for the pit, *Water Act* Approval No. 00286979-00-00 will be amended to modify the reclamation plan accordingly. *Water Act* Approval No. 00286977-00-00 will be modified to increase the volume of water discharged offsite annually.

Joburg holds *Water Act* Licence No. 00286978-00-00 for aggregate washing and dust control. That being said, washing of aggregate has not occurred at the pit, but may be as operation progress in the future.

All amendments to these authorizations will be submitted to AEP via the Digital Regulatory Assurance System (DRAS). Joburg will not implement the proposed water management and reclamation changes until authorization under the *Water Act* authorizations are received. A copy of the current *Water Act* authorizations are available in Appendix D.

### 3.13 Authorizations under the *Public Lands Act*

Since the issuance of the development permit, the Crown has taken claim to a wetland within the SW 25. A Licence of Occupation (DLO) application has been made under the *Public Lands Act* on behalf of Joburg for the disturbance of the crown claimed wetland to facilitate extraction and disturbance of the wetland. No aggregate extraction or disturbance will occur within the bed and banks of the feature until the DLO has been issued.

### 3.14 Alberta Culture, Multiculturism, and Status of Women

The Listing of Historical Resources identifies lands that contain or are believed to contain historical resources and primarily include archaeological and paleontological sites, Aboriginal traditional use sites of a historic resource nature, and historic structures. The Alberta *Historical Resources Act* (HRA) may require proposed activities likely to threaten the integrity of a historical resource to be preceded by a Historical Resources Impact Assessment (HRIA).

An application to Alberta Culture, Multiculturalism and Status of Women (then Albert Culture and Community Spirit) was made in 2010 in support of the Reperio Resources Corp. registration application for the pit. A letter of clearance was provided indicating no further assessments were required but with the stipulation that any archaeological and paleontological resources discovered be reported should they be found during the operation of the pit. As there are no additional areas proposed for disturbance, the 2010 letter of clearance remains valid. A copy of the letter is included in Appendix E.

## 4.0 Existing Conditions

As previously mentioned, the pit is currently operational within a 59.30 ha portion of the SW 36 and NW 25 with aggregate extraction, processing (including crushing and washing), soil stripping and stockpiling as well as reclamation activities occurring. The undisturbed portions of the NW 25 continued to be used for cultivation and is currently seeded to canola. The SW 25 remains seeded to hayland. The pit boundary remains the same, the previously proposed 30 m extraction buffer along the eastern edge of the pit within the SW 36 was disturbed as Joburg thought it would be beneficial to the neighbors to the east/northeast, if they stockpiled reclamation material in the buffer to act as a sight and sound barrier to their operations. Wetlands previously identified along the eastern and northern pit boundary in the SW 36 have remained undisturbed. It should be noted that the previous development permit application indicated that the gravel extraction / processing project area would be comprised of 156 ha of land over the life of the project, following the review of the 2016 Development Permit Application it appears that the 156 ha reflected the proposed excavation area and did not include the extraction buffer areas that would be disturbed for safety berms and/or sight and sound barriers.

There are three pipelines located within the north portion of the SW 25 running east/west across the property. Joburg maintains proximity agreements with the pipeline operators and extraction operations will not encroach on the established pipeline rights-of-way. The surrounding landscape is primarily used for agricultural purposes with oil and gas well sites and pipelines also common in the area. A copy of the agreements made with the pipeline operators are included in Appendix F.

Currently there is 274,887 $m^3$ of reclamation material stockpiled throughout the active area of the pit. The stockpiled material consists of 72,537 $m^3$ of topsoil and 202,350 $m^3$ of subsoil. Upon reclamation, these stockpiles will be spread as evenly as possible throughout the site in order to facilitate the agricultural end land use. Please refer to Table 1 below for details on the available stockpiled reclamation material, locations of the stockpiles are presented on Drawing No 2-13.

| Table 1. Stockpiled Reclamation Material at the Joburg Pit | | |
|---|---|---|
| Stockpile Number | Material | Volume ($m^3$) |
| 1 | Topsoil | 31,679 |
| 2 | Topsoil | 1,112 |
| 3 | Subsoil | 83,984 |
| 4 | Topsoil | 14,060 |
| 5 | Topsoil | 4,323 |
| 6 | Topsoil | 5,337 |
| 7 | Topsoil | 6,341 |
| 8 | Subsoil | 105,030 |
| 9 | Subsoil | 7,120 |
| 10 | Subsoil | 1,377 |
| 11 | Subsoil | 455 |
| 12 | Topsoil | 9,686 |
| 13 | Subsoil | 4,383 |
| Total Topsoil | | 72,537 |
| Total Subsoil | | 202,350 |

### 4.1 Topography and Drainage

Prior to disturbance, the north portion of the pit is located on a level plain with fine textured water laid deposits as parent material. The southern portion of the pit is located within an undulating, low relief landform with the same fine textured parent materials as the north portion. Limiting slopes range from 1-2% across the property. (Alberta Soil Information Viewer).

As shown on Drawing No. 3-13, pre-disturbance drainage was primarily directed north and west towards the County ditch where it flows north to the unnamed watercourse north of Township Road 550. Aspen conducted a site assessment on the undisturbed areas within the W 1/2 25 on July 19, 2022. Overall, the majority of the assessment points were described as level to nearly level with slopes of 0-2%.

### 4.2 Soil

The undisturbed portion of the pit is located within the map units, NVR1/L1 and MMO2/U1l as described by the AGRASID model (ASIC 2001). Gleyed or Eluviated Black Chernozem soil subgroups are dominant in these map units.

On July 19, 2022, Aspen conducted a site assessment to assess soil, vegetation and landscape parameters of the lands within the undisturbed portion of the pit. A total of 21 assessment points were completed within the undisturbed agricultural land within the W 1/2 25. All assessment points presented an undisturbed soil profile (aside from agricultural use) and were consistent with that of a Chernozemic Soil Order. The soil profile consisted of an Ap, Ah, Bt and C horizon at the majority of assessment locations. The average depth of topsoil (Ap and Ah horizons combined) and subsoil (Bt horizon) was found to be 28 cm for both horizons. Topsoil texture was predominantly silty loam in texture with a few instances of clay loam or loam textures. Subsoil was predominantly silty clay loam with few instances of clay loam and sandy clay loam. The upper profile was consistent with granular structure, friable consistence, and the majority having no coarse fragments. When encountered, the C horizon was variable. Most assessment locations exhibited silty clay or clay C horizons with two locations having a sandy C horizon. There were little to no coarse fragments encountered throughout the soil profile during the assessment. The soil profile was noted to be well drained, and surface stoniness was observed be non-stony.

Upon analyzing the soil data, it was determined that the soils found during the assessment most closely correlated to the Malmo soil subgroup. This subgroup does not typically have a distinct colour change between the topsoil and subsoil horizons (Soil Series Information for Reclamation Planning in Alberta, GOA 1993). This has resulted in the topsoil being stripped to a depth of approximately 10 cm (the plow layer) and the subsoil to a depth of 24 cm for the current disturbance. Going forward, as operations proceed into the currently undisturbed area within the W 1/2 25, soil stripping will be more consistent with what was determined during the soil assessment and topsoil and subsoil will both be stripped at approximately 28 cm each.

For the majority of the SW 36 and NW 25, the Canada Land Inventory (CLI) Land Capability for Agriculture has been identified as Subset A, Class 4, subclass S and W. This indicates that the soils in this class have severe limitations that restrict the range of crops or require special conservation practices due to excess water and a combination of subclasses. For the remainder of the NW 25 (southeast portion) and the SW 25, the CLI for Agriculture has been identified as Subset A, Class 2, Subclass S. This indicates that the soils in this class have moderate limitations due to a combination of subclasses. As per the Code, areas with Class 4 CLI (SW 36) will be required to be reclaimed with internal slopes of 10:1 or gentler and areas with Class 2 CLI (W 1/2 25) will be required to be reclaimed with internal slopes of 20:1 or gentler to match the surrounding landscape.

### 4.3 Geology

The geology in the area can be described as part of the Belly River Group which consists of nonmarine deposits of sandstone, siltstone and mudstone, grey to greenish grey in colour (Hamilton, Price and Langenberg, 1999).

Drawing No. 3-13 illustrates the surface conditions and the stratigraphy within the pit area prior to development. Stratigraphy of the pit is outlined in Table 2 and is based on the July 2022 field assessment and historical test hole data.

| Table 2. Stratigraphy of the Joburg Pit | |
|---|---|
| Soil Layer | Average Depth |
| Topsoil | 0.28 m |
| Subsoil | 0.28 m |
| Overburden | 6.28 m |
| Sand | 1.67 m |
| Gravel | 3.67 m |

### 4.4 Surface Water

Cadastral mapping shows an unnamed watercourse running approximately from the southwest to northeast corner of the SW 36, was present at the site prior to disturbance. There is no defined channel in this location however overland flow follows the approximate drainage pathway of the watercourse mapping. Due to operations projection, surface water either flows to open excavations and is managed through the groundwater diversions or is directed to flow to the east-northeast through the natural wetland network. Upon reclamation, a drainage swale will be conducted to convey flow between end pit waterbodies complexes and offsite. More details on surface water management at the pit are in Section 5.10.1.

#### 4.4.1 Wetlands

A majority of the wetlands within the SW 36 have been removed since operations have begun. Wetlands that remain undisturbed are depicted on Drawing No. 5-13. Removal of the wetlands has been authorized by AEP under *Water Act* Approval No. 00286979-00-00. However, Joburg is proposing to amend their mining plan to avoid the wetlands along the eastern pit boundary and remove them from the mining area, as shown on Drawing No. 5-13. These wetlands will not be disturbed by pit operations and will remain in place following reclamation of the pit. A 5 m operational boundary will be placed on these wetlands to avoid disturbance.

As noted previously, the Crown has taken claim to a wetland within the SW 25. A Licence of Occupation (DLO) application has been made under the *Public Lands Act* on behalf of Joburg for the disturbance of the crown claimed wetland to facilitate disturbance and extraction of aggregate around the wetland feature. No disturbance of the Crown claimed wetland will occur until the DLO has been received.

### 4.5 Groundwater

A groundwater study was conducted by Hydrogeological Consultants Ltd. (HCL) which was subsequently revised at the request of AEP to account for the proponent's name change from Reperio to Joburg. Currently, there is a recharge pond located within the northwest potion of the active area of the pit. As part of the extraction operations, groundwater will continue to be intercepted at 2 to 6 m below surface as determined in the groundwater study. Within the pit area, the groundwater flow is from the southeast to the northwest. Dewatering of the gravel from a typical pit to allow for the mining of the gravel will require in the order of 900 to 4,500 $m^3$/day of groundwater to be removed from the aquifer. As part of this transferring of groundwater, it is estimated that up to 288 $m^3$/day of the groundwater that is pumped from dewatering pits will be lost to evaporation and adhesion, with the remainder of the groundwater returned to the aquifer via recharge ponds; this net loss of 288 $m^3$/day of groundwater will not have an adverse effect on the aquifer or any nearby water wells.

Aggregate extraction will remove the sand and gravel aquifer from the mining area. Once the sand and gravel aquifer is removed and replaced with a minimum one-metre-thick layer of sand material. Groundwater flow through the reclaimed area may be reduced, which may result in the mounding of groundwater upgradient from the mined area. However, because the ground surface upgradient of the proposed development area is generally more than ten metres higher in elevation than within the development area, mounding is not expected to result in water levels rising above ground surface outside the development area. Additional details on groundwater management during operations is in Section 5.10.2 and a copy of the HCL Groundwater Review (Revised 2018) is included in Appendix G.

### 4.6 Vegetation

Within the active portion of the pit, vegetation has been removed, however, reclamation material piles consisting of topsoil and/or subsoil have been seeded with vegetation grown present. During the July 2022 site assessment, Aspen observed that the majority of the undisturbed area was cultivated and was seeded to canola. A portion of the property in the SW 25 was seeded to hayland and had been cut in the weeks prior to assessment. There was some vegetation regrowth occurring at the time of assessment. Few weeds were observed during the assessment and were primarily focused around the area adjacent to the pipeline right-of-way.

A search on AEP's Alberta Conservation Information Management System (ACIMS) was completed to determine the presence of any known sensitive vegetation species. The tool did not identify any elemental occurrences within Sections 25 & 36-054-22-W4M. Please refer to Appendix H for a copy of the information search.

A biophysical and wetland assessment was conducted by Spencer Environmental Management Services Ltd. (Spencer) and a report was prepared in January 2011 in support of the original Reperio applications to AEP and the County. The upland areas included in the biophysical study area included species such as aspen, balsam poplar, red-osier dogwood, willows, western snowberry, prickly rose, wild red raspberry, smooth brome, Kentucky bluegrass and quackgrass, stinging nettle, creeping thistle, brittlestem hempnettle, common dandelion, northern bedstraw and perennial sowthistle. The weeds encountered during the biophysical assessment were thought to have been due to cattle and horses grazing in the area and the surrounding agricultural lands.

Wetland vegetation found in the biophysical assessment varied based on the class and type of wetland. Wetlands with wet meadow centres (Class II) typically were dominated by species such as fowl bluegrass, quackgrass and smooth brome. Willow, red-osier dogwood, wild black currant and wild gooseberry were also present. Wetlands with shallow marsh centres (Class III) typically included vegetation such as awned sedge, bottle sedge and reed canary grass, also with willow, red-osier dogwood, wild black currant and wild gooseberry present. The wetlands with deep marsh centres (Class IV) had species such as common cattail, tall mannagrass, sloughgrass, rivergrass, awned sedge, wild mint, marsh yellowcress, willowleaf dock, creeping thistle and pale smartweed. Weedy species were also common throughout the wetland assessment and the dominant species found includes creeping thistle, perennial sowthistle, brittlestem hempnettle, common dandelion and stinkweed. A copy of the Spencer Biophysical and Wetland Assessment is included in Appendix I.

### 4.7 Wildlife

A search on AEP's Fish and Wildlife Internet Mapping Tool (FWIMT) was completed to determine the presence of any inventoried or stocked wildlife species within a 2 km radius of the pit. The tool listed American kestrel and black tern have been inventoried within the search radius. Please refer to Appendix H for a copy of the search.

The biophysical and wetland assessment conducted by Spencer also included a wildlife assessment where specific assessments were conducted to detect bird and amphibian species and more passive assessments were conducted for wildlife such as mammals and fish. A total of 13 bird species were recorded during the breeding bird survey in the summer of 2010; alder flycatcher, American goldfinch, Baltimore oriole, black-billed magpie, brown-headed cowbird, clay-coloured sparrow, european starling, house wren, red-winged blackbird, savannah sparrow, song sparrow, vesper sparrow and yellow warbler. Only one of the bird species (Baltimore oriole) is listed as sensitive by AEP, however Spencer identified that the study area (pit area) did not provide suitable habitat for the oriole and that it was likely nesting elsewhere within the wooded areas surrounding the pit. The amphibian call survey yielded four calls from two species within the current pit boundary. Boreal chorus frogs and wood frogs were detected during the assessment. No fish are present within the pit area as the wetlands within the property are shallow and freeze completely during the winter, therefore do not make for suitable fish habitat. A copy of the Spencer Biophysical and Wetland Assessment is included in Appendix I.

### 4.8 Noise

Since operations have commenced at the pit, Joburg has been collected noise data that is being emitted from the pit. Noise complaints have been limited since operations began, complaints were initial received regarding back-up alarms, which prompted Joburg to install white noise back up alarms on equipment. Since the installation of the white noise backup alarms, Joburg has not received any direct noise complaints.

Acoustical Consulting Inc. has been retained to review the noise historical noise data emitted from the pit and determine impacts and recommendations for some of the proposed changes to the operations at the pit.

## 5.0 Project Operations

Operations at the pit will continue to include aggregate extraction and processing (including washing and crushing), hauling of product and reclamation activities. Additionally, Joburg is proposing to commence clay extraction at the pit to sell as product and import marginal clay material to off-set the extraction of clay. The total extraction area within the 167.93 ha pit area will decrease from 156 ha to 133.48 ha to account for the avoidance of the wetlands along the eastern edge of the pit. Joburg will also be proposing details on changes to hours of operations, haul route, mining plan, and reclamation plan.

### 5.1 Project Timing

While aggregate demand is market driven, based on current demands, it is expected that Joburg will progress through the pit at a rate of approximately one mining block per year, should market conditions change, Joburg may be able to implement a 2-cut system allowing would increase the number of mining blocks per year. Based on current demands the pit could be operational for upwards of 25 years. Joburg intend to operate the pit year-round, while conditions allow.

### 5.2 Pit Access and Haul Routes

Access to the pit is located at the northwest corner of the property, from Range Road 221. This access will remain the primary haul route for the lifespan of the pit. The primary haul route for the pit is to remain the same with trucks leaving the pit and travelling north on Range Road 221, east on Township Road 550 and south or north on Highway 830 to market, as shown on Drawing No. 13-13. Traffic from the pit will be variable with up to 200 truckloads hauled per day. On average, it is anticipated there will be 60 truckloads per day throughout the year. The portions of the primary haul route that required upgrading was completed as per the agreed upon standards with the County have been completed including the intersection improvements at Township Road 550 and Highway 830. Completion of the upgrades was confirmed by the County on September 24, 2021.

Joburg initially applied for a road use agreement with the County in January 2018 to bring equipment onto the site. Road Use Agreement No. RUA-2018-0116-011 was issued on January 16, 2018. Since then, Joburg has entered into multiple road use agreements with the County and are currently hauling under Road Use Agreement No. RUA-2022-005. Should the road use agreement need to be updated or renewed at any time, Joburg will do so in order to remain in compliance with the County

Joburg is requesting an alternate haul route be added for small local hauls for projects located in Fort Saskatchewan and the immediate vicinity. This would involve trucks leaving the pit and travelling north on Range Road 221 and west on Township Road 550. It is anticipated that a maximum of 75 truckloads per day up to 30 days per a year would use this route when leaving the pit. If a project specific requires a variance, both the County and the City of Fort Saskatchewan (the City) will be notified. As Township Road 550 west of Range Road 220 (north) is under the jurisdiction of the City, Joburg will require authorization from the City in order to proceed with the proposed alternate route. No hauling on the alternate route will occur until the necessary haul route agreement with the City is in place.

Joburg is committed to ensuring safety of the local residents and drivers on haul routes from the pit. All contractors and truckers complete a safety orientation, review the Pit Hauling Regulations and are required to sign a copy of the Joburg Trucking Form (acknowledging the Pit Hauling Regulations) daily when hauling from the pit. Safety checks are conducted weekly on the haul route. Additionally, to ensure an additional level of safety for drivers on the haul route, Joburg has contracted a local resident to monitor the stop sign to ensure all truck drivers are coming to a complete stop. A copy of the Pit Hauling Regulations and Joburg Trucking Form are included as Appendix N.

### 5.3 Hours of Operation

Joburg is proposing changes to the hours of operation at the pit as described below:

Pit Operations (including stripping, aggregate and clay extraction, stockpiling, loading trucks and reclamation)

- Monday through Saturday from 6am to 7pm
- No Sundays or Statutory Holidays

Product Hauling

- Monday through Saturday from 6am to 7pm

- No Sundays or Statutory Holidays

Following the previous operations, it was determined that the best way to mitigate the introduction of hauling traffic to local roads during peak times would be to modify the hours of pit operations and hauling to provide Joburg the opportunity to coordinate hauling activities outside of peak traffic hours including times when school buses are expected on the roads. Based on the Transportation Impact Assessment conducted by Bunt & Associates, morning peak traffic at the intersection of Township Road 550 and Range Road 221 was determined to be between 7:30 and 8:30am. Commencing loading and hauling activities at 6am will allow Joburg to reduce haul trucks on the road during peak traffic and school bus operation. A copy of the Bunt & Associates Transportation Impact Assessment is included as Appendix J. Should there be a designated school bus stop for student pick up/drop off location on Township Road 550 between Range Road 221 and Highway 830, Joburg will pause trucks leaving the pit during the pickup and drop off time.

Aggregate Processing (including crushing, screening and washing)

- 7 days a week, 24 hours a day*

* Based on current demands it is estimated crushing will occur for periods of approximately 20-30 days, per mining block.

Please note that 24-hour crushing will enable Joburg to reduce the total amount of days they are crushing material per mining block from approximately 40-45 days currently to 20-25 days under the proposed 24/7 conditions.

The gate of the pit remains locked until precisely the time in which operations are permitted to commence on days where the pit is operational. In some instances, trucks may wait outside of the locked gate prior to the gate opening, however no entrance into the site is made. Joburg management have security cameras installed at the entrance to the site to ensure compliance with the permitted hours of operation. A large stockpile of material is positioned in the northeast corner of the pit which shields residents to the east from any truck or equipment headlights.

### 5.4 Equipment and Facilities

Joburg is expected to have various equipment on site based on the operations occurring at any time during operations. Equipment present onsite during stripping, extraction, and reclamation may include:

- Six - Cat 627 motor scrapers (or equivalent)
- One - Cat 140 grader (or equivalent)
- Three- Cat 345 track excavator (or equivalent),
- Six - Volvo A40 haul trucks (or equivalent),

- One -Cat D8 dozer (or equivalent)
- Two- Cat D6 dozers (or equivalent)

While crushing is occurring, the equipment present onsite may also include the following:

- 36’ belt feeder with hydraulic grizzly
- 20” x 8’ – 3 deck inclined screen
- 60” cone crusher
- Conveyors - 6 of 36”x50’ transfer conveyors
- 36” "Tele-stacker” conveyor
- 36” x 100’ radial stacking conveyor for reject sand
- Diesel-electric generator and switch gear
- Two- Cat 980 (or equivalent) loader
- Three- Volvo A40 haul trucks (or equivalent),

Should washing occur at the pit, the wash plant set up may include the following equipment:

- 36” belt feeder
- 24’ x 8’ – 3 deck flat screen with spray bars
- 9 station classifier
- Dewatering screen for sand
- Log washer for 20 mm stone
- Log washer for 40 mm stone
- 3 “Tele stacker” conveyors
- Cat 980 (or equivalent) loader
- Electric water pump and fresh water hauling system
- Waste water handling system (possible slurry pump)

### 5.5 Signage and Security

Joburg has signage on each of the corners of the property lines in the quarter sections where mining is currently taking place. The signs indicate the purpose for which the lands are to be used, danger open pit excavation no trespassing and the location where additional information may be obtained. Signage related to hauling has also been installed along the haul route and within the pit indicating the truck hauling route and site access location, locations of facilities (such as portable crushers and weigh scales).

The entire property is fenced and will be maintained throughout the mining operation. Access utilized for the extraction operation will be gated and locked when not in operation. A safety berm has been constructed adjacent to Range Road 221, as shown on Drawing No. 2-13. Warning signs have been installed approximately 250 meters apart along the fence lines that state, “Danger, Open Pit Excavation, No Trespassing”.

### 5.6 Vegetation Clearing and Soil Salvage

During topsoil stripping operations, a minimum pre-stripped buffer of 5 m will be maintained in front of all pit faces unless constrained by undisturbed buffer zones. The integrity of topsoil and overburden stockpiles will be conserved by leaving a minimum separation distance of 3 m between the reclamation material and all product stockpiles. Where stockpiling is required, topsoil will be placed on un-stripped or replaced topsoil, and overburden will be placed on overburden or aggregate material. All stockpiles will be placed in stable locations that are at least 5 m from the edge of pit faces. Topsoil stripping operations will be suspended during wet or partially frozen conditions in order to limit terrain disturbance and soil structure damage and will only be reconvened when conditions improve.

### 5.7 Pit Boundary, Buffers and Setbacks

A 30 m extraction buffer will be applied from the pit boundary along Range Road 221 and adjacent to any pipeline right away, within this 30 m buffer, safety berms in addition to sight and sounds berms may be installed. A 3 m undisturbed property line buffer will be maintained between the pit boundary, and all adjacent undisturbed property boundaries where applicable. A 5 m operational buffer between the wetlands on the wetlands intended to be avoided east side will be in place. There will be no buffer between the pit boundary and the crown claimed wetland within the SW 25 as Joburg has submitted an application under the *Public Lands Act* to extend operations into the wetland. Upon reclamation, the public lands will be integrated with the surrounding private lands in a cohesive reclamation plan.

### 5.8 Development and Mine Sequencing Plan

As discussed, Joburg is proposing changes to the previously permitted mining sequencing plan to increase the size of each block to approximately 5 ha for increased operational efficiency and cohesive reclamation (Drawing No. 5-13). Aggregate within Mining Block (MB) 1A has been depleted, while overburden material from MB 3 A has been used to backfill MBs 1A and 2A, following extraction of aggregate material in MB 3A, extraction will progress into MB4 A and continue through the mining blocks in sequence, resulting in reclamation material being directly placed in previous mining blocks as extraction operations progress to the south

Following the completion of Phase A, extraction will proceed to Phase B in the SW 25, south of the pipeline right-of-way. Operations will progress in a general counterclockwise direction starting in the west with MB 1B and ending in the center of Phase B with MB 9B. Once operations are completed in Phase B, extraction operations will proceed to the final mining blocks in the northwest corner of the property (MB 17A though 20A).

Should market demand increase, Joburg would commence operations in a 2-phase system in which operations would occur simultaneously in Phase A and B. This would allow for a mining block in one phase to have stripping and stockpiling operations take place while a mining block in the other phase is being excavated.

### 5.9 Importation Program

The clay material at the pit is a suitable building material, as such Joburg is proposing to include the extraction of clay material from the pit and addition to the extraction of sand and gravel. Joburg is committed to the intentions of the previous reclamation plan and intend to ensure they can meet the reclamation objectives of an agriculture end land use with the establishment of wetlands/end pit waterbody complexes to offset the wetlands disturbed. Given their commitment, Joburg only proposes to import material to offset the quantity of clay material sold as product and/or top up the total replacement depth of topsoil.

A site-specific importation management plan (IMP) has been prepared on behalf of Joburg and is provided in Appendix K. The IMP outlines the definitions, expectations, and sampling requirements to be implemented, including:

- source specific fill declaration requirements;
- supporting documentation/source location pre-characterization requirements;
- site controls such as record keeping, confirmation/due diligence sampling, and monitoring; requirements
- load rejection process; and
- record keeping.

Acceptable fill material will consist of soils such as marginal material, topsoil, subsoil, and/or overburden material of various textures. All acceptable fill material will be characterized to ensure that the material meets the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Alberta Tier 1 Guidelines) and will be tested for clubroot if the source location of the material was used for agriculture in the past 10 years. Under no circumstances will imported material containing construction waste, rebar, asphalt, tires, rubber, plastic, garbage, sludge, peat, woody debris, or hydrovac material be accepted. No material will be imported to the pit until acceptance of the IMP has been received from AEP.

### 5.10 Water Management

#### 5.10.1 Surface Water Management

During operations, all surface runoff from the disturbed areas within the active pit area will, as much as possible, be maintained on site and redirected to existing excavations, or other low areas within the pit boundary.

#### 5.10.2 Groundwater Management

Where extraction operations intercept the groundwater table, water will be pumped pit to pit, to the dewatering pond, or directly offsite. The current dewatering pond is located within the northwest portion of the active area as shown on Drawing No. 3-13. When dewatering offsite, water is discharged into the ditch adjacent to Range Road 221 where it flows north to Township Road 550 and then north to the creek via culvert. Figure 1, below show the Off-Site Dewatering Alignment.

Water dewatered off-site is pumped a maximum discharge rate of 62L/s via DV80C 4" x 3" 880GPM pump or equivalent to a ditch between the safety berm and the groundwater recharge pond. The discharge location within the ditch contains erosion control matting and/or rip rap, which allows sediments to settle out before flowing offsite into the County ditch towards the Josephburg WMP.

With groundwater expected to be encountered in the upcoming mining blocks, Joburg is proposing to increase the volume of water discharged offsite while remaining within the 1,000,000 $m^3$ of water discharged that was approved in DP No. 2015-1108-DP. Currently, *Water Act* Approval No. 00286978-00-00 currently allows Joburg to discharge 76,500 $m^3$ into the Range Road 221 ditch. Please note that the rate at which water is discharged will remain constant (up to 62 L/s, varying seasonally), the duration of offsite pumping will increase to account for the additional volume required to be dewatered. An amendment to *Water Act* Approval No. 00286978-00-00 will be submitted to AEP under separate cover, Joburg will not increase the quantity of water being discharged offsite until authorization is granted.

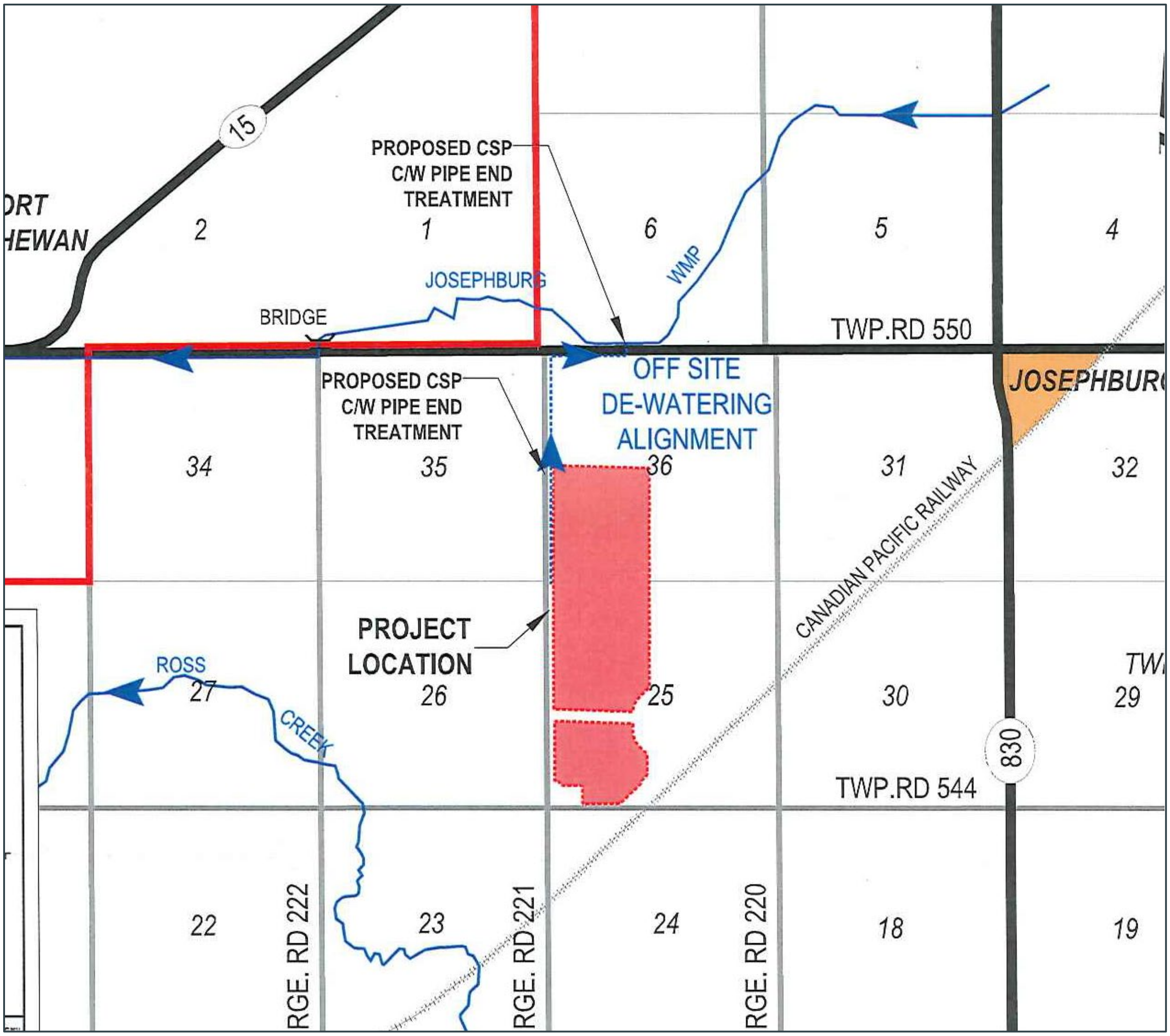



Figure 1. Offsite Dewatering Alignment

(Source: Josephburg Gravel Extraction Operation Pit Registration Water Act Approval and Development Permit Applications- 3rd Submission, Sameng Inc., September 2016)

#### 5.10.3 Aquifer Restoration Plan

To ensure that groundwater continues to flow northwest through the extraction area, Joburg will restore the aquifer with a minimum 1 m thick sand layer for the entire gravel extraction area, with the exception of the bottom of end pit waterbodies as they will be hydraulically connected to the groundwater aquifer. If there is not enough sand to satisfy the minimum depth requirement, reject material will be used. HCL has estimated that with the proposed replaced sand aquifer in place, based on preliminary model parameters, mounding will come to the surface in topographical low areas. These topographically low areas are where the end pit lake waterbody complexes are proposed.

#### 5.10.4 Groundwater Protection Plan

Joburg will maintain the implemented groundwater response plan as conditioned through the December 2017 SDAB decision. In the event that any resident living within 2 miles of the pit boundary who believe that there is a problem with their well water supply can contact Joburg at their 24-hour telephone number. If the resident is without water, Joburg will provide the resident with an alternative potable water supply within 24 hours of the complaint. Joburg will retain a qualified hydrogeologist to determine the cause of the problem. If it is determined the problem is a result of the operation Joburg will provide the resident with a permanent alternate supply of potable water.

### 5.11 Dust Control

Joburg will continue to take measures to reduce dust generated by pit operations and hauling. All trucks are to be tarped upon exiting the pit and drivers are to adhere to posted speed limits on internal access roads as well as haul routes. Roads and areas where dust generation is increased will be watered in accordance with *Water Act* Licence No. 00286978-00-00.

It is to be noted that Item 21 (k) of the Subdivision and Development Appeal Board (SDAB) Decision for Appeal File No. 8-2017 and 9-2017 may have been misprinted as covering aggregate stockpiles in clay is not operationally feasible as these types of stockpiles are typically short term. The aggregate is wet when it is extracted which aids in dust suppression, however Joburg will water aggregate stockpiles if dust observed coming from the piles.

### 5.12 Erosion and Siltation Control Plan

Joburg will continue to employ mitigation measures to control wind and water erosion, including seeding any long-term stockpiles of reclamation material to a grass mix and employing progressive reclamation techniques as soon as possible to reduce the overall disturbance associated with the pit at any one time. An erosion and siltation plan was developed to support the previous development permit application and is still applicable to current and future operations. Joburg will continue to implement the following erosion and siltation plan.

To provide immediate erosion protection, temporary sedimentation control facilities (i.e., silt fences) will be installed around the stockpiles and berms. The silt fences are to be installed in strategic semi-circles with the crown of the curve to be in the direction of the water flow. The fabric is to be trenched in, tight and consistent between all posts. The intent is to increase stabilization and effectiveness of the silt fence. Sediment must be removed and placed on site when accumulation reaches a third (1/3) of silt fence heights. To provide long-term erosion protection, the berms will be seeded to a native grass mix in accordance to the County requirements. The topsoil and subsoil stockpiles will have 3:1 side slopes and will be bounded by silt fences on all sides to minimize erosion potential by climatic factors.

Small safety berms comprised of overburden and/or reject material will be constructed around the mining area and infrastructure to prevent surface drainage from flowing into these areas. The post-mining impacts of rainfall runoff will be mitigated by progressively reclaiming previously mined out areas to their natural ground elevation, thereby restoring natural drainage patterns.

The topsoil safety berms, located along Range Road 221, will have 2:1 side slopes. As the safety berms will remain in place for a long period of time, they will be compacted and seeded to a native grass mix, in accordance to County requirements to provide for long term erosion control.

Wetland soil will be temporarily stockpiled and will be utilized in inoculating the reclaimed end pit waterbody complex or wetland shorelines. These stockpiles will have a maximum height of 0.3 meters. No erosion protection is recommended around the wetland stockpiles as they should not be subject to significant erosion concerns. However, if erosion or sediment transport is an issue, appropriate measures (e.g., silt fencing) will be undertaken.

During gravel mining operations, the active mining face will be the steepest slope possible (about 1:1 or steeper). If a portion of the pit operation becomes non-active for more than six months, then the mining face will be back sloped to a 3:1 slope to conform with the County's requirements and to ensure public safety and to reduce erosion potential. Nonactive mining faces will be back sloped with overburden material only; no topsoil or subsoil shall be used.

Berms will be constructed of overburden around the clean and dirty water ponds to prevent surface drainage from flowing into them. The dirty water pond will be cleaned when sedimentation volumes affect its efficacy. Drainage adjacent to the internal access haul roads will maintain a positive slope towards the recommended overland drainage path such that pooling of water along the haul roads is prevented. Silt fencing will be installed along drainage paths that have the potential to transfer sediments off site or into any open pit areas. Any pooling water within a disturbed area that is currently creating or has the potential to create additional erosion problems and/or that could negatively affect the mining operations and infrastructures will be pumped to the designated dewatering pond. This water will be allowed to settle to reduce sediment transfer before being diverted (pumped) off site.

The off-site diversion channel will be protected from erosion and sedimentation and will be monitored as required. Riprap will be installed downstream of the outlet pipe from the on-site dewatering pond and both upstream and downstream of all proposed culverts. This will prevent erosion and reduce velocities at downstream of the discharge location.

During ditch improvement constructing period, silt fences will be installed along the disturbed ditch area. After the construction is completed, any excavated channel and disturbed area will be re-vegetated (e.g., hydro-seeding). Installed silt fences can be removed after the planting of the re-vegetated area is established

### 5.13 Noise Control

All operations within the pit will be conducted in accordance with all municipal regulations governing noise levels. To minimize impacts associated with noise, Joburg will continue to implement such measures as:

- properly maintaining equipment;
- where possible, maintaining vegetative buffers between operations and roads;
- requiring all trucks hauling from the pit to be in good working order and adhere to posted speed limits;
- continue to use white noise backup devices in place of beepers within the pit;
- strategically place stockpiles to reduce noise;
- strategically place equipment so that noise generation is facing away from local residents;
- prohibit the use of engine retarder brakes while hauling near residential areas.

Back-up beepers are an essential part of safety within the pit and are required by provincial safety regulations. In response to resident complaints regarding traditional back-up beepers, Joburg switched all of their equipment to white noise back up beepers and are committed to all long-term equipment on site being outfitted with wite noise back up beepers. The sound from these beepers is extremely directional and is only prominent when located directly behind the machinery. On occasion, vehicles equipped with conventional back-up beepers may enter the site (such as delivery trucks and fuel trucks) however these vehicles will only be on site temporarily to complete their designated task.

Joburg has taken additional efforts to limit noise travelling to residents located east of the pit by orienting mining, stripping and reclamation material replacement to be primarily travelling in a forward direction while facing east and backward while facing west, away from the residents to the east. Directionality of stationary equipment will also be considered, where possible equipment will be positioned facing away from the most impacted residents. Stockpiles may be strategically placed around stationary equipment such as crushers to reduce noise impacts to residents.

To limit cumulative effects of equipment noise, Joburg will reduce the number of pieces of equipment to the minimum number required to do the given task or activity and where possible, smaller pieces of equipment will be utilized where large equipment is not necessary. Joburg has chosen to use rock trucks instead of tandem trucks in their operation to avoid noise generated from tailgates opening and closing.

All generators on site are WhisperWatt type generators which are extremely quiet machines meant for residential construction sites, neighbourhoods and hospitals. The manufacturer indicates the WhisperWatt produces 66 decibels of noise at a distance of 23 feet. Generators only run at night during certain circumstances. The temperature must be colder than -15 but warmer than -25 degrees Celsius. At -25 degrees Celsius, Joburg ceases operations. When the temperature is between -15 and -25 degrees, and Joburg is operational at the pit, the WhisperWatt generators will remain on at night in order to plug equipment in to avoid freezing. The estimated number of nights where this occurs is approximately 4 to 5 nights, annually.

Additionally, there is a water pump that operates to consistently pump water during periods of extensive dewatering. The pump is housed in a silent pack and placed behind a berm in order the limit the noise produced.

In addition to the mitigation measures mentioned above, Joburg has retained ACI Acoustical Consultants Inc. (ACI) to conduct a noise study at the pit, specifically focused on noise generated from crushing activities at the pit and based on data collected during aggregate crushing in 2022. The Noise Impact Assessment Report is included as Appendix M.

### 5.14 Environmental Management Practices

To minimize the impact on the environment, Joburg adheres to a number of environmental management practices during the operation and reclamation of the pit, in addition to adhering to all provincial and municipal legislation and guidelines. Some environmental management practices include:

- Installation of spill kits on all equipment being utilized within the pit;
- utilization of double wall fuel storage tanks for any long-term fuel storage within the pit;
- properly storing and regularly hauling any industrial waste generated at the pit to an approved municipal or Class II landfill;
- properly collecting and regularly hauling all sanitary waste to an approved wastewater management treatment facility;
- development of an active weed control program to prevent the initial establishment of weeds;
- proper application of herbicides; and
- ensuring that no herbicides, pesticides or any other hazardous substance will be stored onsite.

### 5.15 Weed Control

Joburg will ensure compliance with the *Alberta Weed Control Act*. Measures will be taken during the operation and reclamation of the pit to prevent the establishment of weeds, control noxious weeds and prohibited noxious weeds. The following weed prevention and control measures will be undertaken when necessary to ensure weeds are properly managed in accordance with regulations:

- All equipment will be cleaned before arriving onsite to prevent the introduction of weeds;

- The pit will be inspected during the growing season when the pit is operational by a qualified
- individual for presence of prohibited noxious and noxious weeds;
- Mowing, hand pulling, spot spraying or seeding stockpiles of reclamation material to prevent and control the establishment of weeds;
- The application of chemical methods will not be performed within 30 metres of any water body or watercourse, unless otherwise authorized;
- Only individuals holding a Pesticide Service Registration will be contracted to use herbicide.

### 5.16 Clubroot Fungus Management

Prior to commencing operations at the pit, Sameng Inc. conducted sampling to determine if clubroot was present within the pit area as it was previously determined by the County that there was trace amounts of clubroot present within the adjacent quarter section (NE 25). All samples taken within the pit area (SW 36, NW 25 & SW 25) came back negative for the presence of clubroot. To prevent the spread of clubroot to the pit, the preventative measures and best management practices detailed in the *Alberta Clubroot Management Plan* will be implemented.

### 5.17 Emergency Response Plan

Joburg has developed and implemented a comprehensive Emergency Response Plan for the pit. The response plan includes key site contacts, procedures for dealing with a variety of potential emergency situations, communication methods with appropriate emergency services and location information. Additionally, general site information that would be useful in the event of an emergency is provided. Joburg also has a designated STARS Remote Landing Site in case of serious emergency. A copy of the Emergency Response Plan and STARS Remote Landing Site Card are available in Appendix O.

## 6.0 Conservation and Reclamation Plan

As previously mentioned, the pit will be reclaimed to an agricultural end land use with three end pit waterbody complexes and one seasonal wetland. A farmable drainage swale will be constructed to facilitate drainage between the three northern waterbodies. Further details on the construction of the waterbodies are in Section 6.3.

### 6.1 Material Replacement and Contouring

Based on the reclamation material that is currently available, the estimated volumes of topsoil and subsoil to be salvaged in the currently undisturbed area and the proposed end pit waterbody complexes, subsoil will be replaced at an estimated depth of 27 cm and topsoil will be replaced at an estimated depth of 14 cm, accounting for the standard 20% estimated loss due to stockpiling and handling.

As previously mentioned, a minimum of 1 m of sand will be replaced prior to replacement of reclamation material across all mining blocks with the exception of the bottoms of the end pit lakes. This will be done to ensure reestablishment of the groundwater gradient following reclamation.

The objective of reclamation is to ensure that all disturbed lands resulting from pit activities are reclaimed to an equivalent land capability. Because the land's CLI capability for agriculture includes as area rated as Class 2, all internal slopes will be contoured at 20:1 or gentler. Slopes adjacent to property boundaries will be contoured at 3:1 or gentler to match the surrounding landscape as shown on Drawing No. 6-13 to 11-13.

As the reclaimed pit will include three end pit waterbody complexes and a seasonal wetland, contouring and grading will be completed to ensure that drainage is directed toward the features without causing any excessive erosion along the edges of the waterbodies. Where possible material salvaged from naturally occurring wetlands will be used as topsoil replacement in the emergent vegetation of areas of the waterbody complexes or seasonal wetland. A conceptual reclamation plan and cross sections showing reclaimed conditions can be seen on Drawing No. 6-13 to 12-13.

### 6.2 Revegetation

The pit will be reclaimed to an agricultural end land use, with the upland landscape seeded to a pasture or cultivated to be determined on an annual basis by the renter.

Re-vegetation around the end pit lake complexes and seasonal wetland will extend up to 30 meters from the full supply level and will consist of aquatic plants and vegetation from the seedbank from previous wetland soils. If wetland soils are not available a seed mix native to the central parkland sub-region for consisting of hydrophytic plant species will be used to established desirable wetland vegetation communities within the emergent vegetation zones of the waterbody complexes/wetlands, prior to the area being inundated with water. A wetland meadow/low prairie seed mix will be applied to all other lands within the wetland transitional zone, and include species such as, *Poa palustris, Agropyron, trachycaulum, Beckmania syzigachne, Agropyrum smithii, Descharmpsia caesitosa*.

### 6.3 End Pit Waterbody Complex Design

Construction of three end pit waterbody complexes and a seasonal wetland area will occur in order to fulfill the reclamation objective of the pit and have been designed primarily for agriculture use, with passive wildlife/waterfowl habitat purposes. The waterbody complexes are proposed to have full supply levels of approximately 629.5 masl for Wetland A, 630.5 masl for Waterbody Complex A, 631.0 masl for Waterbody Complex B and 632.0 masl for Waterbody Complex C. Additional details on the waterbodies are below in Table 3. Slopes will be contoured to the standard 5:1, one metre above and one metre below the FSL, and depths greater than one metre below the FSL slopes will be contoured at 3:1 or gentler.

| Table 3. End Pit Waterbody Complex Details | | | |
|---|---|---|---|
| End Pit Waterbody/Wetland | Surface Area (ha) | Average Depth (m) | Full Supply level (masl) |
| Wetland A | 4.03 | 2.0 | 629.5 |
| WB Complex A | 4.87 | 7.5 | 630.5 |
| WB Complex B | 4.81 | 7.0 | 631.0 |
| WB Complex C | 2.38 | 6.0 | 632.0 |

It is expected that the waterbody complexes will be hydraulically connected to the local groundwater aquifer, and that the water levels will fluctuate seasonally depending on the water levels within the aquifer. A drainage swale will be constructed between Waterbody complex B, Waterbody complex A and Wetland A to facilitate overland drainage to the north between the water features during periods of high runoff. When Wetland A reaches capacity, it will be outlet via an additional drainage swale to the northwest corner of the property and into the Range Road 221 ditch. From there water will flow north to Township Road 550 and onto the unnamed watercourse to the north.

The waterbody complexes will be constructed to have shallow littoral zones with emergent and transitional vegetation zones, while the seasonal wetland will consist of hydrophytic vegetation more consistent with a seasonal wetland. Across one reclaimed wetland and three waterbody complexes there will be a total of 16.37 ha of emergent/wetland vegetation area and 7.32 ha of transitional vegetation area, as shown on Drawing No. 12-13. These areas will serve as wetland compensation for the removal of existing wetlands on the landscape. An amendment to *Water Act* Approval No. 00286979-00-00 will be submitted under separate cover to propose the changes in waterbody design and wetland compensation to AEP for approval.

## 7.0 Financial Security

Financial security has been provided to AEP in the amount of $1,083,121.75 representing the current maximum liability for the pit. When the Updated Activities Plan and upcoming Five-Year Report are provided to AEP, an updated security estimate will be provided and the Letter of Credit will be amended if necessary.

## 8.0 References


Government of Alberta. 1995-2016. Alberta Soil Information Viewer. Available at: https://soil.agric.gov.ab.ca/agrasidviewer/ (Accessed September 16, 2021).

Canada Department of Agriculture. 1967. Canadian Land Inventory. Ottawa, Ontario, Available at http://sis.agr.gc.ca/cansis/publications/maps/cli/250k/agr/index.html (Accessed January 15, 2019)

Pedocan Land Evaluation Ltd. 1993. Soil series information for reclamation planning in Alberta. Prepared for Alberta Conservation and Reclamation Council (Reclamation Research Technical Advisory Committee). Alberta Conservation and Reclamation Council. Edmonton, AB.

Fenton, M.M., Waters, E.J., Pawley, S.M., Atkinson, N., Utting, D.J. and Mckay, K. (2013): Surficial geology of Alberta; Alberta Energy Regulator, AER/AGS Map 601, scale 1:1 000 000.

## 9.0 Limitations

This report has been prepared for the sole benefit of Joburg Aggregates Ltd This document may not be used by any other person or entity, with the exception of Alberta Environment and Parks and Strathcona County without the express written consent of Aspen Land Group Inc. and Joburg Aggregates Ltd Any use of this report by a third party, or any reliance on decisions made based on it, or damages suffered as a result of the use of this report are the sole responsibility of the user.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted scientific practices current at the time the work was performed. The conclusions and recommendations presented represent the best judgment of Aspen Land Group Inc. based on the data obtained. Due to the nature of the data available, Aspen Land Group Inc. cannot warrant against undiscovered environmental liabilities. Conclusions and recommendations presented in this report should not be considered legal advice.

Prepared by:

Aspen Land Group Inc.
11213 Winterburn Road NW
Edmonton, AB T5S 2B2

| Written by: | Reviewed by: |
|---|---|
| Keira Nystrom | |
| Keira Nystrom, AIT | Lesley Foy, P. Ag. |

# Appendix A

Certificates of Title

# LAND TITLE CERTIFICATE

S

| LINC | SHORT LEGAL | TITLE NUMBER |
| --- | --- | --- |
| 0038 284 790 | 4;22;54;36;SW | 192 254 781 |

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 54
SECTION 36
QUARTER SOUTH WEST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

| | HECTARES | (ACRES) MORE OR LESS |
| --- | --- | --- |
| A) PLAN 1920981 ROAD | 0.805 | 1.99 |

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: STRATHCONA COUNTY

REFERENCE NUMBER: 192 069 468 +2

REGISTERED OWNER(S)

| REGISTRATION | DATE(DMY) | DOCUMENT TYPE | VALUE | CONSIDERATION |
| --- | --- | --- | --- | --- |
| 192 254 781 | 22/10/2019 | TRANSFER OF LAND | $720,000 | $1,250,000 |

OWNERS

1488098 ALBERTA LTD.
OF 11610-151 STREET
EDMONTON
ALBERTA T5M 4E9

ENCUMBRANCES, LIENS & INTERESTS

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
| --- | --- | --- |
| 022 024 110 | 21/01/2002 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - CORRIDOR PIPELINE LIMITED.<br>ORDER #0024/2002 |
| 062 329 195 | 28/07/2006 | SURFACE RIGHTS BOARD ORDER |

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| | | IN FAVOUR OF - ACCESS PIPELINE INC.<br>ORDER #0764/2006 |
| 072 405 844 | 09/07/2007 | CAVEAT<br>RE : SEE CAVEAT<br>CAVEATOR - INTER PIPELINE (CORRIDOR) INC.<br>3200, 215-2 STREET SW<br>CALGARY<br>ALBERTA T2P1M4<br>AGENT - HMA LAND SERVICES LTD.<br>(DATA UPDATED BY: CHANGE OF ADDRESS 172108696) |
| 072 513 485 | 25/08/2007 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - ENBRIDGE PIPELINES (ATHABASCA) INC.<br>ORDER # 0719/2007 |
| 082 090 149 | 27/02/2008 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - INTER PIPELINE (CORRIDOR) INC.<br>ORDER #0322/2008 |
| 082 348 664 | 16/08/2008 | CAVEAT<br>RE : LEASE , ETC.<br>CAVEATOR - 1785416 ALBERTA LTD.<br>202, 2520 ELLWOOD DRIVE SW<br>EDMONTON<br>ALBERTA T6X0A9<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 152345124) |
| 172 250 091 | 25/09/2017 | CAVEAT<br>RE : LEASE INTEREST<br>CAVEATOR - CANADIAN WESTERN BANK.<br>2500, 10303 JASPER AVE<br>EDMONTON<br>ALBERTA T5J3N6<br>AGENT - JONATHAN C. CALVERT |
| 222 184 314 | 22/08/2022 | UTILITY RIGHT OF WAY<br>GRANTEE - WOLF CARBON SOLUTIONS INC. |

TOTAL INSTRUMENTS: 008

( CONTINUED )

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 1 DAY OF SEPTEMBER, 2022 AT 02:41 P.M.

ORDER NUMBER: 45320603

CUSTOMER FILE NUMBER:

*END OF CERTIFICATE*

---

LAND TITLE CERTIFICATE

S

| LINC | SHORT LEGAL | TITLE NUMBER |
|---|---|---|
| 0038 284 774 | 4;22;54;25;NW | 192 069 468 |

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 54
SECTION 25
QUARTER NORTH WEST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

| | | HECTARES | (ACRES) MORE OR LESS |
|---|---|---|---|
| A) PLAN 1920981 | ROAD | 0.804 | 1.99 |

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: STRATHCONA COUNTY

REFERENCE NUMBER: 152 059 571 +1

---

REGISTERED OWNER(S)

| REGISTRATION | DATE(DMY) | DOCUMENT TYPE | VALUE | CONSIDERATION |
|---|---|---|---|---|
| 192 069 468 | 25/03/2019 | ROAD PLAN | | |

OWNERS

JOBURG AGGREGATES LTD.
OF 11610 151 STREET
EDMONTON
ALBERTA T5M 4E9
(DATA UPDATED BY: CHANGE OF ADDRESS 192177447)

---

ENCUMBRANCES, LIENS & INTERESTS

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| 022 040 006 | 01/02/2002 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - CORRIDOR PIPELINE LIMITED.<br>ORDER #<br>0087/2002 |

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| 062 295 241 | 08/07/2006 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - ACCESS PIPELINE INC.<br>ORDER # 0748/2006 |
| 072 513 486 | 25/08/2007 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - ENBRIDGE PIPELINES (ATHABASCA) INC.<br>ORDER # 0720/2007 |
| 082 106 191 | 10/03/2008 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - INTER PIPELINE (CORRIDOR) INC.<br>ORDER #0342/2008 |
| 142 314 375 | 22/09/2014 | SURFACE RIGHTS BOARD AMENDING ORDER<br>AFFECTS INSTRUMENT: 022040006<br>ORDER#0087/2002;AMENDING ORDER#1981/2003.<br>PARTY NAME AMENDED TO<br>TERASEN PIPELINES (CORRIDOR) INC. |
| 142 314 376 | 22/09/2014 | SURFACE RIGHTS BOARD AMENDING ORDER<br>AFFECTS INSTRUMENT: 022040006<br>ORDER#0087/2002;AMENDING ORDER#0431/2012.<br>TERMINATED AS TO LANDS ON PLAN B.<br>PARTY NAME AMENDED TO<br>INTER PIPELINE (CORRIDOR) INC. |
| 172 248 538 | 22/09/2017 | MORTGAGE<br>MORTGAGEE - CANADIAN WESTERN BANK.<br>100, 12230 JASPER AVE<br>EDMONTON<br>ALBERTA T5N3K3<br>ORIGINAL PRINCIPAL AMOUNT: $7,000,000 |
| 172 248 539 | 22/09/2017 | CAVEAT<br>RE : ASSIGNMENT OF RENTS AND LEASES<br>CAVEATOR - CANADIAN WESTERN BANK.<br>2500, 10303 JASPER AVE<br>EDMONTON<br>ALBERTA T5J3N6<br>AGENT - JONATHAN C CALVERT |
| 182 254 786 | 11/10/2018 | CAVEAT<br>RE : DEVELOPMENT AGREEMENT PURSUANT TO MUNICIPAL GOVERNMENT ACT<br>CAVEATOR - STRATHCONA COUNTY.<br>C/O JOSELYN THRASHER-HAUG, ACTING DIRECTOR<br>PLANNING AND DEVELOPMENT SERVICES<br>2001 SHERWOOD DRIVE<br>SHERWOOD PARK<br>ALBERTA T8A3W7 |

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| 222 184 124 | 22/08/2022 | UTILITY RIGHT OF WAY<br>GRANTEE - WOLF CARBON SOLUTIONS INC. |

TOTAL INSTRUMENTS: 010

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 1 DAY OF SEPTEMBER, 2022 AT 02:41 P.M.

ORDER NUMBER: 45320603

CUSTOMER FILE NUMBER:

*END OF CERTIFICATE*

LAND TITLE CERTIFICATE

S

| LINC | SHORT LEGAL | TITLE NUMBER |
|---|---|---|
| 0029 250 982 | 4;22;54;25;SW | 032 118 945 |

LEGAL DESCRIPTION

THE SOUTH WEST QUARTER OF SECTION TWENTY FIVE (25)
TOWNSHIP FIFTY FOUR (54)
RANGE TWENTY TWO (22)
WEST OF THE FOURTH MERIDIAN
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT (A) 0.773 HECTARES (1.91 ACRES) MORE OR LESS FOR RIGHT
OF WAY AND EXTRA LAND BY THE CANADIAN PACIFIC RAILWAY
COMPANY AS SHOWN ON RAILWAY PLAN 834EO
(B) ALL THAT PORTION OF THE SOUTH WEST QUARTER LYING SOUTH EAST OF
RAILWAY PLAN 834EO CONTAINING 0.688 HECTARES (1.70 ACRES) MORE OR LESS
EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: STRATHCONA COUNTY

REFERENCE NUMBER: 022 094 280

REGISTERED OWNER(S)

| REGISTRATION | DATE(DMY) | DOCUMENT TYPE | VALUE | CONSIDERATION |
|---|---|---|---|---|
| 032 118 945 | 07/04/2003 | TRANSFER OF LAND | $235,500 | SEE INSTRUMENT |

OWNERS

CHRISTOPHER ALAN MCEACHERN
OF 22155 TWP ROAD 544
FORT SASKATCHEWAN
ALBERTA T8L 3Z8

ENCUMBRANCES, LIENS & INTERESTS

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| 3194HP | 20/07/1950 | LEASE<br>LESSEE - AUSTIN SMYTH |

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| | | "FOR 15 MONTHS FROM 15 04 1950" |
| 396JK | 09/06/1953 | CAVEAT<br>CAVEATOR - CANADIAN NATURAL RESOURCES LIMITED.<br>BOX 6926, STN D<br>CALGARY<br>ALBERTA T2P2G1<br>"4;22;54;25;;5,6"<br>(DATA UPDATED BY: CHANGE OF ADDRESS 982277302)<br>(DATA UPDATED BY: CHANGE OF NAME 182061200) |
| 7192JI | 28/08/1953 | CAVEAT<br>CAVEATOR - BERNUM PETROLEUM LTD.<br>SUITE 203,2303-4 STREET SW<br>CALGARY<br>ALBERTA T2S2S7<br>(DATA UPDATED BY: CHANGE OF ADDRESS 982277718)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 012029285)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 042172955)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 042249848)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 082421598)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 152114973) |
| 2669TQ | 24/04/1973 | CAVEAT<br>CAVEATOR - EDMONTON REGIONAL PLANNING COMMISSION. |
| 842 031 275 | 13/02/1984 | UTILITY RIGHT OF WAY<br>GRANTEE - ATCO GAS AND PIPELINES LTD.<br>10035-105 ST<br>EDMONTON<br>ALBERTA T5J2V6<br>"DISC. EX. PT. AS DESC. 852024919 07 02 1985"<br>(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 012021727) |
| 892 326 219 | 12/12/1989 | CAVEAT<br>RE : SURFACE LEASE<br>CAVEATOR - RALLY CANADA RESOURCES LTD.<br>ATTN:SURFACE MANAGER<br>520,815 8TH AVE SW<br>CALGARY<br>ALBERTA T2P3P2<br>(DATA UPDATED BY: CHANGE OF ADDRESS 952007848)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT |

( CONTINUED )

REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS

002015985)
(DATA UPDATED BY: CHANGE OF NAME 062194830)
(DATA UPDATED BY: CHANGE OF ADDRESS 072290523)
(DATA UPDATED BY: TRANSFER OF CAVEAT 102211692)
(DATA UPDATED BY: CHANGE OF ADDRESS 122333937)
(DATA UPDATED BY: TRANSFER OF CAVEAT 152148540)

912 031 518   06/02/1991 UTILITY RIGHT OF WAY
GRANTEE - RALLY CANADA RESOURCES LTD.
ATTN:SURFACE MANAGER
520,815 8TH AVE SW
CALGARY
ALBERTA T2P3P2
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 002026989)
(DATA UPDATED BY: CHANGE OF NAME 062195040)
(DATA UPDATED BY: CHANGE OF ADDRESS 072208345)
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 102235828)
(DATA UPDATED BY: CHANGE OF ADDRESS 122325045)
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 152147530)

912 051 746   04/03/1991 CAVEAT
RE : SURFACE LEASE
CAVEATOR - RALLY CANADA RESOURCES LTD.
ATTN SURFACE LAND DEPARTMENT
SUITE 520, 815 8 AVE SW
CALGARY
ALBERTA T2P3P2
(DATA UPDATED BY: TRANSFER OF CAVEAT 912102582)
(DATA UPDATED BY: TRANSFER OF CAVEAT 132071028)
(DATA UPDATED BY: TRANSFER OF CAVEAT 152373262)

912 340 347   11/12/1991 DISCHARGE OF UTILITY RIGHT OF WAY 912031518
PARTIAL
EXCEPT PLAN/PORTION:  9122472

972 355 386   18/11/1997 CAVEAT
RE : RIGHT OF WAY AGREEMENT
CAVEATOR - BERNUM PETROLEUM LTD.
203, 2303 4 ST SW
CALGARY
ALBERTA T2S2S7

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| | | (DATA UPDATED BY: TRANSFER OF CAVEAT 042172955)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 042249848)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 082422257)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 182062712) |
| 982 342 987 | 05/11/1998 | CAVEAT<br>RE : RIGHT OF WAY AGREEMENT<br>CAVEATOR - WEST LAKE ENERGY CORP.<br>SUITE 410, 396 - 11 AVENUE SW<br>CALGARY<br>ALBERTA T2R0C5<br>(DATA UPDATED BY: CHANGE OF NAME 132150233)<br>(DATA UPDATED BY: TRANSFER OF CAVEAT 192047975) |
| 012 078 423 | 19/03/2001 | UTILITY RIGHT OF WAY<br>GRANTEE - INTER PIPELINE (CORRIDOR) INC.<br>3200, 215-2 STREET SW<br>CALGARY<br>ALBERTA T2P1M4<br>(DATA UPDATED BY: CHANGE OF NAME 072665531)<br>(DATA UPDATED BY: CHANGE OF ADDRESS 172105554) |
| 012 414 665 | 20/12/2001 | SURFACE RIGHTS BOARD ORDER<br>IN FAVOUR OF - CORRIDOR PIPELINE LIMITED.<br>ORDER #3575/2001 |
| 022 450 471 | 25/11/2002 | DISCHARGE OF UTILITY RIGHT OF WAY 012078423<br>PARTIAL<br>EXCEPT PLAN/PORTION: 0226586 |
| 052 320 548 | 04/08/2005 | UTILITY RIGHT OF WAY<br>GRANTEE - ACCESS PIPELINE INC. |
| 062 152 882 | 12/04/2006 | UTILITY RIGHT OF WAY<br>GRANTEE - RALLY CANADA RESOURCES LTD.<br>ATTN:SURFACE MANAGER<br>520,815 8TH AVE SW<br>CALGARY<br>ALBERTA T2P3P2<br>(DATA UPDATED BY: CHANGE OF NAME 112308330)<br>(DATA UPDATED BY: CHANGE OF NAME 132161171)<br>(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 152100464)<br>(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT |

( CONTINUED )

OF WAY 152147681)

062 188 628 06/05/2006 UTILITY RIGHT OF WAY
GRANTEE - ENBRIDGE PIPELINES (ATHABASCA) INC.

062 391 542 02/09/2006 UTILITY RIGHT OF WAY
GRANTEE - INTER PIPELINE (CORRIDOR) INC.
3200, 215-2 STREET SW
CALGARY
ALBERTA T2P1M4
(DATA UPDATED BY: CHANGE OF NAME 072664980)
(DATA UPDATED BY: CHANGE OF ADDRESS 172099025)

082 044 031 28/01/2008 SURFACE RIGHTS BOARD AMENDING ORDER
AFFECTS INSTRUMENT: 012414665
ORDER #3575/2001;AMENDING ORDER NO 1385/2007.
PARTY NAME AMENDED TO
INTER PIPELINE (CORRIDOR) INC.

082 103 925 07/03/2008 NOTICE OF SECURITY INTEREST
RE : FIXTURES
IN FAVOUR OF - ROYAL BANK OF CANADA.
PERSONAL SERVICE CENTRE
180 WELLINGTON ST WEST
TORONTO
ONTARIO M5J1J1
DEBTOR - DAVID WAYNE ADCOCK
DEBTOR - SOPHIA PETRONELLA ADCOCK
BOTH OF:
22074 TWP RD 544
FORT SASKATCHEWAN
ALBERTA T8L3Z8
AMOUNT: $134,041
EXPIRES: 2053/03/05

092 272 679 07/08/2009 DISCHARGE OF UTILITY RIGHT OF WAY 052320548
PARTIAL
EXCEPT AS TO PLAN 0926369

092 395 648 03/11/2009 CAVEAT
RE : LEASE , ETC.
CAVEATOR - REPERIO RESOURCES CORP.
1990, 10020 101A AVE
EDMONTON
ALBERTA T5J3G2
AGENT - DARRELL WILSON

092 450 550 14/12/2009 DISCHARGE OF UTILITY RIGHT OF WAY 062391542
PARTIAL
EXCEPT PLAN/PORTION: 0925353

( CONTINUED )

| REGISTRATION NUMBER | DATE (D/M/Y) | PARTICULARS |
|---|---|---|
| 102 041 117 | 04/02/2010 | DISCHARGE OF UTILITY RIGHT OF WAY 062188628<br>PARTIAL<br>EXCEPT PLAN/PORTION: 0928336 |
| 152 030 887 | 28/01/2015 | SURFACE RIGHTS BOARD AMENDING ORDER<br>AFFECTS INSTRUMENT: 012414665<br>PARTY NAME CHANGED TO INTER PIPELINE<br>(CORRIDOR) INC. |
| 152 345 120 | 03/11/2015 | CAVEAT<br>RE : LEASE INTEREST , ETC.<br>CAVEATOR - 1785416 ALBERTA LTD.<br>201, 2520 ELLWOOD DRIVE SW<br>EDMONTON<br>ALBERTA T6X0A9<br>AGENT - MARK E HILLENBRAND |
| 162 079 168 | 18/03/2016 | UTILITY RIGHT OF WAY<br>GRANTEE - ATCO ENERGY SOLUTIONS LTD. |
| 172 250 091 | 25/09/2017 | CAVEAT<br>RE : LEASE INTEREST<br>CAVEATOR - CANADIAN WESTERN BANK.<br>2500, 10303 JASPER AVE<br>EDMONTON<br>ALBERTA T5J3N6<br>AGENT - JONATHAN C. CALVERT |
| 222 184 316 | 22/08/2022 | UTILITY RIGHT OF WAY<br>GRANTEE - WOLF CARBON SOLUTIONS INC. |

TOTAL INSTRUMENTS: 029

## PENDING REGISTRATION QUEUE

| DRR NUMBER | RECEIVED DATE (D/M/Y) | CORPORATE LLP TRADENAME | LAND ID |
|---|---|---|---|
| D008BMU | 29/07/2022 | STRATHCONA RESOURCES LTD.<br>587-224-4123<br>CUSTOMER FILE NUMBER:<br>BERNUM 29 | |
| 001 | | CHANGE OF NAME | #032 118 945 |
| D008BP5 | 29/07/2022 | STRATHCONA RESOURCES LTD.<br>587-224-4123<br>CUSTOMER FILE NUMBER:<br>BERNUM 36 | |

( CONTINUED )

| DRR NUMBER | RECEIVED DATE (D/M/Y) | CORPORATE LLP TRADENAME | LAND ID |
|---|---|---|---|
| 001 | | CHANGE OF NAME | #032 118 945 |

TOTAL PENDING REGISTRATIONS: 002

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 1 DAY OF SEPTEMBER, 2022 AT 02:41 P.M.

ORDER NUMBER: 45320603

CUSTOMER FILE NUMBER:

*END OF CERTIFICATE*

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER, SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION, APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).

IF MORE INFORMATION IS REQUIRED ON A PENDING REGISTRATION WHERE THE CONTACT INFORMATION DISPLAYS N/A PLEASE EMAIL LTO@GOV.AB.CA.

# Appendix B

Development Permit No. 2015-1108-DP, SDAB Decision (December 27, 2017) &
Development Permit Application Form

STRATHCONA COUNTY

# Development Permit

## Decision

2001 Sherwood Drive
Sherwood Park, Alberta
T8A 3W7
Phone: (780) 464-8080
Fax: (780) 464-8142

## DEVELOPMENT PERMIT NUMBER: 2015-1108-DP

### PROPERTY DESCRIPTION

| | |
|---|---|
| | 4225300005 |
| *Civic Address* | *Roll Number* |
| SW-25-54-22-W4, NW-25-54-22-W4 & SW-36-54-22-W4 | |
| *Legal Description* | *Subdivision Name* |
| | AG - Agriculture: General |
| *Additional Description* | *Land Use District* |

### APPLICANT

**Joburg Aggregates Ltd.**
11610 151 Street NW
Edmonton, Alberta
T5M4E9

**Contact:** Peter Wall
**Phone:** 780-233-3588, 780-454-0700
**Fax:** 780-452-3050

### LANDOWNER

Joburg Aggregates Ltd.
Edmonton, AB
T6X 0A9

### PROPOSED DEVELOPMENT

*The development proposed is described as follows:*

**Aggregate Extraction/Processing Use - Gravel Extraction and Processing Operation - Temporary Use Expires October 27, 2022**

### DECISION

*The proposal has been reviewed by Planning and Development Services and the following decision was rendered pursuant to the Land Use Bylaw:*

**APPROVED**

*Please see below or Schedule A for the conditions of Approval.*

*The decision on this application was made by:*

**Chris Gow**
*Development Officer*

**October 27, 2017**
*Date*

This permit has been issued on a TEMPORARY basis and will expire in approximately 5 Years on October 27, 2022. Please contact Planning and Development Services at least one month prior to the expiry date for information regarding reapplication, extension or renewal of this permit.

### APPEAL

*The decision and/or conditions of this permit are subject to a fourteen (14) day appeal period.*

**Appeal Notification Date: OCTOBER 27, 2017** **Appeal Expiry Date: NOVEMBER 10, 2017**

*Appeals must be submitted to the Subdivision and Development Appeal Board prior to the Appeal Expiry Date. For further information, contact the Secretary to the Subdivision and Development Appeal Board at (780) 464-8140.*

STRATHCONA COUNTY

October 27, 2017

DP#2015-1108-DP

Joburg Aggregates Ltd.
11610 – 151 Street NW
Edmonton, AB
T5M 4E9

Attention: Peter Wall

**RE: Proposed Aggregate Extraction Use**
**Aggregate Extraction/ Processing Use – Gravel Extraction and Processing Operation**
**Temporary Use – Expires October 27, 2022**
**SW-25-54-22-W4, NW-25-54-22-W4 and SW-36-54-22-W4**
**STRATHCONA COUNTY**

Please be advised that on October 27, 2017 Planning & Development Services **APPROVED** your application for an Aggregate Extraction/ Processing Use – Gravel Extraction and Processing Operation – Temporary Use, on the subject property.

**This letter constitutes development approval subject to the following conditions. Please review these conditions and ensure any outstanding requirements are addressed prior to the commencement of any activity on site.**

1. That the proposed Aggregate Extraction/ Processing Use – Gravel Extraction and Processing Operation shall be developed and operated in conformance with the plans and information submitted and approved with this application (Executive Summary and Supporting Documents dated September 2016). In this regard, the approved development shall also be developed and operated in accordance with the Alberta Environment's Code of Practice for Pits.

2. A separate development permit application is required for any expansion of the proposed Gravel Extraction and Processing Operation outside the designated area indicated on the approved plans, change of operating hours, intensification of use, etc.

3. That no sales of raw material or product shall be conducted on the subject property.

4. That the owner enters into the Development and Development/Cost Contribution Agreements with Strathcona County for the required Range Road 221(S) and Township Road 550 improvements respectively, per the terms of Memorandum of Agreement dated August 30, 2017.

5. That this development permit is valid for a temporary period **expiring October 27, 2022.** In this regard, a new development permit application is required to be submitted to Planning & Development Services for any proposed development and operations intended after the expiry date.

6. That all stockpiles and operations proposed on-site shall be contained within the pit disturbance areas as indicated on the plans approved with this application.

2001 Sherwood Drive
Sherwood Park, Alberta T8A 3W7

780-464-8111
www.strathcona.ca

7. That all aggregate extraction/ processing operations shall be carried out so as to create a minimum of dust and environmental disturbance.

8. That this development permit approval for the proposed Aggregate Extraction Use does not include operation of an asphalt plant, asphalt mixing or asphalt truck box spraying on site.

9. That there shall be no truck hauling during school bus operation.

10. **That all on-site activities associated with the proposed aggregate extraction operation shall be limited to:**

    **July 1 – August 31; Monday to Saturday 7:00am to 10:00pm and on Sundays & Statutory Holidays 10:00am to 10:00pm**

    **September 1 – June 30; Monday to Thursday 7:00am to 9:00pm, Friday to Saturday 7:00am to 10:00pm and Sunday & Statutory Holidays 10:00am to 9:00pm**

    **and shall only be conducted on the approved haul route. Further, all truck traffic leaving the site shall ensure loads are tarped to the satisfaction of Strathcona County Transportation and Agriculture Services.**

11. **That prior to commencement of any activity on the site related to the proposed aggregate extraction development, the applicant shall enter into a Road Use Agreement with Strathcona County.** In this regard, the applicant is advised to contact Transportation and Agriculture Services at 780-417-7100 to ensure that the required agreement is in place at all times during hauling activities.

12. That a Roadside Development Permit be obtained and maintained from Alberta Transportation due to the proximity to a Provincial Highway.

13. **That all site access and/or alterations to site access shall be to the satisfaction of the County Engineer with respect to location, design, and construction standards. In this regard, the applicant is to contact Transportation & Agriculture Services at 780-417-7100 for any site access that requires upgrading.**

14. That any vehicles accessing the site shall not be permitted to park on any municipal road. In this regard, an on-site parking area shall be provided to accommodate any vehicles including those waiting to load and transport aggregate materials.

15. Any required outdoor lighting shall be in accordance with Land Use Bylaw 6-2015 (Part 3, Section 3.11–Outdoor Lighting) and Strathcona County's Light Efficient Community Policy unless otherwise required under provincial or federal regulation. An Outdoor Lighting Plan including location and fixture specifications shall be submitted by the Applicant to the Development Authority for review and acceptance prior to installation.

16. That the applicant shall ensure the proper reclamation and restoration of the site after completion of extraction activities. The applicant shall:

    a) Obtain development and reclamation approval from Alberta Environment, including the provision of security to the satisfaction of Alberta Environment, and

    b) Upon satisfactory completion of reclamation on-site, the applicant shall obtain a Reclamation Certificate from Alberta Environment.

17. That the applicant is responsible for posting appropriate safety signs on and about the property.

18. Failing to conform to the aforementioned conditions would render this permit invalid.

Furthermore, the applicant is advised:

1. That building, plumbing, gas or electrical permits may be required prior to any construction on-site, including any proposed buildings or structures on-site. Please contact Planning & Development Services for further information at 780-464-8080.

2. **That the applicant / landowner is advised to review the attached comments from Strathcona County Departments.**

3. That the applicant is responsible for contacting utility companies regarding the proposed development in proximity to underground / overhead utilities and to discuss any applicable regulations or requirements.

4. That a separate development permit application is required for any future expansion or development (i.e. increases or changes in uses, accessory buildings, etc.).

5. That Transportation and Agriculture Services (780-417-7100) should be contacted in regard to construction traffic requirements (i.e. clean-up of mud tracking, parking restrictions). The applicant is also responsible to post appropriate safety signage to the satisfaction of Public Works Operations.

6. Any development permit conditional approval by Strathcona County Planning & Development Services does not excuse the applicant / landowner from ascertaining and complying with the requirements of any easement or right-of-way registered on the subject property. We advise that the applicant / developer is responsible for maintaining authorization from ATCO Electric and AltaLink L.P. as well as any other parties with an interest in rights-of-way registered on the title of the subject properties. Please also note that access to transmission tower right-of-ways is to be maintained during operation of the aggregate extraction operation.

7. That the applicant is responsible to provide weed control on-site (including stockpiles) in accordance with the requirements of Strathcona County Transportation & Agriculture Services (780-417-7100).

8. That the applicant is responsible for provisions for fire prevention and protection to the satisfaction of Strathcona County Emergency Services (contact Rod Kuhn, Fire Marshal at 780-449-9651).

9. That the applicant is responsible for ensuring that the use of the site and hauling activity is in compliance with the Strathcona County Noise Control Bylaw (contact Bylaw Services at 780-449-0170). In this regard, the applicant is advised to review and adhere to Strathcona County Bylaw #66-99 for the purpose of prohibiting, eliminating or abating noise.

10. The Federal Migratory Birds Convention Act prohibits the damaging, destroying, removing or disturbing of nests or migratory birds. Therefore, migratory bird nesting surveys are required prior to any tree clearing activities. Migratory bird nesting surveys must be conducted by a qualified professional if tree clearing is proposed during the prime wildlife

reproduction period from April 1 to July 31. If tree clearing is proposed between February 15 and April 15, a survey specific to owls is required.

11. That the applicant is responsible for contacting Alberta Environment & Sustainable Resource Development (AESRD) regarding any required approvals under the Water Act for diversions of water, dewatering of the site and any activity within the floodplain of a water body / watercourse, etc.

12. That the applicant is responsible for and not excused from ascertaining and complying with the requirements of any Federal, Provincial or other Municipal legislation; or the condition of any easement, covenant, building scheme, or development agreement affecting the land. In this regard, the applicant is advised to contact Alberta Environment & Sustainable Resource Development with respect to any required approvals.

The approval is subject to appeal. Pursuant to Section 2.17 of Land Use Bylaw 6-2015, a person affected by a development permit issued by the Development Officer may appeal this to the Subdivision and Development Appeal Board within fourteen (14) days of the date of issuance of the subject development permit. In this regard, affected parties have until 4:30 p.m., November 10, 2017 to appeal this decision.

Yours truly,
STRATHCONA COUNTY

Chris Gow
Coordinator, Development Permitting
Permitting, Inspections & Customer Service
Planning & Development Services
:cg:

pc: Diana Mossing, Land Development Engineering
Karolina Haggerty, Land Development Engineering
Ryan Wilson, Transportation and Agriculture Services
Garry Johnston, Transportation Planning and Engineering
Fire Prevention, Emergency Services
Shannon Yacyshyn, Alberta Environment & Sustainable Resource Development

## STRATHCONA COUNTY COMMENTS

**RE: Proposed Aggregate Extraction Use**
**Aggregate Extraction/ Processing Use – Gravel Extraction and Processing Operation**
**Temporary Use – Expires October 27, 2022**
**SW-25-54-22-W4, NW-25-54-22-W4 and SW-36-54-22-W4**
**STRATHCONA COUNTY**

### Land Development Engineering – Landscape Architecture Comments

L1. As per Section 3.10 of the Land Use Bylaw, landscape shall be provided on all Zoning Districts, unless otherwise stated on the Bylaw. Please provide calculations that state the minimum planting requirements for the site and clarify how they will be achieved. If trees and shrubs are proposed to be planted to meet this requirement, please provide landscape plans for review accordingly.

L2. Once the road improvements are defined, *undisturbed buffer* along Range Road 221 must be updated accordingly to ensure it is properly displayed on Figures 12 and 13.

L3. With the proposed construction of the safety berm along Range Road 221, it is anticipated that the existing vegetation will be disturbed and/or removed within the limits of the berm. Please provide a plan identifying the location and limits of vegetation removal (grasses, trees and shrubs) within the 30m buffer along Range Road 221. Specifically identify any existing trees within the 30m buffer and indicate if they are to remain or be removed as a result of the proposed berm construction.

L4. With regard to the offsite construction, be advised that all disturbed areas shall be repaired. Please refer to the Design and Constructions Standards for the Rural Road seed mix.

Please contact Catalina Cano at 780-464-8062 if you require additional information.

### Land Development Engineering – Transportation Comments

T1. Preliminary road upgrade plans indicate 10m right-of-way widening along Range Road 221, as such the 3.0m Undisturbed Buffer Zone, as identified on Figures 12 and 13, must be increased along this roadway to minimum 10m in order to locate the proposed safety berm outside of the 10m right-of-way widening.

T2. Per previous comments, as condition of the permit, the Developer will be required to enter into a Development Agreement for required off-site road upgrades and enter into a Road Use Agreement with the County.

Please contact Karolina Haggerty at 780-416-7232 if you require additional information.

### Land Development Engineering– Utilities Comments

U1. Per previous comments, as condition of the permit, the Developer will be required to enter into a Development Agreement for required off-site ditch improvements and provide a separate set of offsite ditch improvement drawings for review and acceptance. The offsite ditch improvements can be incorporated into the same Development Agreement as identified in Item #T2 above.

U2. Terms of the Development Agreement must be identified and acknowledged by the applicant through a mutually agreed upon draft Development Agreement, prior to Development Permit being issued.

Please contact Devin Boudreau at 780-464-8258 if you require additional information.

**General Comments**

G1. Please have the applicant submit three (3) revised signed and sealed copies of the application package and associated drawing set for further review and acceptance prior to the issuance of the Development Permit.

G2. The final version of the Development Permit application technical document and associated engineering drawings will be required to be stamped, signed and dated by an Engineering Professional accredited by ASET and/or APEGA to practice Civil Engineering in accordance with the Engineering, Geological and Geophysical Professions Act.

Please contact Steve Csaszar at 780-464-8124 if you require additional information.

**STRATHCONA COUNTY**
**Subdivision and Development Appeal Board**

2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Email: SDAB@strathcona.ca

| | |
|---|---|
| Appeal File Numbers: | 8-2017 and 9-2017 |
| Application Number: | 2015-1108-DP |
| Appeals Against: | Development Authority of Strathcona County |
| Appellants in #8-2017: | Gerold Fischer, Darlene Galiwoda, Steve Galiwoda, Tim Schoenleber, Janice Simmons, Chris Theroux |
| Appellant in #9-2017: | Coralie Mohr, James Mohr |
| Applicant: | Joburg Aggregates Ltd. |
| Date and Location of Hearing: | November 29, 2017, December 14, 2017 and December 19, 2017 at Sherwood Park, Alberta |
| Date of Decision: | December 28, 2017 |
| SDAB Members: | Gary Peckham, Chair<br>Jay Ramotar<br>Beverly Sawicki<br>Heather Sharp |

## NOTICE OF DECISION

[1] This is the decision of the Strathcona County Subdivision and Development Appeal Board (the "SDAB") on two appeals filed with the SDAB pursuant to sections 685 and 686 of the *Municipal Government Act*, RSA 2000, c M-26 (the "MGA").

[2] The appellants in appeal #8-2017 are: Gerold Fischer, Darlene Galiwoda, Steve Galiwoda, Tim Schoenleber, Janice Simmons, and Chris Theroux (collectively the "#8-2017 Appellants").

[3] The appellants in appeal #9-2017 are: Coralie Mohr and James Mohr (collectively the "#9-2017 Appellants").

[4] Both appeals are from the decision of the Development Authority of Strathcona County ("Development Authority") to issue a development permit with conditions for a proposed aggregate extraction / processing use (gravel extraction and processing operation) temporary use expiring October 27, 2022 (the "Gravel Operation") on the properties legally described as SW-25-54-22-W4, NW-25-54-22-W4, and SW-36-54-22-W4 (the "Property").

[5] The Applicant for the Development Permit is Joburg Aggregates Ltd. (the "Applicant").

[6] Appendix "A" attached to this decision includes a list of printed materials received by the SDAB related to this appeal, and a list of persons who made oral presentations at the hearing.

## PROCEDURAL MATTER - ADJOURNMENT REQUEST

[7] At the outset of the hearing of these appeals on November 29, 2017, the Applicant requested an adjournment to December 14, 2017 because the Applicant's preferred counsel was unable to attend the November 29, 2017 hearing. The Applicant noted that consent was received from the #8-2017 Appellants and the #9-2017 Appellants to the requested adjournment.

[8] The #9-2017 Appellants confirmed they consented to the requested adjournment, especially given the volume of submissions and the time needed to prepare for the hearings.

[9] The Development Authority did not take a position on the adjournment request, but confirmed they were ready to move forward on November 29, 2017.

[10] Given the consent of the #8-2017 Appellants and the #9-2017 Appellants, and the neutral position taken by the Development Authority, the SDAB made the decision to adjourn the hearings to December 14, 2017 so that the Applicant's preferred counsel could be present.

## PROCEDURAL MATTER - HEARING PROCESS

[11] There were no objections to the SDAB hearing both of these appeals together with the evidence in each appeal also being evidence in the other appeal.

## PROCEDURAL MATTERS - SDAB COMPOSITION

[12] There were no objections to any of the SDAB members hearing this appeal.

## ISSUES

[13] The grounds of appeal raised by one or more of the Appellants were as follows:

a. The Gravel Operation does not conform to the Agriculture Master Plan or Strathcona County's Municipal Development Plan.

b. The Gravel Operation is not compatible with the general purpose of the Agriculture: General district.

c. The Development Permit was granted for an Aggregate Extraction/Processing use, which is neither a permitted nor a discretionary use in Agriculture: General districts.

d. The Gravel Operation will create an unacceptable level of traffic.

e. The Gravel Operation will create an unacceptable level of noise.

f. The Gravel Operation will create an unacceptable level of dust.

g. The Gravel Operation may interfere with the Appellants' water supply from their wells.

h. The Gravel Operation will decrease the Appellants' property values.

i. Some of the Appellants were not properly notified of the issuance of the Development Permit.

j. The Applicant or its independent contractor truck drivers may not comply with the conditions of the Development Permit, including using only the roads which form part of the haul route.

k. The Gravel Operation will adversely affect the rural character of adjacent properties.

l. The Applicant's character is such that the Applicant should not receive a development permit for the Gravel Operation.

[14] Accordingly, the issues before the SDAB arising from the above grounds of appeal are as follows:

a. compliance with the Municipal Development Plan and the Agriculture Master Plan;

b. consistency with the purpose of the Agriculture: General district;

c. whether the Gravel Operation is a permitted or discretionary use in an Agriculture: General district;

d. traffic;

e. dust;

f. noise;

g. light pollution;

h. impact on the rural character of adjacent properties;

i. impact on well water supply;

j. impact on property values;

k. enforcement of the Development Permit;

l. notice of issuance of the Development Permit; and

m. character of the Applicant.

## SUMMARY OF THE DEVELOPMENT AUTHORITY'S POSITION

[15] On October 27, 2017, the Development Authority issued development permit 2015-1108-DP (the "Development Permit") for the Gravel Operation subject to conditions. The Development Authority submits that the SDAB should confirm the development permit as issued for the Gravel Operation on the Property.

[16] The Development Authority submits:

a. The Property consists of three contiguous quarter sections of land. It is bare land except for one corner, which has some farm buildings. The area with the farm buildings does not form part of the extraction operation.

b. The Property is districted AG – Agriculture: General ("AG"). The Development Permit was issued for an Aggregate Extraction/Processing use, that use being gravel extraction and gravel processing, including crushing, screening and washing.

c. The Strathcona County Land Use Bylaw 6-2015 (the "Land Use Bylaw") lists Aggregate Extraction as a discretionary use in AG districts. There is no definition of Aggregate Extraction in the Land Use Bylaw, but the definition of Aggregate Extraction from the previous version of the land use bylaw, Bylaw 8-2001, was carried over into the Land Use Bylaw and used as the definition of Aggregate Extraction/Processing. Any reference to Aggregate Extraction in the Land Use Bylaw should be read as a reference to Aggregate Extraction/Processing.

d. There are nine residences within 800 meters of the boundaries of the Property. Various residents expressed concerns about noise, dust, light spill and traffic. Conditions were added to the Development Permit to address these concerns.

e. The development permit application was circulated to a number of internal and external agencies. Conditions were added to the Development Permit to address the comments received from these agencies.

f. Where the approval of an agency, such as Alberta Environment, was required, approval was obtained by the Applicant.

g. The Development Permit is a temporary permit which expires 5 years after it was issued. If the Applicant wishes to continue its aggregate extraction and processing operation after the Development Permit expires, the Applicant will be required to obtain a new development permit. If the Applicant wishes to expand its operation at any time, the Applicant will be required to obtain a new development permit for the expansion.

## SUMMARY OF THE #8-2017 APPELLANTS' POSITION

[17] The #8-2017 Appellants submit:

a. Gerold Fischer lives about ½ mile from the farthest north corner of the Property. He has lived on his property for almost 45 years. His farm runs along Range Road 221 for a mile. The gravel trucks will raise dust on that road, and the dust will smother the leaves of his crop. There is a lot of farm equipment using Range Road 221. The gravel trucks will create noise, and kick up rocks which will damage the windshields of other vehicles travelling on the road.

b. Tim Schoenleber lives one quarter over from the Property, about ½ mile from the proposed gravel pit. He has lived on his property for over 20 years. Mr. Schoenleber played a sound recording he made at Bruderheim Industrial Minerals when gravel trucks were being loaded, to demonstrate how much noise the gravel trucks will make. The sound level of the recording was 86 dB due to limitations of the recording device, but the actual sound level was 94.5 dB. Dust raised by the gravel trucks will also be a problem, as will smell from the extraction operation.

c. Steve Galiwoda lives near Tim Schoelenberger and Chris Theroux, about ½ mile from the proposed gravel pit. Mr. Galiwoda said that the front door of his residence is 380 feet from "that intersection", which appeared to be a reference to the intersection between Range Road 221 and Highway 550. Trucks waiting to turn would back up past his driveway, and he would be subjected to unacceptable levels of dust, fumes and noise. Mr. Galiwoda's well was 60 feet deep and the Applicant was planning to mine to a depth of 90 feet, so the Gravel Operation might adversely affect his supply of well water.

d. Chris Theroux lives about ½ mile from the proposed gravel pit. He bought his property in 1989. The design of Highway 550 was not adequate to ensure that the highway could be used safely by gravel trucks. The gravel trucks would create an unacceptable amount of noise. Mr. Theroux was also concerned about the possible impact of the Gravel Operation on his supply of well water.

e. All of these Appellants said that the presence of the Gravel Operation would reduce the value of their property because no one wants to live beside or near a gravel pit.

**SUMMARY OF THE #9-2017 APPELLANTS' POSITION**

[18] The #9-2017 Appellants submit:

a. The Gravel Operation contravenes the Agriculture Master Plan and the Strathcona County Municipal Development Plan.

b. The Gravel Operation will remove 480 acres of Class 2 soil from agricultural production for at least 10 years and returns only 257 acres of that land to production once the Gravel Operation is concluded.

c. The Gravel Operation is neither a permitted nor a discretionary use in an AG district.

d. These Appellants' property backs onto the northernmost quarter section of the Property.

e. The Appellants use and enjoy their whole property. For example, their and the neighbour's children ride their horses around the entire perimeter of the property.

f. Four hundred trips a day by gravel trucks means that there will be one gravel truck on the haul route every 1 ½ to 2 minutes. This volume of heavy truck traffic will create a safety risk to the local residents, including a significant risk of increase in traffic accidents as residents try to cross intersections with roads occupied by gravel trucks or to make turns onto roads carrying a high volume of gravel trucks.

g. Dust from the Gravel Operation will create health risks for the residents, particularly the silica dust which is created when gravel is crushed. Silica dust is particularly dangerous for small children with lung disease.

h. The Gravel Operation will be exempt from Strathcona County's Noise Control Bylaw.

i. Noise from the Gravel Operation will be clearly audible at their house, notwithstanding the construction of a berm around the gravel pit.

j. The Outdoor Lighting Plan should have been submitted with the development permit application so that the neighbours could understand what steps will be taken to minimize light pollution from the Gravel Operation.

k. These Appellants enjoy observing deer and moose move across their property. This movement of wildlife will not happen once the gravel pit is in place. The gravel pit will be visible to these Appellants, adversely affecting the rural nature of their property.

l. The Gravel Operation will decrease the value of these Appellants' property.

m. The behaviour of the Applicant disqualifies the Applicant from receiving the Development Permit.

## SUMMARY OF POSITION OF PERSONS WHO SPOKE AGAINST THE GRAVEL OPERATION

[19] No persons other than the #8-2017 Appellants and the #9-2017 Appellants spoke at the hearing against the Gravel Operation.

## SUMMARY OF POSITIONS OF PERSONS WHO SPOKE IN SUPPORT OF THE GRAVEL OPERATION

[20] No persons other than the Applicant and its witnesses spoke at the hearing in support of the Gravel Operation.

[21] The Applicant submits:

a. While gravel operations can cause dust, noise and increased traffic levels, the Applicant has carried out extensive studies and consultations to identify the steps that will be taken to address those concerns.

b. The gravel pit will occupy only 25 to 30 acres. As the gravel in one area is exhausted, the pit and pit operations will be moved to a new area. The pit will initially be at the north end of the Property, but as the pit is moved southward, the impact of the gravel operations on the residents living near the north boundary of the Property will be reduced. Any portion of the Property that is not being mined for gravel will be farmed.

c. Currently, the Property has a number of small scattered wetlands. When the Property is reclaimed, the wetlands will consist of three end pit lakes, each with a surrounding naturalized area. The drainage from the Property will be better than it is now. Alberta Environment has approved the Reclamation Plan.

d. The primary haul route for the gravel trucks runs north on Range Road 221, then east on Township Road 550, then south on Highway 830 to Highway 16. Eventually, the Gravel Operation will add between 72 and 404 vehicles per day to the traffic on the haul route, depending on the time of year. There will be no gravel trucks on the haul route during the time school busses are on the haul route.

e. The Applicant has made the following agreement with Strathcona County. The Applicant will pay the cost of upgrades to the roads which form part of the haul route. Range Road 221 will be a gravel road for the first 2-3 years, then it will be paved. Township Road 550 will be widened. The intersections of Range Road 221 and Township Road 550, and Township Road 550 and Highway 830, will also be upgraded. While Range Road 221 is a gravel road, calcium chloride and water will be applied to the road surface to reduce dust.

f. All gravel trucks will be registered with the Alberta Sand and Gravel Association (the "Association") and will carry a large sticker with an identification number. If a resident observes a gravel truck being driven unsafely or off-route, the resident can call the Association. The Association will pass the complaint on to the Applicant, and the complaint will be dealt with.

g. Any noise from the crusher will be attenuated by 10-15 dB due to the berm that will be built on three sides of the gravel pit.

h. The noise generated by gravel trucks travelling on the haul route will not constitute a significant increase from the noise levels created by existing traffic on the haul route. In any event, by the time the traffic noise from the gravel trucks reaches any of the Appellants' residences, the noise will be attenuated to a point where the residents will not hear any more noise than they hear now.

i. The people who will be most at risk of exposure to silica dust from the crushing process are the pit workers. In accordance with occupational health and safety requirements, steps must, and will, be taken to protect the workers from the silica dust. The silica dust will not travel off the Gravel Operation site.

j. The gravel at the Property is saturated gravel, that is, wet, which reduces the dust from the gravel itself.

k. To further reduce dust, the gravel stockpile will be covered by the clay overburden removed when the pit is dug, and the clay overburden will be planted with grass. The stockpile will be watered, as will the roads within the Property.

l. Dust levels at the Property will be monitored by the Applicant.

m. The loads on the gravel trucks will be covered with tarpaulins to prevent rocks or dust from escaping from the trucks onto the road or other vehicles.

n. Lights at the gravel pit will comply with Strathcona County's Light Efficient Community Policy. The lights will be turned off except during the Gravel Operation's operating hours. Security will be provided by infra-red cameras with motion sensors.

o. The existence of the Gravel Operation may cause a 5 to 10% decrease in the value of neighbouring properties, but this situation will be temporary.

p. Groundwater levels will be monitored for the first year of operation using piezometers.

q. Of the water wells located within 1000 m of the Gravel Operation, most are drilled all the way into the bedrock and, therefore, will not be affected by the Gravel Operation. There are three wells which are drilled only into the sandy gravel aquifer, and two of those are not in use.

r. If a resident in the area has a water well concern, the Applicant will:

   i. provide a temporary alternate water supply within 24 hours if the resident is without water;
   ii. hire an independent consultant to determine the cause of the problem; and
   iii. if the problem is due to the Gravel Operation, provide a permanent alternate supply of water.

s. Deer and moose move between stands of trees and bushes. None of the stands of trees and bushes on the #9-2017 Appellants' property will be removed, so wildlife movement on their property will not be affected by the Gravel Operation.

t. Any bad behaviour has been by the #9-2017 Appellants, not by the Applicant.

**FINDINGS**

[22] The Board finds:

a. The Property is located in Strathcona County's Agriculture Large Holdings Policy Area. The Property is districted AG – Agriculture: General.

b. The maximum life of the Gravel Operation will be 10 years.

c. The Development Permit will expire 5 years after it was issued.

d. The Property will be mined in 25-30 acre segments, starting at the north end of the Property, then moving southward.

e. The primary haul route for the gravel trucks will be north on Range Road 221, then east on Township Road 550, then south on Highway 830 to Highway 16.

f. The Property is currently being farmed. During the lifetime of the Gravel Operation, those portions of the Property which are not being mined, will be farmed.

g. When the Gravel Operation is operating at its highest capacity, there will be an additional 400 vehicles per day on the roads comprising the haul route. These vehicles will be gravel trucks. This represents an increase of about 25% in the traffic currently using these roads.

h. Except for Range Road 221, the roads included in the proposed haul route have the capacity to carry the additional traffic generated by the Gravel Operation. The capacity of the portion of Range Road 221 which will be used by the gravel trucks needs to be upgraded.

i. Township Road 550 needs to be widened between Range Road 221 and Highway 830 to ensure that traffic flows smoothly and safely.

j. The gravel at the Property is saturated gravel. Saturated gravel produces less dust than unsaturated gravel.

k. The gravel stockpile will be covered with clay overburden, and the clay overburden will be planted with grass.

l. Roads within the Property will be watered. Calcium chloride and water will be applied to any part of the haul route that had a gravel road surface.

m. When trucks leave the Property, their loads of gravel will be covered with tarpaulins.

n. The crusher at the gravel pit will produce noise levels of about 120 dBA.

o. The Applicant will construct berms around three sides of the gravel pit. These berms will reduce the noise from the crusher to about 40 dBA. The berms will also help contain dust generated in the gravel pit.

p. All lights at the Gravel Operation will be turned off when the Gravel Operation is not operating and after 7:00 p.m. on days when the Gravel Operation is operating.

q. Most of the wells on properties within 1000 m of the Property are drilled into the bedrock, but there are a few wells which are drilled into the sandy gravel aquifer from which gravel will be mined.

## DECISION

[23] The issuance of the Development Permit is upheld.

[24] Condition #10 of the Development Permit is deleted and replaced with the following:

10.1 That all on-site activities associated with the proposed aggregate extraction operation shall be limited to 7:00 a.m. to 7:00 p.m., Monday through Saturday inclusive, except that there shall be no such activities on statutory holidays.

10.2 That hauling activities associated with the proposed aggregate extraction operation shall occur only on the approved haul route. Further, all truck traffic leaving the site shall ensure loads are tarped to the satisfaction of Strathcona County Transportation and Agriculture Services.

10.3 That hauling activities shall not take place during times when school busses are being operated.

[25] The following condition is added:

19. That any resident living within 2 miles of a boundary of the Gravel Operation who believes that there is a problem with his or her well water supply may contact the Applicant at a 24-hour telephone number to be provided by the Applicant. If the resident is without water, the Applicant will provide the resident with a temporary potable water supply within 24 hours after the resident calls the 24-hour telephone number. The Applicant will then hire an independent consultant to determine the cause of the problem. Should the problem be determined to be caused by the Gravel Operation, the Applicant will provide the resident with a permanent alternate supply of potable water.

[26] Otherwise, the Development Permit is upheld as drafted by the Development Authority.

## REASONS FOR THE DECISION

<u>Compliance with the Agriculture Master Plan and the Municipal Development Plan</u>

[27] The #9-2017 Appellants argue that the Gravel Operation does not conform with Strathcona County's Agriculture Master Plan or Strathcona County's Municipal Development Plan, Bylaw 20-2017 (the "MDP").

[28] The Agriculture Master Plan is not one of the types of statutory plans described in Division 4 of Part 17 of the *Municipal Government Act*, RSA 2000, c. M-26, as amended (the "MGA"). Because the Agriculture Master Plan is not a statutory plan, it is not binding on the Board[1]. However, the Board may have regard to the Agriculture Master Plan, since the Plan sets out planning policies and planning considerations relating to agricultural land in Strathcona County.

[29] However, the MDP is a statutory plan and, therefore, is binding on the Board[2]. If the Board is of the opinion that the Gravel Operation contravenes the MDP, the Board must revoke the Development Permit.

[30] The #9-2017 Appellants point to section 5.5 of the MDP, which sets out the policies applicable to the Agriculture Large Holdings Policy Area. They highlight two parts of section 5.5:

> Promote the prioritization of extensive agricultural operations by encouraging:
>
> > 1. the development of extensive agricultural operations.
>
> Ensure viability in the long term by requiring:
>
> > 26. aggregate resource extraction operations to be carried out in accordance with an approved reclamation plan.
> >
> > 27. development permits for aggregate resource extraction to provide for the following:
> >
> > > a. reclamation of the site to an equivalent land capacity/capability;

[31] Section 5.5. of the MDP clearly contemplates the possibility of new aggregate extraction operations in the Agriculture Large Holdings Policy Area. However, those operations must comply with the MDP.

[32] These Appellants argue that the Gravel Operation will remove 480 acres of Class 2 soil from agricultural production for the duration of the Gravel Operation. That is not correct. Only 25 to 30 acres of the Property will be used for mining at any given time, and the rest will be farmed.

[33] These Appellants also argue that once the reclamation called for in the Applicant's Reclamation Plan is completed, only 257 acres of the Property will be usable for farming. The Applicant acknowledges that less of the Property will be usable for farming but points to the consolidation of the existing

[1] MGA, sections 631 to 638.1
[2] MGA, section 687(3)(a.1)

scattered wetlands on the Property into three ponds, called end pit lakes, and argues that these end pit lakes and surrounding naturalized areas will provide enhanced wildlife habitat and a source of water for irrigating crops.

[34] The Reclamation Plan proposed by the Applicant was approved by Alberta Environment. The Board is satisfied that the Gravel Operation does not contravene requirement #26 in the MDP.

[35] These Appellants have not persuaded the Board that the Gravel Operation contravenes requirement #27 of the MDP. The requirement is that the land will have "equivalent" capacity/capability after reclamation, not that the land capacity/capability after reclamation will be identical to the land capacity/capability before reclamation. However, assuming for the sake of discussion that the requirement is that the land must be returned to the same, or nearly the same, number of arable acres, the Board cannot decide whether this requirement is met because no evidence was provided as to how many of the 480 acres are currently arable.

[36] This ground of appeal is dismissed.

Consistency with the Purpose of the Agriculture: General District

[37] The #9-2017 Appellants argue that the Gravel Operation is inconsistent with the purpose of the Agriculture: General district. That purpose is set out in section 9.5.1. of the Land Use Bylaw as follows:

> To foster agriculture and conserve agricultural lands outside of the Urban Service Area by providing for a compatible range of agricultural uses with regulations that maintain large parcel sizes.

[38] "Aggregate extraction" is listed as a discretionary use in the Agriculture: General district. It follows that aggregate extraction is not inconsistent with the purpose of this district. This ground of appeal is dismissed.

Permitted or Discretionary Use

[39] The #9-2017 Appellants point to the fact that "Aggregate Extraction" is listed as a discretionary use in the Agriculture: General district, but there is no definition of "Aggregate Extraction" in the Land Use Bylaw. There is a definition of "Aggregate Extraction/Processing" in the Land Use Bylaw, but this use class is not listed as a discretionary use in the Agriculture: General district. These Appellants acknowledge that the current definition of Aggregate Extraction/Processing is the same as the definition of Aggregate Extraction in the previous version of the Land Use Bylaw, but argue that the addition of the word "Processing" means that "Aggregate Extraction" is limited to extraction only, that is, does not include processing activities such as crushing, washing and separating.

[40] The Board does not accept this argument. The definitions in the previous and current versions of the Land Use Bylaw are identical; only the name of the use class has changed. Had Strathcona County Council wished to have a use class for aggregate extraction only, they would have retained the Aggregate Extraction use class and modified the definition to exclude processing, then created a new use class of Aggregate Extraction/Processing which included processing, but Council did not do that. The Board is satisfied that the continued use of "Aggregate Extraction" in the Land Use Bylaw is simply an editing error, and that wherever that phrase occurs, it ought to be read as, "Aggregate Extraction/Processing". This ground of appeal is dismissed.

Nuisances and Other Impacts

[41] Section 5.5 of the MDP contains the following requirement:

> 25. new aggregate extraction to mitigate nuisance impacts resulting from the aggregate extraction on the adjacent agricultural lands and operations with buffering, site orientation and other techniques.

[42] Section 1.17.4 of the Land Use Bylaw defines "nuisance" as follows:

> NUISANCE means anything that in the opinion of the Development Authority may cause adverse effects to the amenities of the neighbourhood or interfere with the normal enjoyment of adjacent land or building. This could include that which creates or is liable to create:
>
> • noise, vibration, smoke, dust, odour, heat, electrical interference, glare, light, fumes, fire, explosion, or any other hazard to health or safety; and
>
> • unsightly or unsafe storage of goods, salvage, junk, waste or other materials.

[43] Section 2.15.3 of the Land Use Bylaw provides:

> In determining the significance of a nuisance, the Development Authority may consider: a) the expected magnitude and consequence of the effect or nuisance; b) the expected extent, frequency, and duration of exposure to the effect or nuisance; c) the use and sensitivity of adjacent or nearby sites relative to the effect or nuisance; d) adherence to relevant environmental legislation or widely recognized performance standards; and e) the reliability and record of the proposed methods, equipment and techniques in controlling or mitigating detrimental effects or nuisances.

[44] The Board finds the above to be a useful and appropriate approach, and adopts it.

[45] Since the Gravel Operation is a discretionary use, the Board must also consider the compatibility of the Gravel Operation with the uses of adjacent lands[3]. If the Gravel Operation will have a significant negative impact on adjacent uses, and the impact cannot be adequately mitigated, then the Gravel Operation is incompatible with adjacent uses.

[46] Thus, the Board will consider whether the Gravel Operation will have any significant nuisance or other negative impacts on the adjacent uses and if so, whether the impact can be adequately mitigated.

[47] The Appellants identify a number of nuisance or other negative impacts which will be created by the Gravel Operation, and argue that none of these impacts can be adequately mitigated. These impacts are:

a. traffic;
b. dust;
c. noise;
d. light pollution;
e. reduced or no well water supply at the Appellants' properties; and
f. loss of rural character of adjoining properties.

(a) Traffic

[48] There is no doubt that the Gravel Operation will cause increased traffic on Range Road 221, Township Road 550 and Highway 830, and that the increased traffic will consist of heavy trucks.

[49] The Board accepts the Applicant's evidence that the upgrades to roads and intersections which the Applicant is required to make as a condition of the Development Permit will adequately address the Appellants' concerns about traffic levels and traffic safety. The Board is satisfied that the Applicant has adequately mitigated any negative impacts arising from the increase in traffic. This ground of appeal is dismissed.

(b) Dust

[50] The Appellants expressed concerns regarding dust generated at the site of the Gravel Operation and dust raised on the roads by the gravel trucks.

[51] The Board accepts the evidence put forward by the #9-2017 Appellants that silica dust can cause health problems for human beings, and that the

[3] *Rossdale Community League (1974) v. Edmonton (Subdivision and Development Appeal Board)*, 2009 ABCA 261, paragraph 14

crushing process will create silica dust. However, these Appellants have not persuaded the Board that silica dust will escape from the Property and have a significant impact on them. In any event, the Board is satisfied that the Applicant will adequately mitigate any nuisance caused by silica dust by following accepted occupational health and safety procedures and by monitoring dust production at the Property.

[52] The Board also accepts that the creation of other kinds of dust on site will be adequately mitigated by the steps the Applicant will take, those being watering the gravel stockpile, covering the stockpile with clay overburden and grass, and monitoring the site for dust levels. These steps, coupled with the fact that the gravel is saturated gravel, will reduce the impact of dust produced on site to an insignificant level.

[53] The Board accepts that the traffic from the Gravel Operation will create road dust which will have a significant impact on the Appellants unless that impact is adequately mitigated.

[54] In the Board's opinion, the impact will be adequately mitigated by the application of calcium chloride and water to gravel road surfaces and the requirement to cover all loads of gravel with tarpaulins.

[55] In summary, while dust created at the Property or by gravel trucks travelling along the haul route will have an impact on the Appellants, the steps the Applicant will take in mitigation will reduce the impact to an insignificant level. This ground of appeal is dismissed.

(c) Noise

[56] The Appellants expressed concern regarding the noise of the crusher and also traffic noise.

[57] Overall, the Board prefers the Applicant's evidence regarding noise over the Appellants' evidence regarding noise. The Applicant's evidence came from qualified experts whereas the sound recording provided by the Appellants was made in a yard, and may not accurately reflect the noise made by a gravel truck while stopping, then starting up and turning onto a highway.

[58] The Board accepts the Applicant's argument that as the pit and crusher are moving southward on the Property, the impact of noise from the crusher on the Appellants will be reduced. However, that is not a full answer to the issue of crusher noise.

[59] The Sound Levels Chart and supporting expert reports provided by the Applicant shows that the noise created by the crusher will be 120 dBA. Noise at that level has a significant negative impact on human beings. However,

the Sound Levels Chart also shows that the noise levels at the Appellants' residences will be acceptable, with or without the construction of berms.

[60] The #9-2017 Appellants stated that they use their whole property, and they will hear crusher noise when using the portion of their property immediately adjacent to the Property. The Board accepts that will be the case. While the Board is not persuaded that the noise will be loud, even a relatively soft noise can be irritating when the noise is repeated over and over.

[61] At the Board hearing, the Applicant agreed to reduce its hours of operation from those set out in the Development Permit. The Board finds that the reduced hours of operation will adequately mitigate the negative impact of crusher noise on the #9-2017 Appellants, and will vary Condition #10 of the Development Permit accordingly.

[62] With respect to road noise, the Board is satisfied that those of the #8-2017 Appellants who live close to an intersection on the haul route will experience some increase in road noise, although not to the levels those Appellants fear. The Board is also satisfied that the reduction in operating hours will adequately mitigate the impact of road noise on these Appellants, since when the Gravel Operating is operating, all gravel truck traffic will cease at 7:00 p.m.

[63] Accordingly, this ground of appeal is allowed in part. Condition #10 of the Development Permit is varied as set out above under the heading, "Decision".

(d) Light Pollution

[64] The #9-2017 Appellants expressed a concern about light pollution from the Gravel Operation but acknowledged that they could not make detailed submissions on that point because they had not been provided with the lighting plan.

[65] While this ground of appeal could be dismissed on that basis, the Board is satisfied that there will be no light pollution from the Gravel Operation because no lights will be on after 7:00 p.m. on days on which the Gravel Operation is operating and no lights will be on at all on Sundays or statutory holidays. This ground of appeal is dismissed.

(e) Well Water Supply

[66] Some of the Appellants expressed a concern that their water well supply will be adversely affected by the Gravel Operation.

[67] The Board accepts the evidence put forward by the Applicant that most of the wells on properties within 1000 m of the Property will not be affected by the Gravel Operation because those wells have been drilled into the bedrock.

[68] For the wells that have been drilled into the sandy gravel aquifer and which, therefore, might possibly be affected by the Gravel Operation, the Board is satisfied that the water emergency plan proposed by the Applicant adequately mitigates any negative impact the Gravel Operation will have on the Appellants' well water supply.

[69] Accordingly, this ground of appeal is allowed in part. The Board adds a new condition, Condition #19, to the Development Permit, the details of which are set out above under the heading, "Decision".

(f) Rural Character of the Adjacent Property

[70] The Board is not persuaded that the existence of the Gravel Operation will reduce the amount of wildlife travelling across the property of the #9-2017 Appellants or that the gravel pit will constitute an eyesore. Further, any impact of the gravel pit on the rural character of these Appellants' property will be temporary in nature. This ground of appeal is dismissed.

Property Values

[71] Where a subdivision and development appeal board is called upon to exercise its variance power under section 687(3)(d) of the MGA, an anticipated decrease in property values as a result of the proposed development may be a relevant consideration because in order to decide whether to grant a variance, the board must consider the impact of the proposed development on the value of neighbouring properties. However, no variance from the requirements of the Land Use Bylaw was sought or granted in the Development Permit. In these circumstances, in the Board's opinion, the impact of the Gravel Operation on the value of adjacent properties is not a proper planning consideration or planning objective and, therefore, cannot be considered by the Board. This ground of appeal is dismissed for that reason.

[72] In case the above conclusion is wrong, the Board will say that had it considered the merits of this ground of appeal, this ground of appeal would have been dismissed.

[73] The Board is satisfied that as a matter of common sense, the existence of the Gravel Operation will cause a reduction in the value of nearby properties. However, this situation will be temporary, because the Gravel Operation itself is temporary. The Gravel Operation will exist for a maximum of 10 years. None of the Appellants who spoke to this issue said that they had intended to sell their property sometime in the next 10 years but the existence of the Gravel Operation would prevent that. To the contrary, all of the Appellants

spoke of the number of years they had lived on their properties and their desire to stay on their property.

[74] The Board finds that any drop in property values as a result of the Gravel Operation does not constitute a significant negative impact on any of the Appellants. This ground of appeal is dismissed.

Character of the Applicant

[75] The #9-2017 Appellants argue that the Board can, and should, take into account certain conduct by the Applicant. In this regard, the parties referred the Board to the following decisions of the Alberta Court of Appeal: *Dallinga v. Calgary (City)*, 1975 CarswellAlta 92; *Keephills Aggregate Company Ltd. v. Parkland (County) Subdivision and Development Appeal Board*, 2006 ABCA 372; *Dennis McGinn Holdings Ltd. v. Brazeau (County)*, 2016 ABCA 3.

[76] The cases cited above hold that while the character of the developer is usually an irrelevant consideration in a development appeal, a subdivision and development appeal board may, in limited circumstances, take the character or conduct of the developer into account in deciding a subdivision and development appeal.

[77] In the Board's opinion, a subdivision and development appeal board ought to be cautious about considering evidence of a developer's character or conduct. Generally, the evidence should be considered only if it is relevant to a planning consideration or planning objective which arises in respect of the development which is the subject of the appeal before the board.

[78] In this appeal, the evidence about the Applicant's character and conduct relates to a dispute between these Appellants and the Applicant as to whether there was an agreement between the predecessor developer, Reperio Resources Corp. to buy the Appellants' property and if so, whether that agreement was binding on the Applicant.

[79] This evidence is entirely unrelated to any planning considerations or planning concerns about the Gravel Operation. Accordingly, the Board has disregarded all of this evidence, and dismisses this ground of appeal.

Enforcement of the Conditions of the Development Permit

[80] A number of the Appellants expressed a concern that the Applicant, or its independent contractor truck drivers, would not comply with the conditions of the Development Permit. However, when hearing a development permit appeal, the Board has no jurisdiction (power and authority) to deal with enforcement issues. Therefore, the Board has paid no attention to any evidence provided by the parties on this point, and dismisses this ground of appeal.

Notification of Issuance of the Development Permit

[81] Several of the #8-2017 Appellants were unhappy that they did not receive notice of the issuance of the Development Permit directly from Strathcona County; instead, they were told about the Development Permit by Gerold Fischer. However, this did not prevent these Appellants from filing their Notice of Appeal within the statutorily mandated time frame or from making presentations at the Board's hearing. Further, no one argued that they ought to have received written notice of the Board hearing, but did not. In these circumstances, the Board is of the opinion that whether these Appellants ought to have received notice directly from Strathcona County is a matter between these Appellants and the County, not a matter which falls within the Board's jurisdiction. Therefore, the Board has paid no attention to any evidence provided by the parties on this point and dismisses this ground of appeal.

DATED at Strathcona County, in the Province of Alberta, this 28th day of December, 2017.

SUBDIVISION AND DEVELOPMENT APPEAL BOARD

Gary Peckham, Chair

Pursuant to section 688 of the *Municipal Government Act*, RSA 2000, c M-26, an appeal lies to the Court of Appeal on a question of law or jurisdiction with respect to this decision of the Subdivision and Development Appeal Board.

**APPENDIX "A"**
**List of Submissions**

**Printed materials:**

| Received from: | Submission: |
| --- | --- |
| #8-2017 Appellants | -Notice of Appeal #8-2017 (3 pages)<br>-Notice to Highway 830 Residents (1 page) |
| #9-2017 Appellants | -Notice of Appeal #9-2017 (6 pages)<br>-Written Submissions (489 pages)<br>-Photograph (1 page)<br>-Excerpt from the Strathcona County Agriculture Master Plan (10 pages)<br>-Articles re traffic accidents (4 pages)<br>-Calgary Herald articles (7 pages)<br>-Case Law (14 pages) |
| Development Authority | -Presentation notes dated November 29, 2017 (4 pages)<br>-PowerPoint Presentation (14 pages)<br>-Presentation notes dated December 14, 2017 (4 pages)<br>-Emails regarding the Highway 830/Township Road 550 intersection (4 pages) |
| Applicant | -Written Submissions (184 pages)<br>-Aerial Maps (14 pages)<br>-Letter from Alberta Transportation dated January 31, 2017 (2 pages)<br>-Chart of Sound Levels (1 page)<br>-Bundle of emails (51 pages)<br>-Appraisal (15 pages) |

**Persons who made oral presentations:**

| Name: | Capacity: |
| --- | --- |
| Chris Gow | Development Officer, Strathcona County |
| Kendra Andrew | Development Officer, Strathcona County |
| Karolina Haggerty | Strathcona County |
| Gerold Fischer<br>Steve Galiwoda<br>Tim Schoenleber<br>Chris Theroux | Appellants in #8-2017 |

| | |
|---|---|
| Coralie Mohr | Appellant in #9-2017 |
| Ian Wachowicz | Counsel for the Applicant |
| David Yue, P. Eng.<br>Janelle Willis, P. Eng<br>Peter Wall<br>Brad Davis<br>Ben Gillam<br>Chris Baldwin | Witnesses for the Applicant |

STRATHCONA COUNTY

# Development Permit - Application



Planning and Development Services, 2001 Sherwood Drive, Sherwood Park, Alberta T8A 3W7

**Phone** 780-464-8080 **Fax** 780-464-8142
**email** planninganddevelopment@strathcona.ca

Is Application for a New Home? ☐ Yes ☒ No

If Not, Describe Proposed Development
Continuation of Joburg Aggregates sand and gravel extraction operation within the W 1/2 25 & SW 36-054-22-W4M.

Property Address ______ Subdivision ______

Legal description Lot ______ or Condo Unit ______ Block ______ Plan ______
(if applicable) Quarter ______ Section 25/36 Township 054 Range 22 Meridian 4

**Applicant Name(s)** Joburg Aggregates Ltd. Contact Name Lucas Bodnar
(If different than applicant)

Applicant Address 11610 151 Street NW

| Edmonton | AB | T5M 4E9 |
|---|---|---|
| City | Province | Postal code |
| 780-454-0700 | | lbodnar@gjconstruction.ca |
| Phone number | Alternate phone | email |

**Landowner Name** Please see consent forms Contact Name ______
(If different than applicant) (If different than landowner)

Landowner Address ______

| | | | | |
|---|---|---|---|---|
| City | Province | Postal code | Phone number | Alternate phone |

Notifications regarding your application will be sent by email. Please indicate if you require a paper copy of your Permit.

☒ yes ☐ no If yes, do you want us to: ☐ contact you for pick up ☒ mail it out

I have been informed of the County bylaws, policies and regulations regarding this application. I understand that this permit application may be refused if the proposed development does not conform to all the aspects of the Land Use Bylaw. I am the owner/I have the consent of the owner to proceed with this Development Permit Application and I give consent to allow Council or a person appointed by it the right to enter the land and/or building(s) with respect to this Application only.

______ Signature of authorized applicant(s)

______ Signature of landowner(s)

**Collection and use of personal information**
Personal information is collected under the authority of s. 33 (c) of the *Freedom of Information and Protection of Privacy Act* and will be used in the management and administration of Strathcona County's planning and permitting processes. Information related to your permit application and/or any permit(s) issued may be disclosed as allowed or required by law. If you have any questions about the collection, use or disclosure of your personal information, contact the Coordinator of Development Services, Planning and Development Services, Strathcona County at 780-464-8080.

## For office use only

Roll number ______

Permitted ☐ Discretionary ☐ Land use district ______ Lot area ______ BP applied for ☐

**Fees**

Development ______ Date received ______ Application no. ______
Notification ______ Received by ______ Entered by ______
Total ______ Date entered ______
Receipt no. ______

Comments ______

Completed form to be submitted as part of the Development Permit application to Planning and Development Services. Information provided will be used during the review of the application. Application will be stored in the property file and retained in accordance with the County's documents retention policy. PDS 15510-K 2019-07-25

Landowner Consent

I, Peter Wall, as a representative of **1488098 Alberta Ltd.**, registered landowner of the SW 36-054-22-W4M hereby provide consent to Joburg Aggregates Ltd. to apply for authorization, and conduct the activities as proposed under the *Code of Practice for Pits*, *Water Act* and Strathcona County Land Use Bylaw for the operation and reclamation of the Joburg Pit.

Signed by:

Signature

Peter Wall

Print

Sept 7/2022

Date

Landowner Consent

I, Christopher McEachern, Christopher Alan McEachern, registered landowner of the SW 25-054-22-W4M hereby provide consent to Joburg Aggregates Ltd. to apply for authorization, and conduct the activities as proposed under the *Code of Practice for Pits*, *Water Act* and Strathcona County Land Use Bylaw for the operation and reclamation of the Joburg Pit.

Signed by:

Signature

Christopher McEachern

Print

Sept 9/22

Date

# Appendix C

EPEA Registration No. 395091-00-00

Alberta Environment and Parks

# REGISTRATION
## PROVINCE OF ALBERTA

## ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT
## R.S.A. 2000, c.E-12, as amended

REGISTRATION NO.: **395081-00-00**

APPLICATION NO.: **001-395081**

EFFECTIVE DATE: **December 5, 2017**

REGISTRATION HOLDER: **Joburg Aggregates Ltd.**

**Registration is issued for the following activity:**

The construction, operation and reclamation of a pit located in the NW 25-54-22-W4, SW 36-54-22-W4 and SW 25-054-22 W4M as described in the Activities Plan submitted with the registration application.

Designated Director under the Act ................ Mohammad Habib, P.Eng

Date Signed December 5, 2017

# Appendix D

*Water Act* Approval No. 00286979-00-00 and 00286977-00-00 & *Water Act* Licence No. 00286978-00-00

Alberta Environment and Parks

# APPROVAL
# PROVINCE OF ALBERTA
# WATER ACT, R.S.A. 2000, c. W-3, as amended

APPROVAL NO.: 00286979-00-00

FILE NO.: 00286977

WATERBODY: Wetlands

ACTIVITY LOCATION: SW 25-054-22-W4, NW 25-054-22-W4 and SW 36-054-22-W4

EFFECTIVE DATE: December 5, 2017

EXPIRY DATE: December 1, 2037

APPROVAL HOLDER: Joburg Aggregates Ltd.

Pursuant to the Water Act, R.S.A. 2000, c. W-3, as amended, an Approval is issued to the Approval Holder for the following activity:

placing, constructing, operating, maintaining, removing, disturbing works, in or on any land, water or water body;

maintaining, removing or disturbing ground, vegetation or other material in or on any land, water or water body;

subject to the attached terms and conditions.

Designated Director under the Act: [signature]
Mohammad Habib, P.Eng.

Date Signed: December 5, 2017

## DEFINITIONS

1.0 All definitions from the Act and the Regulations apply except where expressly defined in this Approval.

1.2 In all parts of this Approval:

(a) "Act" means the Water Act, RSA 2000, c. W-3, as amended;

(b) "Director" means an employee of the Government of Alberta designated as a Director under the Act; and

(c) "Regulations" means the regulations, as amended, enacted under the authority of the Act.

## GENERAL

2.0 The Approval Holder shall immediately report to the Director by telephone, any contravention of the terms and conditions of this Approval at (780) 422-4505.

2.1 The terms and conditions of this Approval are severable. If any term or condition of this Approval is held invalid, the application of such term or condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2.2 The Approval Holder shall comply with Alberta Wetland Construction Directive, as amended or replaced from time to time.

2.3 The Approval Holder shall retain a copy of:

(a) this Approval; and

(b) the plan(s)/report(s) referred to in Section 3.1

at the site of the activity at all times while conducting the activity.

## PARTICULARS

3.0 This Approval is appurtenant to the undertaking as described as wetland removal and wetland replacement located at SW 25-054-22-W4, NW 25-054-22-W4 and SW 36-054-22-W4 as shown in report(s) referred to in Section 3.1.

3.1 The Approval Holder shall undertake the activity in accordance with the following plan(s)/report(s):

| TITLE | AEP NUMBER |
|---|---|
| Letter Report: *RE: Water Act Application for Draining and* | 00286979-R001 |

| | |
|---|---|
| *Infilling of Wetlands for the Josephburg Gravel Extraction within Sections: SW 25-54-22-W4, NW 25-54-22-W4 and SW 36-54-22-W4, Strathcona County, Alberta*, dated August 8, 2016, submitted by Sameng Inc. | |
| Update Report: *RE: Water Act Application for Draining and Infilling of Wetlands for the Josephburg Gravel Extraction within Sections: SW 25-54-22-W4, NW 25-54-22-W4 and SW 36-54-22-W4, Strathcona County, Alberta*, dated April 10, 2017, submitted by Sameng Inc. | 00286979-R002 |

3.2 The Approval Holder shall not undertake the activity in any manner or use any material that causes or may cause an adverse effect on the aquatic environment, human health or public safety.

3.3 The Approval Holder shall not release water affected by the activity to any water body unless the quality of water is equal to or better than the quality of water in the receiving water body.

3.4 The Approval Holder shall replace the Wetland 42 described in 00289676-R001 at a 1:1 ratio and include Wetland 42 in the Monitoring Program Proposal required in Section 5.

3.5 The Approval Holder shall not conduct maintenance except for the following:

(a) basic reconstructed wetland maintenance; and

(b) any other maintenance actions authorized in writing by the Director.

3.6 The Approval Holder shall notify the Director in writing, a minimum of 7 days prior to the commencement of each maintenance event.

## SILTATION AND EROSION CONTROL

4.0 The Approval Holder shall minimize:

(a) siltation; and

(b) erosion

of any receiving water body as a result of the activity.

## MONITORING AND REPORTING

5.0 On or before January 1, 2020, the Approval Holder shall submit a Wetland Construction / Reclamation Proposal to the Director.

5.1 If the Wetland Construction / Reclamation Proposal is found deficient by the Director, the Approval Holder shall correct all of the deficiencies:

(a) as specified in writing by the Director; and

(b) within the time specified in writing by the Director.

5.2 The Approval Holder shall implement the Wetland Construction / Reclamation Proposal as authorized in writing by the Director.

5.3 On or before January 1, 2022, the Approval Holder shall submit a Constructed Wetland Monitoring Program Proposal to the Director.

5.4 The Constructed Wetland Monitoring Program Proposal shall include, at a minimum, the following information:

(a) measurable wetland objectives for the constructed mitigation, the rationale for the objectives and proposed timelines to meet these objectives;

(b) a list of parameters to be monitored and the monitoring frequency for each;

(c) a rationale for the proposed Monitoring Program;

(d) a description of water drainage and flow patterns of the constructed wetland;

(e) identification of the boundaries for the Monitoring Program;

(f) a plan showing the location of sampling and monitoring points;

(g) a description of the monitoring, sampling and analytical procedures; and

(h) any other information requested in writing by the Director.

5.5 If the Constructed Wetland Monitoring Program Proposal is found deficient by the Director, the Approval Holder shall correct all of the deficiencies:

(c) as specified in writing by the Director; and

(d) within the time specified in writing by the Director.

5.6 The Approval Holder shall implement the Constructed Wetland Monitoring Program Proposal as authorized in writing by the Director.

5.7 The Approval Holder shall compile an Annual Monitoring Program Summary Report for each calendar year or as authorized in 5.6.

5.8 The Annual Monitoring Program Summary Report shall include, at a minimum, the following information:

(a) the results of the monitoring and sampling as required in the Monitoring Program Proposal;

(b) interpretation of all data collected since the last reporting period, including an assessment of any trends;

(c) an assessment of the progress toward the wetland objectives and timelines to meet these objectives;

(d) any proposed modifications to the Monitoring Program Proposal, including rationale for the modifications; and

(e) any other information requested in writing by the Director.

5.9 The Approval Holder shall submit an Annual Monitoring Program Summary Report to the Director:

(a) on or before February 28$^{th}$ of each year following the calendar year in which the information on which the report is based was collected; or

(b) within a time period specified in writing by the Director.

5.10 The Director reserves the right to:

(a) amend any term or condition of the Approval;

(b) add a term or condition to the Approval; or

(c) delete a term or condition from the Approval,

based on the results of the Annual Monitoring Program Summary Report relating to wetland replacement, conducted by the Approval Holder.

**WETLAND CONSTRUCTION VALIDATION**

6.0 The Approval Holder shall submit a Wetland Construction Validation Report to the Director within 30 business days following the wetland construction activity.

6.1 The Wetland Construction Validation Report shall include, at a minimum, the following information:

(a) validation team roles;

(b) validation assessment; and

(c) validation statement.

**WETLAND CONSTRUCTION MONITORING AND MAINTENANCE**

7.0 After Wetland Construction Validation, the Approval Holder shall compile and undertake a Wetland Construction Monitoring and Maintenance Inspection Report annually.

7.1 The Approval Holder shall undertake vegetation monitoring, at a minimum during the third and fourth year growing season, between June 1 and August 31.

7.2 The Wetland Construction Monitoring and Maintenance Inspection Report shall include, at a minimum, the following information:

(a) record of annual maintenance checks;

(b) photographic evidence of the wetland taken from the same vantage points annually;

(c) annual assessment of wetland class and size;

(d) annual measurement of water levels taken from the same location;

(e) annual inspection of soil indicators;

(f) evidence of wildlife use; and

(g) prescribed vegetation indices and indicators, monitored during the growing season in the third and fourth years post-restoration.

7.3 The Approval Holder shall submit, when requested in writing and within a time period specified by the Director, the annual Wetland Construction Monitoring and Maintenance Inspection Report.

**WETLAND CONSTRUCTION VERIFICATION**

8.0 The Approval Holder shall obtain the services of a qualified wetland professional other than the consultant that assessed the pre-disturbance wetlands to verify and complete the Wetland Construction Verification Report.

8.1 The Approval Holder shall have the wetlands verified four years after wetland restoration is complete unless otherwise authorized in writing by the Director.

8.2 The Approval Holder shall submit a Wetland Construction Verification Report to the Director within 60 business days following the verification assessment.

8.3 The Wetland Construction Verification Report shall include, at a minimum, the following information:

(a) verification team member roles;

(b) monitoring results and analysis;

(c) wetland assessment using the ABWRET-A tool;

(d) verification assessment of replacement success;

(e) verification conclusion; and

(f) replacement plan for any constructed wetland areas that are not verified.

## WETLAND REPLACEMENT

9.0 The Approval Holder shall provide compensation for the loss of wetland if wetland replacement objectives detailed in Monitoring Program Proposal are not met.

## CERTIFICATE OF COMPLETION

10.0 A Certificate of Completion is not required for this activity.

Date Signed: December 5, 2017

Designated Director under the Act
Mohammad Habib, P.Eng.

Alberta Environment and Parks

# APPROVAL
# PROVINCE OF ALBERTA
# WATER ACT, R.S.A. 2000, c. W-3, as amended

APPROVAL NO.: 00286977-00-00

FILE NO.: 00286977

WATERBODY: Water Table

ACTIVITY LOCATION: SW 36- 54-22-W4, NW 25-054-22-W4 and SW 25-054-22-W4

EFFECTIVE DATE: May 14 , 2018

EXPIRY DATE: December 1, 2037

APPROVAL HOLDER: Joburg Aggregates Ltd.

Pursuant to the Water Act, R.S.A. 2000, c. W-3, as amended, an Approval is issued to the Approval Holder for the following activity:

> changing the location of water for the purposes of mining below the water table and dewatering an aggregate extraction site;

subject to the attached terms and conditions.

Designated Director under the Act: Mohammad Habib, P.Eng.

Date Signed: May 14, 2018

## DEFINITIONS

1.0 All definitions from the Act and the Regulations apply except where expressly defined in this Approval.

1.1 In all parts of this Approval:

(a) "Act" means the Water Act, RSA 2000, c. W-3, as amended; and

(b) "Director" means an employee of the Government of Alberta designated as a Director under the Act.

## GENERAL

2.0 The Approval Holder shall immediately report to the Director by telephone, any contravention of the terms and conditions of this Approval at (780) 422-4505.

2.1 The terms and conditions of this Approval are severable. If any term or condition of this Approval is held invalid, the application of such term or condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2.2 The Approval Holder shall retain a copy of:

(a) this Approval; and

(b) the plan(s)/report(s) referred to in Section 3.1

at the site of the activity at all times while conducting the activity.

## PARTICULARS

3.0 This Approval is appurtenant to the undertaking as described as mining below the water table and pit dewatering located at SW 36- 54-22-W4, NW 25-054-22-W4 and SW 25-054-22-W4 as shown in the plan(s)/report(s) referred to in Section 3.1.

3.1 The Approval Holder shall undertake the activity in accordance with the following plan(s)/report(s):

| TITLE | AEP NUMBER |
|---|---|
| Information Request Response Letter *: RE: Off-site Dewatering Application 002-00286977 – Comment Response, including Attachment A – Figures and Attachment B – Updated Groundwater Review Report (HCL), October 2010, revised March 2018*, submitted by Sameng Inc., dated April 16, 2018 | 00286977-R001 |

3.2 The Approval Holder shall not undertake the activity in any manner or use any material that causes or may cause an adverse effect on the aquatic environment, human health or public safety.

3.3 The Approval Holder shall not release water affected by the activity to any water body unless the quality of water is equal to or better than the quality of water in the receiving water body.

3.4 The Approval Holder shall limit the volume of water to be discharged off-site to the Josephburg Water Management Project ditch to 76,500 cubic metres per year.

3.5 The Approval Holder shall measure by meter or pump rate / run time calculations the volume of water discharged off-site to the Josephburg Water Management Project ditch

3.6 The Approval Holder shall compile and retain annual records of the measuring or calculations referred to 3.5 for a period of five years, and supply records to the Director when requested in writing by the Director.

**SILTATION AND EROSION CONTROL**

4.0 The Approval Holder shall minimize:

(a) siltation; and

(b) erosion

of the receiving water body as a result of any offsite dewatering activity.

4.1 The Approval Holder shall:

(a) develop a written Siltation and Erosion Control Plan prior to commencing the activity;

(b) implement the Siltation and Erosion Control Plan; and

(c) retain a copy of the Siltation and Erosion Control Plan at the site of the activity at all times while conducting the activity.

4.2 The Siltation and Erosion Control Plan shall specify measures to minimize and avoid siltation and erosion of the water body and shall include, at a minimum, the following information:

(a) measures to ensure no removal or disturbance of bank vegetation outside the site of the activity;

(b) site preparation practices to be used on erodible soils;

(c) measures for the management of surface and subsurface water flow to minimize siltation and erosion of any water body not authorized for removal;

(d) measures for the stabilization of all disturbed areas until vegetation or other long-term erosion control methods are fully established and functioning; and

(e) measures for the management of excavated material.

**CERTIFICATE OF COMPLETION**

5.0 A Certificate of Completion is not required for this activity.

Date Signed: May 14, 2018

Designated Director under the Act
Mohammad Habib, P.Eng.

Alberta Government

# LICENCE TO DIVERT WATER
# PROVINCE OF ALBERTA
# WATER ACT, R.S.A. 2000, c.W-3, as amended

LICENCE NO.: 00286978-00-00

FILE NO.: 00286977

PRIORITY NO.: 2011-01-25-001

EFFECTIVE DATE: February 27, 2018

EXPIRY DATE: February 26, 2028

SOURCE OF WATER: Groundwater – Recharge Ponds

POINT OF DIVERSION: W 25-054-22-W4, SW 36-054-22-W4

POINT OF USE: Joburg Gravel Extraction Operation – Strathcona County

LICENSEE: Joburg Aggregates Ltd.

Pursuant to the *Water Act*, R.S.A. 2000, c.W-3, as amended, a licence is issued to the Licensee to:

> operate a works and to divert up to 68,000 cubic metres of water annually at a maximum rate of diversion of 0.06 cubic metres per second from the source of water for the purpose(s) of aggregate washing and dust control

subject to the attached terms and conditions.

Acting Designated Director under the Act: Andrew Potter
Mohammad Habib, P. Eng.

Date Signed: February 27, 2018



200506-02

**DEFINITIONS**

1.0 All definitions from the Act and the Regulations apply except where expressly defined in this licence.

1.1 In all parts of this licence:

(a) "Act" means the Water Act, RSA 2000, c. W-3, as amended;

(b) "Application" means the written submissions to the Director in respect of application number 001-00286978 and any subsequent applications for amendments of Licence No. 00286978-00-00;

(c) "Director" means an employee of the Government of Alberta designated as a Director under the Act;

(d) "Point(s) of diversion" means the location(s) where water is diverted from the source of water;

(e) "Point of use" means the location(s) in which the diverted water is used by the Licensee for the licenced purpose;

(f) "Regulations" means the regulations, as amended, enacted under the authority of the Act; and

(g) "Water Use Reporting System" means the secure internet website provided by Alberta Environment and Parks http://wurs.alberta.ca for submitting measuring and monitoring results electronically to the Director.

**GENERAL**

2.0 The Licensee shall immediately report to the Director by telephone any contravention of the terms and conditions of this licence at 1-780-422-4505.

2.1 The terms and conditions of this licence are severable. If any term or condition of this licence is held invalid, the application of such term or condition to other circumstances and the remainder of this licence shall not be affected thereby.

2.2 The Licensee shall not deposit or cause to be deposited any substance in, on or around the source of water that has or may have the potential to adversely affect the source of water.

2.3 Within six months after permanently ceasing operation of the works or diversion of the water, the licensee shall submit an application to the Director for the decommissioning of the works.

2.4 The Licensee shall comply with the terms and conditions of the "Water Use Reporting System User Consent".

## DIVERSION OF WATER

3.0 This licence is appurtenant to the following:

(a) W 25-054-22-W4, SW 36-054-22-W4; and

(b) the Joburg Gravel Extraction Operation washing facility, internal haul roads and Range Road 221.

3.1 The Licensee shall divert water only for the purpose(s) specified in this licence.

3.2 The Licensee shall divert water only from the source of water specified in this licence.

3.3 The Licensee shall divert water only from the following point(s) of diversion:

(a) W 25-054-22-W4, SW 36-054-22-W4.

3.4 The works used to divert the water authorized by this licence shall include, at a minimum, all of the following:

(a) the washing and dust control activities referred to in the 00286978-R001 "*Josephburg Gravel Extraction Operation Phase 1 – Pit Registration, Water Act Approval and Development Permit Applications*" dated January 2011 submitted with the Application;

3.5 The Licensee shall not divert more than 68,000 cubic metres of water per calendar year.

3.6 The Licensee shall not divert water at a rate of diversion greater than 0.06 cubic metres per second.

3.7 Prior to diverting any water from the source of water, the Licensee shall equip the works with a meter or other method, which measures:

(a) cumulatively, the quantity of all water diverted.

3.8 The Licensee shall recirculate the wash water through the washing facility and dewatering ponds.

3.9 The Director may amend this licence to establish or change the water level requirement upon a minimum of 12 months written notice to the Licensee.

## MONITORING AND REPORTING

4.0 Unless otherwise authorized in writing by the Director, the Licensee shall:

(a) measure the total volume of water diverted each month using the meter or other method specified in 3.7(a); and

(b) measure the total volume of water returned to the source of water or recharge area.

4.1 The Licensee shall record and retain all of the following information for a minimum of 5 years after being collected:

(a) the place, date and time of all monitoring and measuring;

(b) the results obtained pursuant to 4.0; and

(c) the name of the individual who conducted the monitoring, measuring and sampling stipulated in (a) and (b).

4.2 The Licensee shall report to the Director the results of the measuring and monitoring required in 4.0 (a) using the "Water Use Reporting System" and any other information required in writing by the Director.

4.3 The Licensee shall submit the report required in 4.2 annually on or before the end of February following the calendar year in which the information is based upon was collected.

## COMPLAINT INVESTIGATION

5.0 The Licensee shall:

(a) investigate all written complaints accepted by the Director relating to allegations of surface water and groundwater interference as a result of the diversion of the water or operation of the works; and

(b) provide a written report to the Director, within a time specified in writing by the Director, detailing the results of the investigation relating to the complaint accepted by the Director in 5.0(a).

5.1 The Licensee shall satisfy the Director that the report submitted pursuant to 5.0(b) has identified remedial and/or mitigative measures relating to the alleged interference.

Date Signed: February 27, 2018

Andrew Patton

Acting Designated Director under the Act
~~Mohammad Habib, P.Eng.~~

# Appendix E

*Historical Resources Act* Letter of Clearance

**Government of Alberta**
Culture and Community Spirit

RECEIVED 20 Sept/10

**Historic Resources Management**
Old St. Stephen's College
8820 – 112 Street
Edmonton, Alberta T6G 2P8
Canada
Telephone: 780-431-2300
www.culture.alberta.ca/hrm

September 14, 2010

Project File: 4650-10-045

Mr. Dan Ward
Sameng Inc.
1500 Baker Centre, 10025 – 106th Street
Edmonton, Alberta
T5J 1G3

Dear Mr. Ward:

**SUBJECT:** REPERIO RESOURCES
PROPOSED BORROW SOURCE – PART SECTIONS 25, 26, 36-54-22-W4M
*HISTORICAL RESOURCES ACT* REQUIREMENTS

Thank you for providing staff of the Historic Resources Management Branch of Alberta Culture and Community Spirit with information regarding the captioned proposed borrow source.

Ministry staff have reviewed the potential for this project to impact historic resources and have concluded that an Historic Resources Impact Assessment is not required. Therefore Reperio Resources has *Historical Resources Act* clearance for this project as outlined in the provided information package.

## *HISTORICAL RESOURCES ACT* REQUIREMENTS

**Reporting the discovery of historic resources:** Pursuant to Section 31 of the *Historical Resources Act*, should any archaeological resources, palaeontological resources, Aboriginal traditional use sites, and/or historic period sites be encountered during land disturbance activities, the Historic Resources Management Branch must be contacted immediately. It may then be necessary to issue further instructions regarding the management of these resources. In particular, gravel pit operations have proven to be a major source of Quaternary palaeontological remains (horses, mammoths, bison, camels etc.) on a province-wide basis. Dr. Chris Jass of the Royal Alberta Museum (780-453-9127) is to be contacted immediately should any bones be discovered during the operation of this pit.

Should you require additional information or have any questions concerning the above, please contact me at 780-431-2330 or by e-mail at barry.newton@gov.ab.ca.

On behalf of the Historic Resources Management Branch, I would like to thank you and officials of Reperio Resources for your cooperation in our endeavour to conserve Alberta's past.

Sincerely,

Barry Newton
Land Use Planner

cc: Dr. Chris Jass, Royal Alberta Museum

# Appendix F

Pipeline Proximity Agreements

Inter pipeline

Faxed to:780--482-2538

August 16, 2012

Reperio Resources Corporation
C/o Sameng Inc.
1500 Baker Centre, 10025 - 106 Street
Edmonton, AB T5J 1G3

**Attention: Dan Ward**

**Re:** **Acknowledgement - Notification of Proposed Activity within 30m, W-25, W-36-54-22-W4M**
**Our Agreement No.: 2012-165-GDN**
**Our File No.: CP0749, CP0750, CP0747, CP0748, CPX**
**Your File: 1025**

Further to your notification of a ground disturbance, the following conditions are to be observed regarding the proposed activity within 30 metres on either side of a high pressure crude oil/condensate pipeline(s) held by Inter Pipeline (Corridor) Inc. (hereinafter referred to as 'GRANTOR'), by the proposed construction of Reperio Resources Corporation (hereinafter referred to as the 'GRANTEE') as shown on the attached Schedule "A".

1. GRANTOR's Crossing Inspector must be notified at least 2 days and not more than 10 days, excluding Saturdays, Sundays and holidays, prior to commencement of any ground disturbance within 30 metres of GRANTOR's pipeline. The Crossing Inspector may be contacted for notification as follows:

   Crossing Inspector – Ron Moen
   Sherwood Park, AB
   Phone: 780-449-2206/780-903-6720
   **Emergency Number: 1-800-721-6761**

2. The GRANTEE shall call Alberta One-Call at 1-800-242-3447 or *3447 on cellular, for the further protection of any other facilities in the area.

3. The GRANTOR's line(s) must be located and flagged prior to commencing a ground disturbance within 30 metres of the GRANTOR's pipeline. A GRANTOR representative will be made available to accurately locate on the surface of the ground the horizontal position and alignment of the pipeline and mark the surface position and alignment with signs and markers at appropriate intervals.

4. No mechanical excavation may be undertaken within five (5) metres of the GRANTOR's pipeline without the express written consent from the GRANTOR.

5. GRANTOR's representative shall be notified and on site, during the proposed ground disturbance to observe the on site work. The GRANTEE shall remedy any areas of deficiencies resulting from this work that may impact the GRANTOR's pipeline. The GRANTEE will comply with any reasonable conditions imposed by the GRANTOR's representative.

Suite 2600, 237-4th Avenue S.W. Calgary, Alberta T2P 4K3 Phone: (403) 290-6051 Fax: (403) 290-6095

6. The GRANTOR's right of way shall not be utilized for construction access, to store vehicles, supplies or equipment or for storage of excavated soils and rocks without written consent from the GRANTOR.

7. The GRANTEE shall not dispose of any materials on the GRANTOR's right of way that may have been involved with or resulted from their proposed activity including but not limited to tailings, soil, sewage, construction materials or any other miscellaneous debris.

8. The GRANTEE will indemnify and save the GRANTOR harmless from and against all loss, costs, charges, damages and expenses which the GRANTOR may suffer or sustain as a result of the operations of the GRANTEE, provided such loss, costs, charges, damages or expenses are not the result of any willful act, omission or negligence of the GRANTOR, its employees or agents.

9. The attached plan shows the location of the construction site relative to the GRANTOR's right-of-way. The GRANTEE shall advise the GRANTOR in writing of any changes to this arrangement.

A copy of this letter must be on site at all times during the ground disturbance near the GRANTOR's right-of-way.

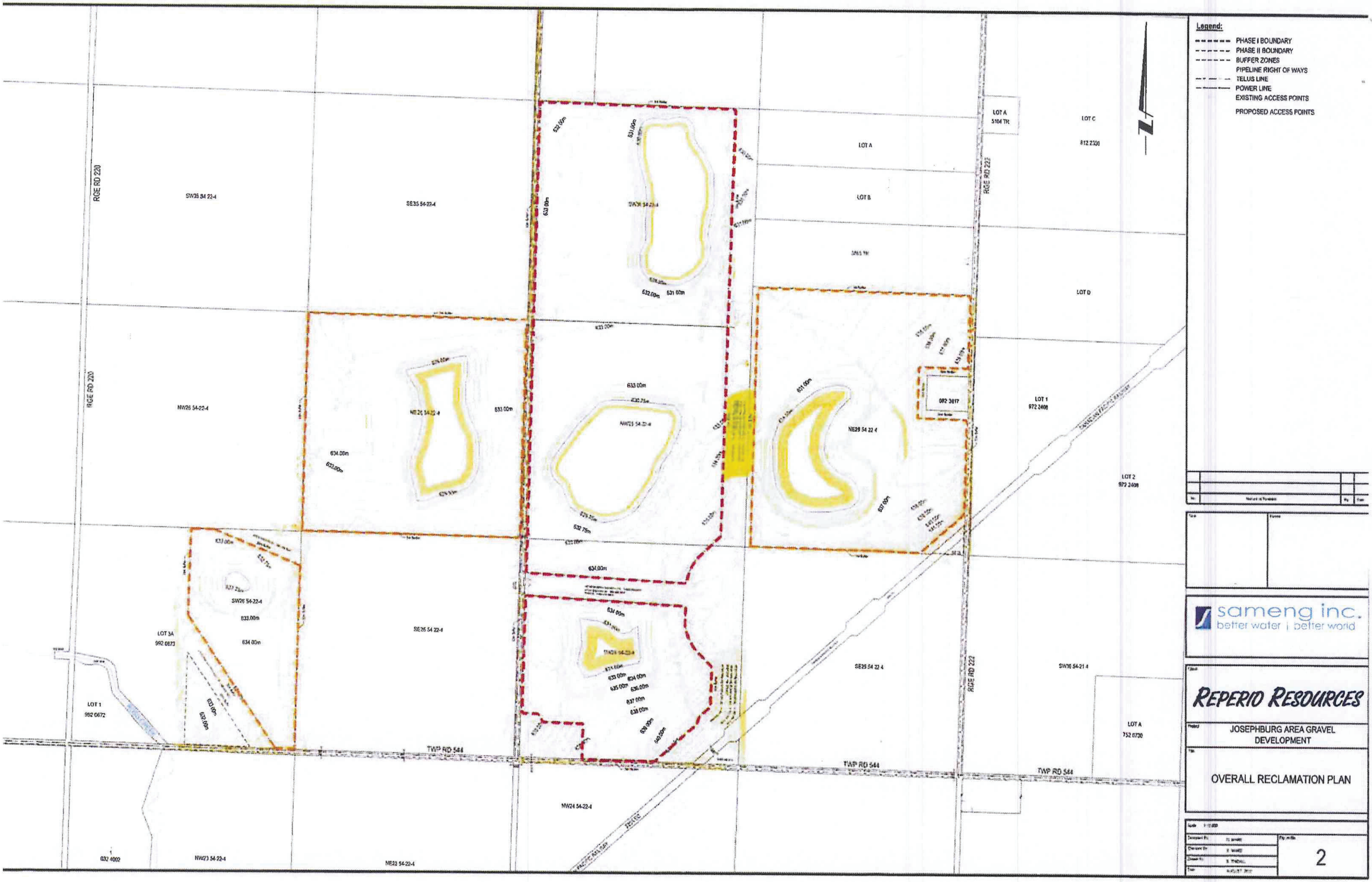
Should you have any questions, please contact Cheryl Ireland at cireland@interpipelinefund.com or 290-6160.

Yours truly,

**Inter Pipeline (Corridor) Inc.**

Cheryl Ireland
Land Administrator

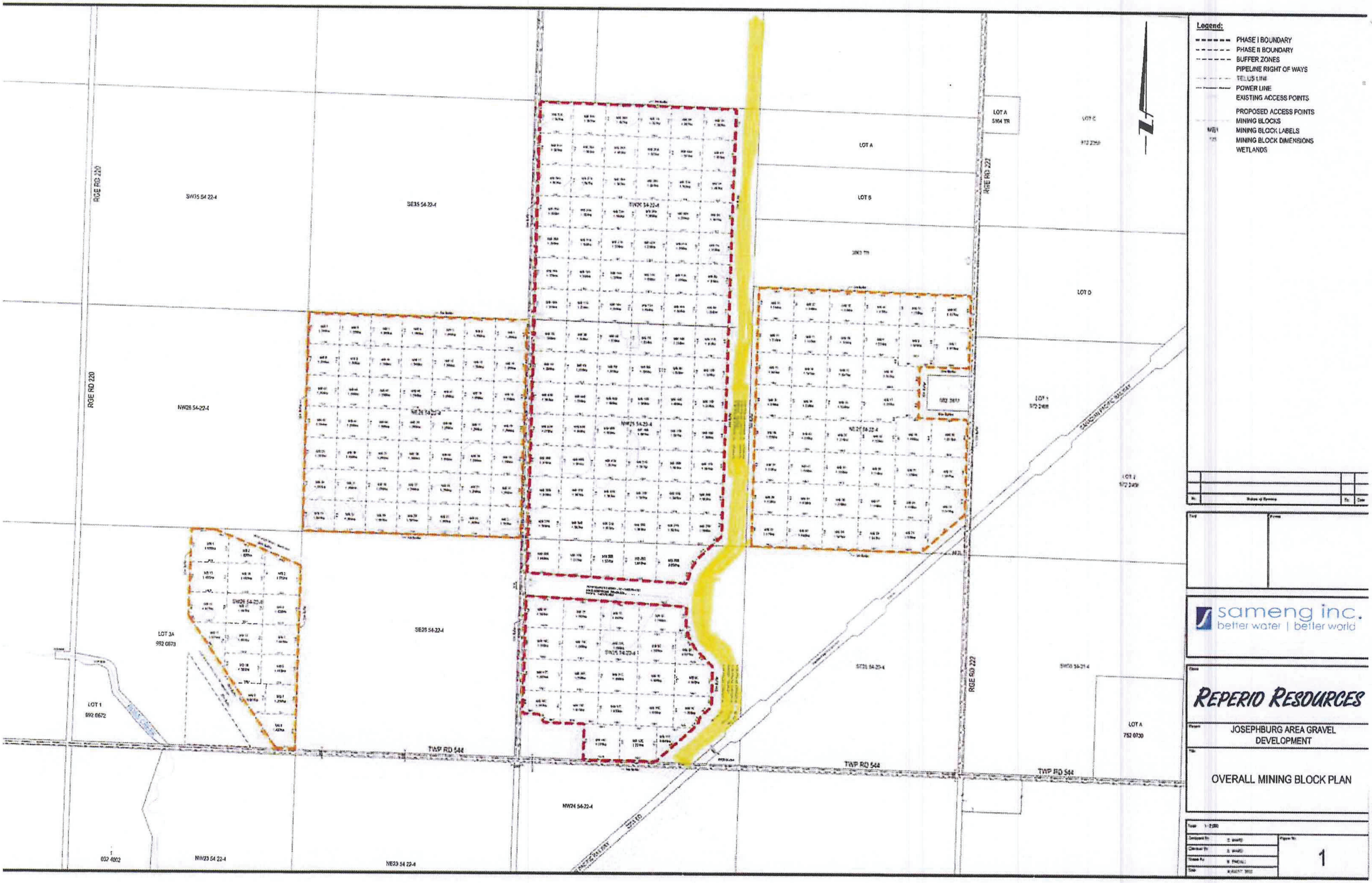
Attachment



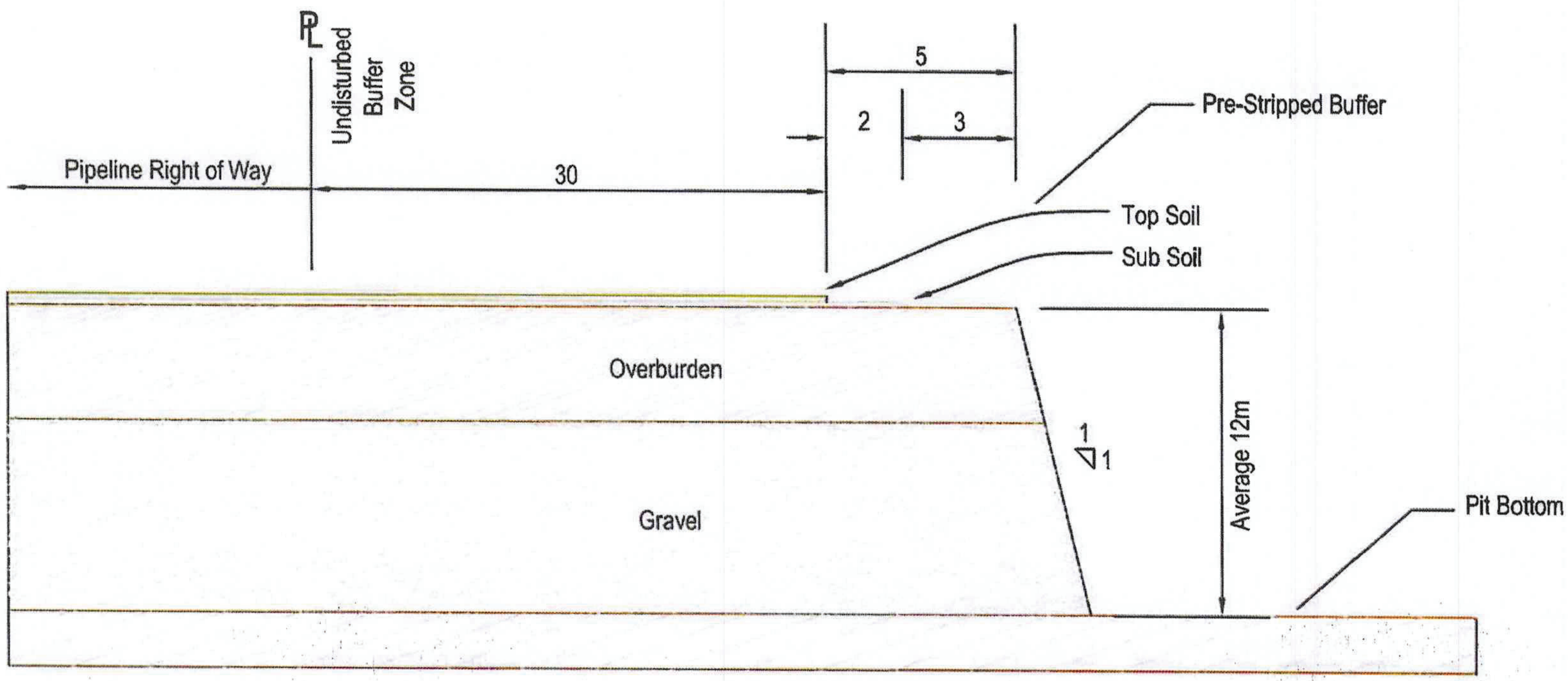

SCHEDULE "A"

PAGE 1 OF 3

FILE # 2012-165 GDN




SCHEDULE "A"
PAGE 2 OF 3
FILE # 2012-165-LDR




TYPICAL CROSS-SECTION

SCHEDULE "A"
PAGE 3 OF 3
FILE # 2014-165-GOW

sameng inc.
better water | better world

REPERIO RESOURCES

JOSEPHBURG AREA GRAVEL DEVELOPMENT

TYPICAL CROSS-SECTION

| | |
|---|---|
| Designed By | D WARD |
| Checked By | D WARD |
| Drawn By | D TINDALL |
| Date | AUGUST 2012 |

Figure No. 3

PETROBAKKEN

A PETROBANK COMPANY

August 31, 2010

**SAM ENGINEERING**

**ATTENTION: Kevin MacTaggart**

Dear Sir:

RE: Pipeline Ownership – NE 25, SE 36-54-22 W4M
Our File: E06897(T)

---

Further to your query on the ownership of the above noted lands, please accept this letter to confirm the Tri-Star Oil & Gas line was never built.

Should you require anything further, please contact the undersigned at (403) 213-2899.

Yours very truly,

**PETROBAKKEN ENERGY LTD.**

Karen Hickey

Karen Hickey
Consulting - Surface Land Coordinator

/kh
Encls.

ACCESS PIPELINE

RECEIVED 1 May 13

Kristina Koch
*HMA Land Services Ltd.*
Suite 100, 7710 – 5th Street SE
Calgary Alberta T2H 2J9
Phone: (403) 692-0850 Fax: (403) 252-0716

# Transmittal Letter

**Date: April 30, 2013**

| | | | |
|---|---|---|---|
| **To:** | Dan Ward | **From:** | Kristina Koch |
| **Company:** | Heartland Aggregates Corp<br>1990, 10020 – 101A Avenue<br>Edmonton, Alberta T5J 3G2 | **HMA File No:** | 07-1621 (2012-2467) |
| **CC:** | | **File No:** | -- |

**RE: HEARTLAND AGGREGATES CORP.**

**ENCLOSED PLEASE FIND:**

| | | | |
|---|---|---|---|
| ☐ | Crossing Agreement | Copies | |
| ☐ | Road Use Agreement | Copies | |
| ☒ | Proximity Consent | Copies | 1 |
| ☐ | Other (Specify): | Copies | |

**ACTION REQUIRED:**

| | | | | | |
|---|---|---|---|---|---|
| ☐ | Comment | ☐ | As Per Your Request | ☐ | Execute and Return |
| ☐ | Further Handling | ☒ | For Your Files | | |
| ☐ | Other (Specify): | | | | |

**COMMENTS:**

Hi Dan,
Please find attached fully executed agreement(s) as noted above for your files.

If you have any questions please feel free to contact me at (403) 287-6802 direct.

Thank you,
Kristina Koch
(403) 692-0850 (main)
kkoch@hmaland.com

ACCESS PIPELINE

April 19, 2013

**Heartland Aggregates Corp.**
1990, 10020 - 101A Avenue
Edmonton, Alberta T5J 3G2

Access-2012-2467

**Attention: Dan Ward**
c/o Sameng Inc.

**RE:** **Access Pipeline Inc. Licence/Line # 46674-12**
**Proximity within 100 m of Pipeline**
**Proposed Josephburg Gravel Extraction Operation**
**Location(s): W½25-054-22W4M & SW36-054-22W4M**
**Your File: 1025**
**Our File: 07-1621 (2012-2467)**

---

Access Pipeline Inc. ("ACCESS") acknowledges receipt of your letter dated August 2, 2012 advising of your proposed Gravel Extraction Operation within Proximity to our facilities at the above-mentioned location as shown on the attached Schedules "B".

At least seventy-two (72) hours notice is to be given to Access by telephone to determine whether a representative is to be on site prior to the commencement of any construction.

> **The telephone notice is to be directed to our Primary Field Representative, Geoff MacKay at (780) 278-8995 or by email at gmackay@accesspipeline.com. An alternate contact is our main office (780) 997-4040.**

Please ensure an Alberta One-Call is completed prior to the commencement of your construction.

No construction shall commence until Access's representative has issued a Controlled Area Access Agreement and has located and marked Access's pipeline and right-of-way, if required. The use of equipment and trucks in the Access right-of-way is not permitted.

This acknowledgement does not grant permission to utilize any portion of Access's right-of-way. In the event that you will be entering on Access's right-of-way for any reason, approval must be obtained by forwarding plan and details to my attention. A formal agreement must be in place **prior to** such entry.

As part of this agreement, attached are Access' specific terms and conditions on the attached Schedule "A".

Thank you for your co-operation.

Yours truly,

**ACCESS PIPELINE INC.**

Per: ______________________
Kurt Roebuck,
Superintendent, Pipeline Ops.

**Schedule "A"**
Attached to Proximity Agreement

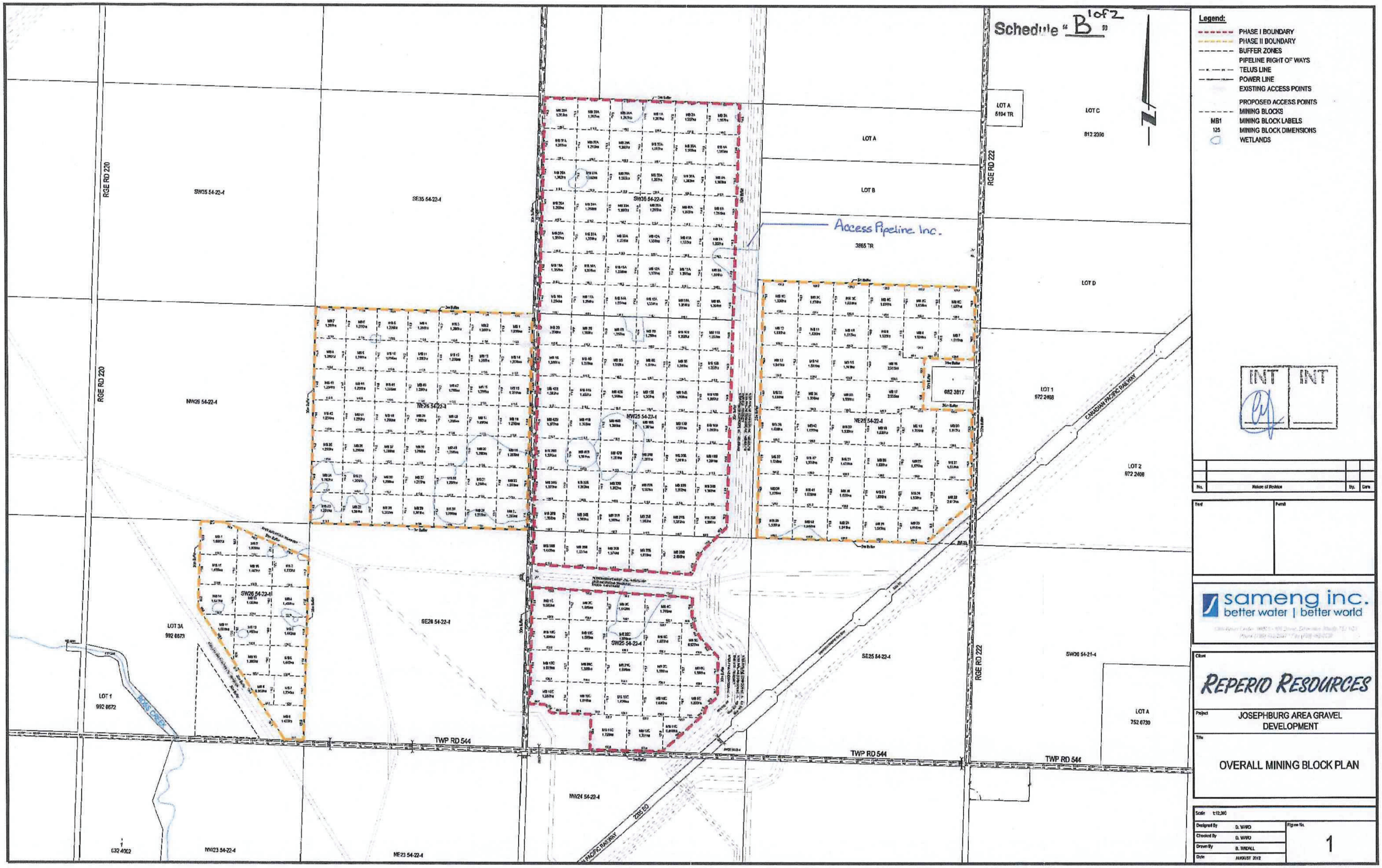
Between

**Access Pipeline Inc**. (Grantor)

And **Heartland Aggregates Corp.** (Grantee)

and dated the 19th day of April, 2013.

1. The Access Pipeline ROW edge must be staked by Grantee.
2. All pipeline and ROW stakes must be maintained throughout the job.
3. Grantee will require a weekly "Controlled Access Agreement" from the Access Representative.
4. Temporary Fencing may be required at the discretion of the Access Representative
5. Additional requirements may be requested by the Access Representative.
6. No equipment storage or travel is permitted on the Access Pipeline ROW without written permission.


Schedule "B" 1 of 2
Legend:
PHASE I BOUNDARY
PHASE II BOUNDARY
BUFFER ZONES
PIPELINE RIGHT OF WAYS
TELUS LINE
POWER LINE
EXISTING ACCESS POINTS
PROPOSED ACCESS POINTS
MINING BLOCKS
MB1 MINING BLOCK LABELS
125 MINING BLOCK DIMENSIONS
WETLANDS
Access Pipeline Inc.
INT
INT
sameng inc.
better water | better world
REPERIO RESOURCES
JOSEPHBURG AREA GRAVEL DEVELOPMENT
OVERALL MINING BLOCK PLAN
Scale 1:12,360
Designed By D. WARD
Checked By D. WARD
Drawn By B. TRENDALL
Date AUGUST 2012
1
RGE RD 220
RGE RD 222
TWP RD 544
CANADIAN PACIFIC RAILWAY
SW35 54-22-4
SE35 54-22-4
SW36 54-22-4
NW26 54-22-4
NE26 54-22-4
NW25 54-22-4
NE25 54-22-4
SW26 54-22-4
SE26 54-22-4
SW25 54-22-4
SE25 54-22-4
SW30 54-21-4
NW24 54-22-4
NW23 54-22-4
NE23 54-22-4
LOT A 5104 TR
LOT C 812 2350
LOT A
LOT B
3865 TR
LOT D
LOT 1 972 2468
LOT 2 972 2468
082 3817
LOT 3A 992 0873
LOT 1 992 0872
LOT A 752 0730
ROSS CREEK


Schedule "B" 2 of 2
Legend:
PHASE I BOUNDARY
PHASE II BOUNDARY
BUFFER ZONES
PIPELINE RIGHT OF WAYS
TELUS LINE
POWER LINE
EXISTING ACCESS POINTS
PROPOSED ACCESS POINTS
RGE RD 220
RGE RD 222
TWP RD 544
SW35 54-22-4
SE35 54-22-4
SW36 54-22-4
NW26 54-22-4
NE26 54-22-4
NW25 54-22-4
NE25 54-22-4
SW26 54-22-4
SE26 54-22-4
SW25 54-22-4
SE25 54-22-4
NW24 54-22-4
NW23 54-22-4
NE23 54-22-4
SW30 54-21-4
LOT A
LOT B
3865 TR
LOT A 5164 TR
LOT C 812 2350
LOT D
LOT 1 972 2408
LOT 2 972 2408
082 3817
LOT A 752 0730
LOT 3A 992 0673
LOT 1 992 0672
032 4002
CANADIAN PACIFIC RAILWAY
ROSS CREEK
INT
INT
sameng inc.
better water | better world
REPERIO RESOURCES
JOSEPHBURG AREA GRAVEL DEVELOPMENT
OVERALL RECLAMATION PLAN
D. WARD
D. WARD
AUGUST 2012
2

## Dan Ward

| | |
|---|---|
| **From:** | crossing requests <crossingrequests@enbridge.com> |
| **Sent:** | December-17-12 9:31 AM |
| **To:** | crossing requests; Leanne Dunnigan |
| **Cc:** | Dan Ward |
| **Subject:** | RE: Followup - Heartland Aggregates Corp. - Sameng Inc. File #: 1025 REVISED |

Good Morning,

Further to Dan Ward's letter of December 4, 2012, I have revised my email below to reflect the new company name from Reperio Resources Corp. to Heartland Aggregates Corp.

Trusting this is satisfactory.

Thank you,

Suzanne Cavers
Enbridge Pipelines Inc.
(780) 420-5164

---

**From:** crossing requests
**Sent:** Tuesday, October 02, 2012 3:00 PM
**To:** Leanne Dunnigan; Rauno Silvennoinen
**Cc:** Dan Ward; crossing requests
**Subject:** RE: Followup - Reperio Resources Ltd - Sameng Inc. File #: 1025

Hi Leanne,

Enbridge Application #: 458

Further to Sameng Inc.'s request letter dated August 2, 2012 with respect to Heartland Aggregates Corp. Application No. 001-286-699 - Proposed Josephburg Gravel Extraction Operation (Proposed Operation) in land sections: N½ 25 Part of SW 25, NE 26 Part of SW 26, SW 36 & Part of SE 36-54-22-W4M, this is to advise that Enbridge Pipelines (Athabasca) Inc. has no issues to the proposed operation as it is in excess of 30m away from Enbridge's pipeline boundary. Please provide notice to Alberta One Call at 1-800-242-3447.

Thank you,
Suzanne

Suzanne Cavers
Crossings Coordinator
Lands & Right-of-Way Operations
Enbridge Pipelines Inc.
Bus. 780-420-5164
Fax. 780-392-4120
suzanne.cavers@enbridge.com

ENBRIDGE
Where energy meets people

**From:** Leanne Dunnigan [mailto:leanne.dunnigan@sameng.com]
**Sent:** Wednesday, September 26, 2012 12:38 PM
**To:** Rauno Silvennoinen
**Cc:** Dan Ward
**Subject:** Followup - Reperio Resources Ltd

Further to our telephone message of Sept 24, 2012, attached please find a copy of the letter and documents mailed to you on August 2, 2012. As we have yet to receive a response from your company, we would like to follow-up with you.

Should you have any questions or require further information, please do not hesitate to contact Dan Ward at (780) 482-2557 or by e-mail: dan.ward@sameng.com.

We look forward to receiving your written approval.

Yours truly,

Leanne Dunnigan
Administrative Assistant
Sameng Inc
780-482-2557

## Dan Ward

| | |
|---|---|
| **From:** | Morgan Alexander <malexander@accesspipeline.com> |
| **Sent:** | September-26-12 1:16 PM |
| **To:** | Leanne Dunnigan |
| **Cc:** | Dan Ward; Rob Leeson; Molly Kendel |
| **Subject:** | RE: Followup - Reperio Resources |

Hello:

Access Pipeline is currently evaluating any risk to our pipelines integrity based on the proposed excavation. We will be responding once the risk assessment is complete.

Thanks

ACCESS PIPELINE

Morgan Alexander
Access Pipeline Inc.
Pipeliner
Office:(780) 997-4063
Cell:(780) 991-0582
Fax:(780) 997-2394
Email: malexander@accesspipeline.com



---

**From:** Leanne Dunnigan [mailto:leanne.dunnigan@sameng.com]
**Sent:** September-26-12 12:38 PM
**To:** Morgan Alexander
**Cc:** Dan Ward
**Subject:** Followup - Reperio Resources

Further to our telephone message of Sept 24, 2012, attached please find a copy of the letter and documents mailed to you on August 3, 2012. As we have yet to receive a response from your company, we would like to follow-up with you.

Should you have any questions or require further information, please do not hesitate to contact Dan Ward at (780) 482-2557 or by e-mail: dan.ward@sameng.com.

We look forward to receiving your written approval.

Yours truly,

Leanne Dunnigan
Administrative Assistant
Sameng Inc
780-482-2557

# Appendix G

Hydrogeological Consultants Ltd. (HCL) Groundwater Review

# Groundwater Review

Gravel Development for Joburg Aggregates Ltd.
Tp 054 and 055, R 21 and 22, W4M

Prepared for
Sameng Inc.

The HCL Project No. 10-0351.00 report was originally finalized in October 2010, and subsequently revised in December 2012.
At the request of AEP, the HCL Project No. 10-0351.00 report was revised in March 2018 to reference Joburg Aggregates Ltd. throughout.

Prepared by
hydrogeological consultants ltd. **(HCL)**
1.800.661.7972
HCL Project No.: 10-0351.00

October 2010
(Revised March 2018)

**PERMIT TO PRACTICE**
HYDROGEOLOGICAL CONSULTANTS LTD.
Signature____________________
Date____________________
**PERMIT NUMBER P 385**
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

# TABLE OF CONTENTS

# Executive Summary

Joburg Aggregates Ltd. (Joburg) intends to develop lands in Strathcona County for gravel extraction. The proposed development site comprises parts of seven quarter sections approximately four kilometres southwest of the Hamlet of Josephburg.

The proposed gravel mining operation will involve dewatering of pits in order to extract gravel below the water table. The groundwater that is removed from the pits as part of the dewatering operation will be used for gravel washing. Any excess groundwater will flow back into the gravel aquifer through recharge pits. The present Groundwater Review has been prepared to review current shallow hydrogeological conditions, and determine possible impacts to the local hydrogeological setting resulting from the proposed mining operation.

Dewatering of the gravel from a typical pit to allow for the mining of the gravel will require in the order of 900 to 4,500 m³/day of groundwater to be removed from the aquifer. As part of this transferring of groundwater, it is estimated that up to 288 m³/day of the groundwater that is pumped from dewatering pits will be lost to evaporation and adhesion, with the remainder of the groundwater returned to the aquifer via recharge ponds; this net loss of 288 m³/day of groundwater will not have an adverse effect on the aquifer or any nearby water wells.

Recharge ponds may not be able to contain the volumes of water being removed from extraction pits in the short-term, and it may be necessary to construct alternate solutions for groundwater containment and diversion. These solutions may include having more than one recharge pond, creating bermed recharge ponds, situating the recharge ponds on topographically high areas downgradient from extraction sites, using recharge wells, or allowing overflow from recharge pits into a surface drainage channel. Joburg intends to divert any excess groundwater into the Josephburg Water Management Project.

At the site of the proposed development, the groundwater flow is from the southeast to the northwest. Once the sand and gravel aquifer is removed and replaced with a minimum one-metre-thick layer of sand material, groundwater flow through the area may be reduced, which may result in the mounding of groundwater upgradient from the mined area. However, mounding is not expected to cause any adverse effects outside the development area.

As part of the proposed development, a meaningful groundwater monitoring program is necessary to ensure that the impact of the groundwater diversions does not pose undo risk to the groundwater from local water wells or to the local hydrogeology. Also, there is a need to provide local water well users with an assurance that Joburg will accept responsibility for any negative impacts to their groundwater supplies as a result of their operations, should they occur.

An operator wishing to proceed with a proposed gravel-washing operation requires an Approval under the *Water Act.*; this report would provide technical support for a groundwater Licence application.

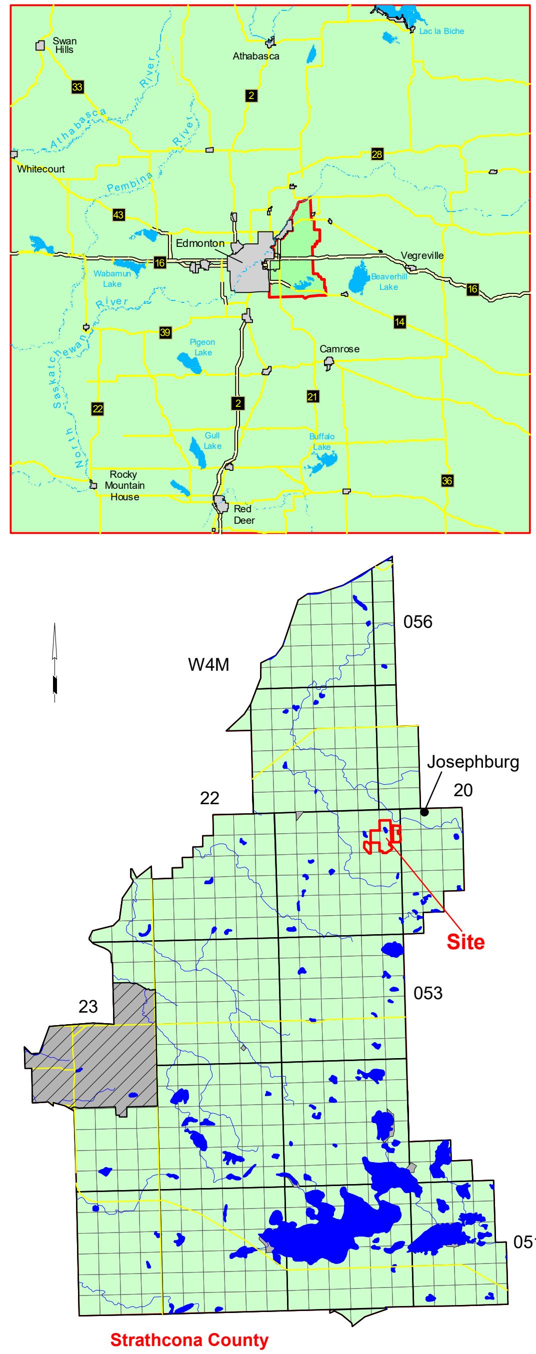
# 1. Introduction

## 1.1. Purpose

Joburg Aggregates Ltd. (Joburg) intends to develop lands in Strathcona County (the County) for gravel extraction. The proposed development site comprises parts of seven quarter sections approximately two kilometres southwest of the Hamlet of Josephburg, as shown in the adjacent index map.

The proposed gravel mining operation will involve dewatering of pits in order to extract gravel below the water table. A small amount of the groundwater that is removed from the pits as part of the dewatering operation will be used for gravel washing, as part of a groundwater management plan integrated with the proposed mining operation. Any excess groundwater is intended to flow back into the gravel aquifer through recharge ponds.

As a result of the proposed mining operation, there will be changes to the local hydrogeological setting. Sameng Inc. (Sameng) has retained the services of Hydrogeological Consultants Ltd. (HCL) to review the available hydrogeological data and to initiate a groundwater program that would allow for an on-going analysis of the effects that the proposed operation may have on the local hydrogeology.




*Index Maps*

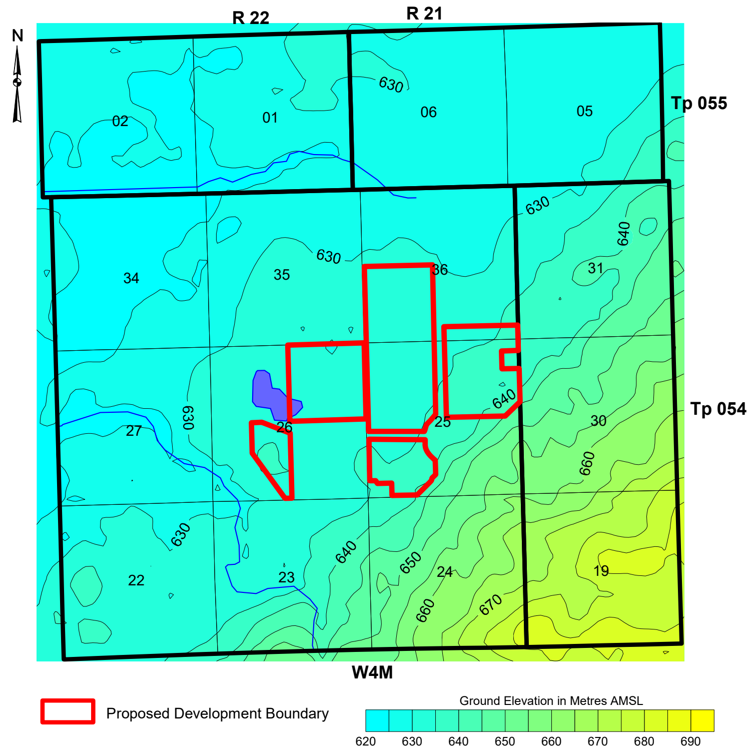
## 1.2. Scope

The present groundwater review includes the following:

- An estimate of the extent of the sand or gravel aquifer that is to be developed
- An estimate of the direction and quantity of groundwater flowing through the sand or gravel aquifer
- An estimate of the quantity of groundwater needed to dewater extraction pits
- An estimate of the change in water level as a result of the proposed activities
- An estimate of the impact the proposed development will have on the water wells in the review area.

Any calculated water levels will be based on a 2D analytical model where boundary conditions are represented by image water wells.

The area of study (AOS) for the present program is the 16-section area shown in the adjacent map. The area of interest (AOI) is the area within 1,000 metres of the boundary of the proposed development area.




***AOS and Topography***

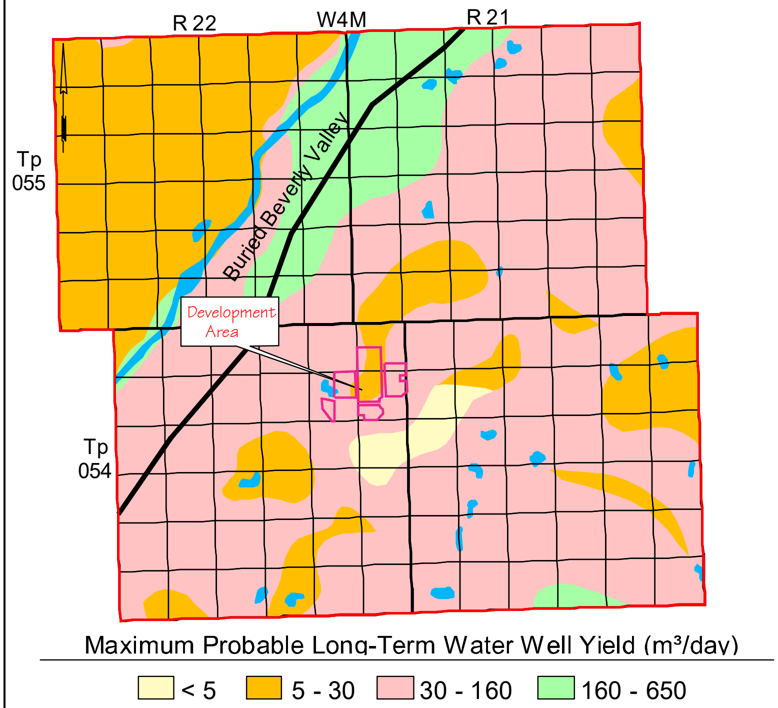
## 2. Background

### 2.1. Physiography

The AOS lies along the western edge of the Eastern Alberta Plains. The ground surface at the location of the proposed development is generally flat-lying at an elevation of approximately 630 to 643 metres above mean sea level (AMSL), and is located at the base of a northeasterly-trending topographic high. The AOS is underlain by varying thicknesses of till deposited by the Wisconsin ice sheet resulting in flat to gently undulating topography in the south and southeastern parts of the AOS and moderately developed hummocky topography in the north and northeastern parts of the AOS (Shetsen, 1990).

The AOS is in the “long, cool summer” Koeppen zone, with mean temperatures of approximately minus 14 °C in January, and plus 17°C in July. The mean annual precipitation is approximately 480 millimetres.

## 2.2. General Hydrogeology




***Hydrogeological Map***
***[after Stein, 1976]***

Surficial deposits in the AOS are primarily composed of till, which contains approximately equal proportions of sand, silt and clay, but generally contains less than ten percent gravel (Bayrock, 1972). Gravels and sands deposited along buried valleys are labelled Saskatchewan gravels and sands. The major buried channel in the study area is the Buried Beverly Valley, which is roughly coincident with the present-day North Saskatchewan River Valley (Stein, 1976). The thalweg of the Buried Beverly Valley has a southwest-northeast orientation, and passes within approximately four kilometres northwest of the proposed Joburg development area (see adjacent map).

The upper bedrock in the AOS is the Oldman Formation, which overlies the Foremost Formation, both of which are part of the Belly River Group. The Belly River Group is comprised of grey to greenish grey, thick bedded, feldspathic sandstone, grey clayey siltstone, grey and green mudstone and concretionary ironstone beds (Green, 1972). The Lea Park Formation underlies the Belly River Group; interfingering of the two units causes difficulties in boundary definitions. The Lea Park Formation is typically composed of medium to dark grey shale with minor amounts of silt (Glass, 1990).

Water wells completed in aquifers within the AOS are generally expected to yield up to 160 cubic metres per day (m³/day). Water wells in the area that are completed in till are usually large-diameter bored wells that obtain water from local sand and gravel lenses within the till (Stein, 1976). Water wells completed in the till that encounter sand and gravel lenses may have groundwater yields of up to 30 m³/day. The Saskatchewan gravels and sands are present in and along the pre-glacial Buried Beverly Valley. Water wells completed in these gravels and sands are expected to have groundwater yields that range from 30 to 650 m³/day, as shown on the hydrogeological map above (Stein, 1976).

Groundwaters from water wells completed in upper bedrock aquifers in the AOS tend to be sodium-bicarbonate-type groundwaters, but varying amounts of sulfates and chlorides are often present. The concentration of total dissolved solids (TDS) from bedrock groundwaters in the AOS is generally between 1,000 and 2,000 milligrams per litre (mg/L).

The chemical composition of groundwaters in the surficial deposits is more variable than in the upper bedrock. The concentration of TDS from surficial groundwaters in the AOS varies from less than 500 mg/L to more than 3,000 mg/L. In general, groundwaters from surficial deposits tend to be hard and have high concentrations of iron and manganese, while upper bedrock groundwaters tend to be chemically soft.

### 2.2.1. Groundwater Query

A groundwater query (gwQuery) was developed by Mow-Tech Ltd. as part of the regional groundwater assessments completed for various counties in Alberta. The results of the groundwater query for NW 25-054-22 W4M provide a summary of expected local hydrogeology. The gwQuery results are based on more than 30 regional maps prepared by HCL, and are provided in the adjacent table. The gwQuery is based on regional data and, therefore, local conditions may vary. The Mow-Tech Ltd. gwQuery is available on the internet: http://www.gwquery.com.

The adjacent table shows that there is an expected 20 metres of surficial deposits overlying bedrock; the uppermost bedrock unit is expected to be the Late Cretaceous Oldman Formation of the Belly River Group. The Oldman Formation is of non-marine origin, and composed primarily of sandstone, siltstone and mudstone units, with occasional coal seams.

**Strathcona County**
**NW 25-054-22 W4M**
MOW-TECH LTD. gwQuery Results

| General Results Depth(s) | Top metre | Yield* m³/day | NPWL metre | TDS mg/L | Sulfate mg/L | Chloride mg/L | Fluid Expected |
|---|---|---|---|---|---|---|---|
| gwQuery Determined Minimum | 37 | 12[2] | 9 | 879 | 265 | -- | Water |
| gwQuery Determined Maximum | 44 | 12[2] | 9 | 879 | 265 | -- | Water |

| Detailed Results Geologic Unit Encountered | Top metre | Yield* m³/day | NPWL metre | TDS mg/L | Sulfate mg/L | Chloride mg/L | Fluid Expected |
|---|---|---|---|---|---|---|---|
| Upper Surficial Deposits | -- | 162[2] | -- | 1930 | 798 | 10 | -- |
| Lower Surficial Deposits | 14 | 30[2] | 3 | 1930 | 798 | 10 | -- |
| Bedrock Surface | 20 | | | | | | |
| Oldman Formation | 20 | 12[2] | 9 | 879 | 265 | -- | Water |

| Parameter | metre |
|---|---|
| Base of Groundwater Protection (Depth) | 20 |
| Ground Elevation (AMSL) | 632 |

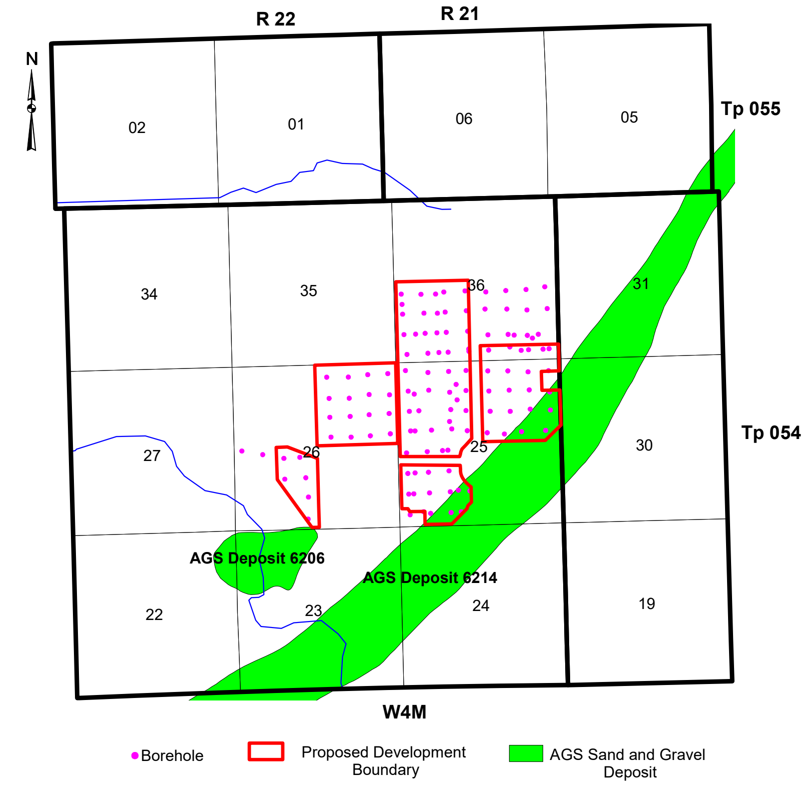
**Legend/Notes**
'--' indicates information not available.
Base of Groundwater Protection (BGP; TDS > 4,000 mg/L).
* Yield based on the 'Fluid Encountered' being water.
[2] Results are based on a regional groundwater study by hydrogeological consultants ltd. (HCL)
[3] Results are based on a summary of Drill Stem Test (DST) results.

Contact at least three local licensed water well drillers to get estimates of drilling and water well completion costs in your area. Consult the 'Water wells that Last for Generations' booklet for advice on hiring a water well driller, and for a check list of items that you and the driller should discuss and agree to before starting the work.

The information calculated with the MOW-TECH LTD. gwQuery is meant only as a guide. Actual drilling conditions may vary. MOW-TECH LTD. is not liable for drilling or groundwater problems as a result of using this data.

***Mow-Tech Ltd. gwQuery Results***

The gwQuery shows that aquifers within the surficial deposits in NW 25 have an expected yield of more than 100 m³/day and are expected to have sulfate concentrations that are in the order of 800 mg/L. Groundwater yields from water wells completed in aquifers within the upper bedrock are expected to be less than 20 m³/day. Concentrations of TDS and sulfate in groundwaters from upper bedrock aquifers are expected to be less than from the surficial deposits.




*2007 - 2008 Borehole Locations and AGS Sand and Gravel Deposits*

## 2.3. Previous Work

The Bibliography section of this report includes documents that relate to hydrogeology in the general area of the proposed development.

In 2007 and 2008, 123 boreholes were drilled for Joburg under the supervision of SNC Lavalin Environment in the area of the proposed gravel operation. The borehole information included spatial coordinates and lithologies. Information from the boreholes and piezometers has been added to The Groundwater Centre (TGWC) database, which is an enhanced version of the Alberta Environment and Sustainable Resource Development (ESRD) groundwater database.

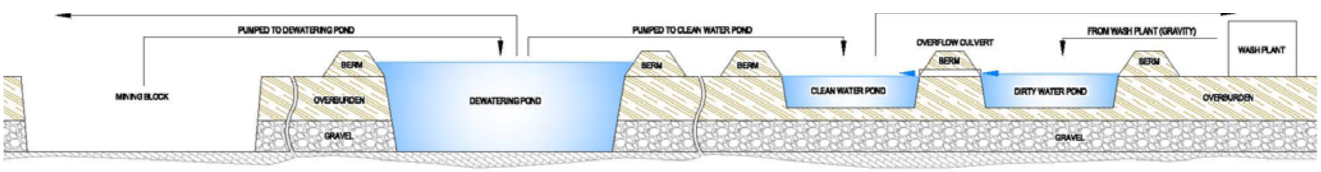
The adjacent map shows the borehole locations and locations of two sand and gravel deposits identified by the Alberta Geological Survey (AGS) as Deposit Nos. 6214 and 6206.[1] AGS information for Deposit No. 6214 includes an area of 896 hectares (ha), a gravel volume of 8,000,000 m³, a sand volume of 72,000,000 m³, and a thickness of 9.0 metres. AGS information for Deposit No. 6206 includes an area of 49 ha, a sand volume of 400,000 m³, no reported gravel, and a thickness of 1.0 metres.

## 2.4. Proposed Development Operation

Joburg proposes that there will be two mining phases. Phase 1 includes lands for the SW 25-54-22-W4M, NW 25-54-22-W4M and SW 36-54-22-W4M. Phase 2 includes lands for the NE 25-54-22-W4M, NE 26-54-22-W4M, the E1/2 of SW 26-54-22-W4M and the south portion of SE 36. For Phase 1, mining operations will involve two portable cone crushers that will be mining simultaneously, with one crusher starting in the northeast corner of the SW 36-54-22-W4M and the other crusher starting in the northwest corner of the NW 25-54-22-W4M. Joburg intends to wash approximately 30% of the gravel that will be mined, with washing to commence sometime within the first three years after extraction begins, after four of the mining blocks have been partially reclaimed to the reclaimed overburden elevation. The wash plant will be set up in the northwest corner of NW 25-54-22-W4M. The washing facility will include one dirty water pond and one clean water pond, each with a capacity of 2,000 m³. Water for these ponds will be drawn from the dewatering pond that will be located in the SW 36-54-22-W4M.

[1] The AGS deposits are based on work conducted by Edwards et al (1985) and Fox (1981).

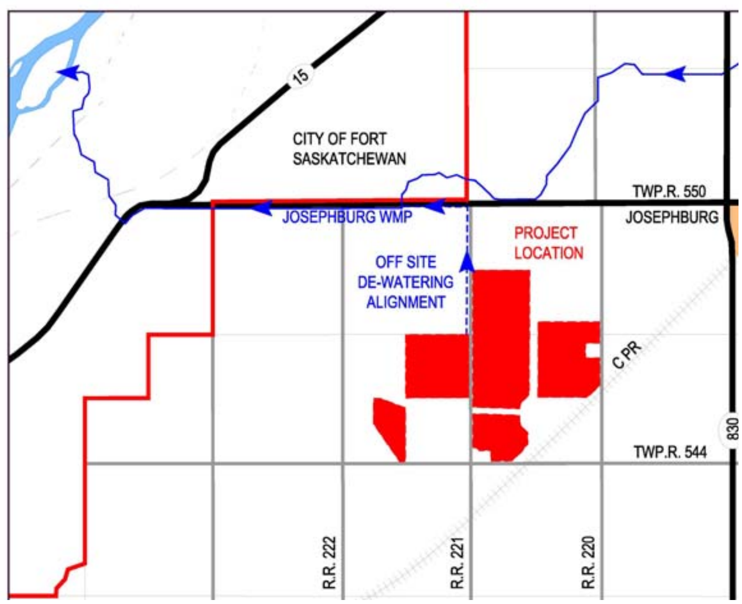
Joburg may operate more than one extraction site at any one time. At each extraction pit, pumps will be employed for dewatering as the gravel pit deepens. Any groundwater from the mining block area will be pumped into the dewatering pond on-site. The dewatering pond serves as the source water for all on-site water processing as shown on the diagram below. Note that any water used for gravel processing will be retained in separate facilities and not returned to the dewatering pond. The function of the dewatering pond is to recharge the excess groundwater produced from the mining block area. There will be no net loss of groundwater other than through evaporation and adhesion to the aggregate.




***Development Technique***

If the rate of groundwater recharge is slow, the excess groundwater will be pumped to the road ditch of Range Road 221 which outlets into the Josephburg Water Management Project (WMP), as shown in the adjacent figure. The Josephburg WMP drains west, and discharges into Ross Creek, approximately 200 metres upstream of its confluence with the North Saskatchewan River. The total distance from the project area is approximately eight kilometres.

Overburden will be removed and stockpiled, and subsequently used for reclamation. The gravel aquifer will be replaced with a layer of sand material at least one metre in thickness. Volume deficiencies will occur near the end of the project, allowing for the development of end pit lakes.




***Proposed Diversion of Excess Groundwater***
***[Figure provided by Sameng Inc.]***

# 3. Present Program

## 3.1. Maps and Aerial Photographs

The AOS is situated within the 83H 1:250,000 National Topographic Series (NTS) map sheet, with local detail available from the 1:50,000 83H/11 map sheet. Digital topographic control is from the 1:20,000 digital elevation model (DEM) prepared by the Spatial Data Warehouse (SDW).

A coloured digital air photo mosaic of the AOS was provided by Sameng. The air photos were taken in June 1999.

## 3.2. Groundwater Database

The Groundwater Centre database, an enhanced version of the ESRD groundwater database, includes 252 records for the AOS.[2] Of the 252 groundwater records, 99 are classified as water wells. Water well classification includes the five categories for "Type of Work" as shown in the adjacent table. The "new well" category, although new at the time the information was filed with ESRD, may now be many years old. Information relating to the records in the groundwater database has been used in the preparation of cross-sections, as the starting point for the water well survey, and to determine aquifer parameters.

Of the 153 groundwater-related records, 123 are abandoned boreholes drilled on behalf of Joburg to investigate the gravel deposit. The 14 Piezometer records included in the table were the piezometers completed for Joburg as part of the present program.

| Type of Work | No. of Records |
|---|---|
| New Well | 55 |
| Chemistry | 27 |
| Well Inventory | 7 |
| Federal Well Survey | 6 |
| Water Test Hole | 4 |
| Borehole | 123 |
| Piezometer | 14 |
| Water Test Hole - Abandoned | 5 |
| Well - Abandoned | 5 |
| New Well - Abandoned | 2 |
| Cathodic Protection | 1 |
| Coal Test Hole | 1 |
| Dry Hole | 1 |
| Dry Hole - Abandoned | 1 |
| ***Total Water Well Records*** | ***99*** |
| ***Total Groundwater-Related Records*** | ***153*** |
| **Total:** | ***252*** |

***Groundwater Records in AOS***

[2] The table includes changes to the database made as part of the present program.

## 3.3. Field Work

### 3.3.1. Field-Verified Water Well Survey

A field-verified water well survey was completed within the AOI by HCL personnel on May 31 to July 03, 2010. All water well records available in the groundwater database for the field-survey area were used as a starting point for the water well survey. Coordinates for water wells located in the field were determined with a hand-held, consumer-grade global positioning system (GPS) unit. When the owner allowed, water levels were measured in water wells. A visit was made to each residence in the AOI. If residents were not home, a letter was left explaining the purpose of the water well survey, and an opportunity was given to the residents to provide details from their water wells for the survey. A copy of the letter used for the survey is in Appendix A.

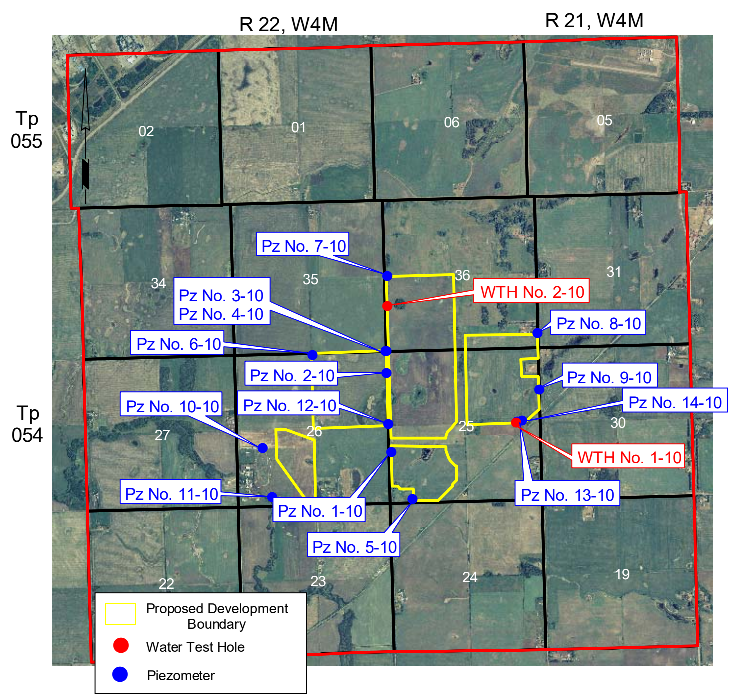
A map and tables of the results of the survey are included in Appendix D.

### 3.3.2. Augering and Drilling

#### *3.3.2.1. Piezometers*

The locations of the 14 shallow monitoring water wells (piezometers) that were completed as part of the present program are shown in the adjacent map. Criteria for site selection were based on:

- the presence of sand and gravel determined from borehole data
- site accessibility based on land use and landowner's consent
- location of underground utilities
- a pattern that surrounds the proposed development.




***2010 Piezometer and Water Test Hole Locations***

Piezometer completion took place from June 14 to July 1, 2010 by Sun-Alta Drilling Ltd. (Sun-Alta) and Lakeland Drilling Ltd. (Lakeland), under the supervision of Mow-Tech Ltd. personnel.

Piezometer (Pz) Nos. 1-10 to 3-10 were augered and completed by Sun-Alta. However, because saturated conditions and low consolidation of the sand and gravel made augering difficult, Pz Nos. 4-10 to 14-10 were completed with a drilling rig operated by Lakeland. The piezometers were completed using 51-mm-diameter plastic (PVC) casing. After completion, elevations of the ground surface and the water level reference points for the piezometers were surveyed by Sameng personnel. Slug tests were conducted with Pz Nos. 2-10 and 3-10 in order to obtain estimates of hydraulic conductivity. Short aquifer tests were conducted with Piezometer Nos. 1-10, and 4-10 to 12-10. Because of sloughing during augering, Pz No. 3-10 had a poor completion, and it was decided to complete Pz No. 4-10 with a drilling rig, as a replacement for Pz No. 3-10.

Details for the piezometers and the results of any tests associated with individual piezometers are included in the Results section of this report and in Appendix B.

#### *3.3.2.2. Water Test Holes*

Lakeland used a mud rotary drilling rig to drill and complete Water Test Hole (WTH) Nos. 1-10 and 2-10 into the gravel aquifer; the locations of the water test holes are shown on the map on the previous page.

### 3.3.3. Aquifer Tests and Groundwater Sampling

#### *3.3.3.1. Piezometers*

The adjacent table summarizes the aquifer tests conducted with the piezometers as part of the present program. The tests were conducted using a submersible pump; water levels were measured with a pressure transducer and data logger, and the pumping rate was determined by measuring the time it took to fill a container of known volume.

| Piezometer No. | Aquifer Test | Date Test Started | Pumping Rate (lpm) | NPWL (m BTOC) | Pumping Interval (min) | Recovery Interval (min) |
|---|---|---|---|---|---|---|
| 1-10 | I | 2010-06-23 | 5.5 | 4.59 | 76 | 72 |
| 4-10 | I | 2010-06-29 | 13.2 | 3.56 | 63 | 69 |
| 5-10 | I | 2010-06-29 | 13.5 | 7.39 | 63 | 22 |
| 6-10 | I | 2010-06-29 | 12.6 | 5.50 | 63 | 60 |
| 7-10 | I | 2010-06-29 | 1.4 | 2.34 | 63 | 89 |
| 8-10 | I | 2010-06-30 | 13.6 | 5.55 | 60 | 60 |
| 9-10 | I | 2010-06-30 | 12.9 | 5.95 | 62 | 49 |
| 10-10 | I | 2010-07-02 | 1.3 | 6.87 | 62 | 60 |
| 11-10 | I | 2010-07-02 | 14.4 | 3.25 | 61 | 61 |
| 12-10 | I | 2010-06-30 | 13.9 | 2.75 | 63 | 67 |

**lpm** - litres per minute
**BTOC** - below top of casing

***Piezometer Aquifer Test Summary***

Groundwater samples were collected from Piezometer Nos. 1-10, and 4-10 to 12-10 during aquifer testing and submitted to Exova for analysis of routine chemical parameters and dissolved and extractable metals.

#### *3.3.3.2. Water Test Holes*

Aquifer tests with the two water test holes were pumping-and-recovery-type tests conducted by Mow-Tech Ltd. Two aquifer tests were conducted with WTH No. 1-10, and two aquifer tests were conducted with WTH No. 2-10. Aquifer Test II with each water test hole was an extended aquifer test that included monitoring of piezometers as observation water wells. Water levels during the extended aquifer tests were measured with downhole pressure transducers connected to data loggers, which were programmed to record a water level every ten minutes. A turbine and flow analyzer were used to measure groundwater production. Instantaneous flow measurements were recorded every ten minutes with the data logger.

Groundwater samples were collected from each water test hole during aquifer testing and submitted to Exova for analysis of routine chemical parameters and dissolved and extractable metals.

###### 3.3.3.2.1. WTH No. 1-10

Aquifer Test I (AT I) with WTH No. 1-10 was a pumping-and-recovery-type aquifer test conducted on July 2, 2010, which consisted of 65 minutes of pumping at 11.5 litres per minute (lpm) followed by 12 minutes of recovery.

Aquifer Test II (AT) with WTH No. 1-10 was an extended pumping-and-recovery-type aquifer test started on July 13, 2010, which consisted of 1,480 minutes of pumping at 705 lpm followed by 2,610 minutes of recovery. The groundwater that discharged from WTH No. 1-10 was piped 300 metres northeast of WTH No. 1-10 on the west side of the range road in the ditch. Twelve of the 14 piezometers were monitored as observation water wells during AT II with WTH No. 1-10.[3]

Results from AT I are included in Appendix B; results from AT II are included in Appendix C.

###### 3.3.3.2.2. WTH No. 2-10

Aquifer Test I (AT I) with WTH No. 2-10 was a pumping-and-recovery-type aquifer test conducted on July 05, 2010, which consisted of 30 minutes of pumping at 1,137 lpm followed by 1,290 minutes of recovery.

Aquifer Test II (AT) with WTH No. 2-10 was an extended pumping-and-recovery-type aquifer test started on July 06, 2010, which consisted of 4,470 minutes of pumping at 1,109 lpm followed by 5,350 minutes of recovery. The groundwater that discharged from WTH No. 2-10 was piped 1,120 metres north of WTH No. 2-10, which is a site approximately 80 metres north of Pz No. 7-10. Thirteen of the 14 piezometers were monitored as observation water wells during AT II with WTH No. 1-10.[4]

Results from AT I are included in Appendix B; results from AT II are included in Appendix C.

A summary of aquifer tests conducted with the two water test holes is shown in the table below.

| Pumping Water Test Hole | Aquifer Test | Date Test Started | Pumping Rate (lpm) | Pumping Interval (min) | Recovery Interval (min) | Observation Water Wells Showing Drawdown |
|---|---|---|---|---|---|---|
| WTH No. 1-10 | I | 02-Jul-10 | 11.5 | 65 | 12 | - |
| | II | 13-Jul-10 | 705 | 1,480 | 2,610 | Pz Nos. 9-10, 13-10 and 14-10 |
| WTH No. 2-10 | I | 05-Jul-10 | 1,137 | 30 | 1,290 | - |
| | II | 06-Jul-10 | 1109 | 4,470 | 5,350 | Pz Nos. 1-10, 2-10, 4-10, 6-10, 7-10 and 12-10 |

[3] Pz No. 4-10 was completed in lieu of Pz No. 3-10, and Pz No. 4-10 was not monitored because the logger had been removed for servicing.
[4] Pz No. 4-10 was monitored in lieu of Pz No. 3-10.

## 3.4. Data Processing

The horizontal coordinates in this report are based on a 10-degree Transverse Mercator (10TM) projection, referenced to 115 degrees west longitude and using the NAD83 datum. Coordinates were determined for features identified in the field using a consumer-grade, hand-held GPS unit.

Transmissivity values from the aquifer test data from the pumped water test holes have been calculated using the following approximation of the Theis non-equilibrium equation:

$$T = \frac{2.3 \cdot Q}{4 \cdot \pi \cdot \Delta s}$$

Where:

T = Transmissivity in m²/day

Q = Discharge in m³/day

$\Delta$s = Drawdown per log cycle in metres

Transmissivity from specific capacity is calculated based on the following equation:

$$\frac{Q}{s} = \frac{4 \cdot \pi \cdot T}{2.3 \cdot \log_{10}\left(\frac{2.25 \cdot T \cdot t}{S \cdot r^2}\right)}$$

Where:

Q = Discharge in m³/day

s = Drawdown in metres

T = Transmissivity in m²/day

S = Storativity, assumed to be 0.0001

t = Time since discharge started in days

r = Effective radius of the water well in metres

Drawdowns at various times and distances from the groundwater discharge point are calculated from the following equation:

$$s = \frac{Q \cdot W(u)}{4 \cdot \pi \cdot T}$$

Where:

s = Drawdown in metres

Q = Discharge in m³/day

W(u) is the well function of u

T = Transmissivity in m²/day

And

$$u = \frac{r^2 \cdot S}{4 \cdot T \cdot t}$$

Where:

| | |
|---|---|
| r | = Effective radius of the water well in metres |
| S | = Storativity, assumed to be 0.0001 |
| T | = Transmissivity in m²/day |
| t | = Time since discharge started in days |

When multiple groundwater discharge points are involved, the principle of superposition is used. The multiple discharge points can be at various locations or at one location.

Drawdowns at various times and distances are calculated based on approximations of W(u). For values of u greater than 0 and less than one, the following approximation is used:

$W(u) = - \ln u + (-0.57721556) + (0.99999193)*u + (-0.24991055)*u^2 + (0.05519968)*u^3 + (-0.000976004)*u^4 + (0.00107857)*u^5$

Where:

ln = natural logarithm

For values of 1 < u < infinity, the following approximation is used:

$W(u) = (1/(u*e^u))*(((0.250621)+(2.334733*u)+u^2))/((1.681534)+(3.330657*u)+u^2))$

Theoretical long-term yield is calculated from the Modified Moell Method (Alberta Government, March 2011), using the following equation:

$$Q_{20} = \frac{Q(H_A)}{s_{100} + 5\Delta s} \times 0.7$$

Where

| | |
|---|---|
| $Q_{20}$ | = sustainable yield for 20 years |
| Q | = pumping rate during the aquifer tests |
| $H_A$ | = available drawdown |
| $S_{100min}$ | = measured drawdown after 100 minutes of pumping |
| $S_{100min\ Theor}$ | = calculated theoretical drawdown after 100 minutes of pumping at Q using effective transmissivity |
| $S_{20yrs\ Theor}$ | = calculated theoretical drawdown after 20 years of pumping at Q using effective transmissivity |
| 0.7 | = safety factor |

All gridding uses the Kriging method with a linear variogram model as provided in Golden software Surfer V9.

A two-dimensional mathematical model is used to calculate the water levels at various times and distances from a pumping water well. The model, developed by Mow-Tech Ltd., is called the Infinite Artesian Aquifer Model (IAAM). The model can be used to calculate water levels at specific locations in the aquifer taking into consideration the effects of boundary conditions, using image water wells, and interference from nearby pumping water wells. The calculations are based on an aquifer that is homogeneous and isotropic and behaves as one of infinite areal extent with no recharge.

# 4. Results

## 4.1. Groundwater Database

The groundwater database is updated as data become available. Therefore, information obtained for or generated during the present program is entered into the database; any discussion that uses the database will reflect the updated information.

The groundwater database for the AOS includes 252 records. Of the 252 records, 123 are the boreholes entered into the database as part of the present program, all of which included a determination of the top of bedrock. An additional 16 bedrock picks were determined from the piezometer and water test hole drilling information compiled as part of the present program. An additional 23 water well records in TGWC database included a determination of the top of bedrock.

In the AOS, there are 67 results for the chemical quality of groundwater, of which 53 include sufficient parameters for determination of the category of chemical quality.[5] Of these 53 analyses, ten are groundwater samples collected from the Joburg piezometers, and two are from the Joburg water test holes. Chemical quality results are discussed in Section 4.5 of this report.

Gravel or sandy gravel was encountered in all 123 boreholes drilled in and near the proposed development area, and in the 14 piezometer locations and two water test hole locations. Gravel thickness encountered in the 139 control points ranged from 0.1 to 15.5 metres, with an average of 3.9 metres. The gravel was identified in the elevation interval between 612 and 636 metres AMSL.

Water-level elevations for the sand and gravel aquifer in the proposed development area are based on depth to water measurements recorded in the 14 piezometers and two water test holes, and processed based on surveyed elevations of water level reference points. Water levels measured in area water wells have been referenced to elevation based on the DEM.

[5] The parameters required are: sodium, potassium, calcium, bicarbonate, chloride and sulfate.

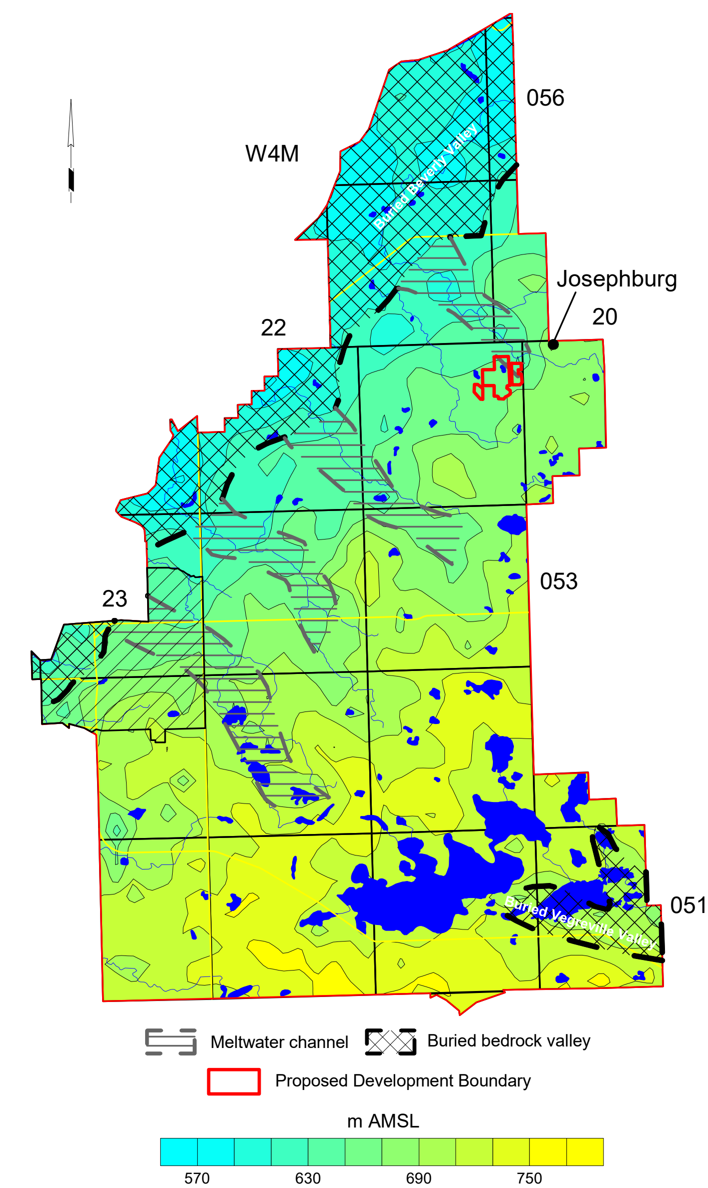
### 4.1.1. Bedrock Topography

#### *4.1.1.1. Regional Data*

The regional groundwater assessment (RGA) for the County prepared by HCL (April 2001) included a bedrock topography map, as reproduced in the adjacent figure. The RGA reported that, over the majority of the County, the surficial deposits are less than 30 metres thick. The exceptions are mainly in association with areas where buried bedrock valleys are present, where the deposits can have a maximum thickness of close to 50 metres. The main linear bedrock low in the County is a southwest-northeast-trending bedrock low that has been designated as the Buried Beverly Valley.

The Buried Beverly Valley is present in the northern part of the County, and mainly parallels the present-day North Saskatchewan River. The Valley is four to ten kilometres wide within the County, with local bedrock relief being up to 60 metres. Sand and gravel deposits can be expected in association with this bedrock low, but the thickness of the sand and gravel deposits is expected to be mainly less than 15 metres. A secondary linear bedrock low, inferred to be a meltwater channel associated with the Buried Beverly Valley, is located north of, and in close proximity to, the proposed development area.

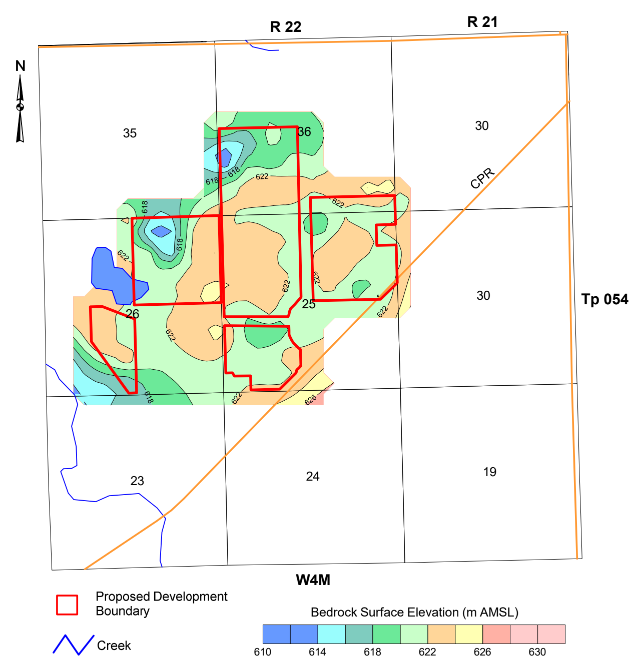
In general, the bedrock topography in the AOS has a gradient from southeast to northwest.




**Bedrock Topography**

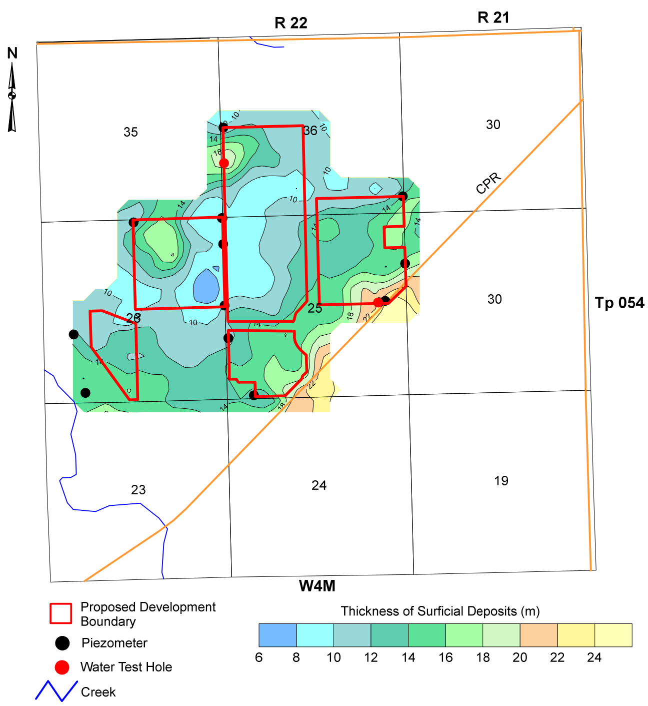
#### *4.1.1.2. Local Data*

The 162 groundwater records in the AOS that included a determination of the top of bedrock were used to create a bedrock topography map for the area near the proposed development, as shown in the adjacent map.[6] The map shows an overall dip to the northwest, except for the presence of a southwestward-trending linear bedrock high that extends diagonally, mainly through the northwestern part of Section 25.




***Bedrock Topography***

Sand and gravel deposits occur between the bedrock surface and the land surface. By subtracting the bedrock surface from the topographic surface, the thickness of the unconsolidated sediments overlying the bedrock surface can be determined. The map below shows that unconsolidated sediments are thickest along the southeastern edge of the proposed development, where the sediment can exceed 20 metres in thickness. The thinnest sediments of less than ten metres occur along a southwestward-trending area, centred in NW 25, which is coincident with the linear bedrock high shown in the map above.




***Thickness of Surficial Deposits***

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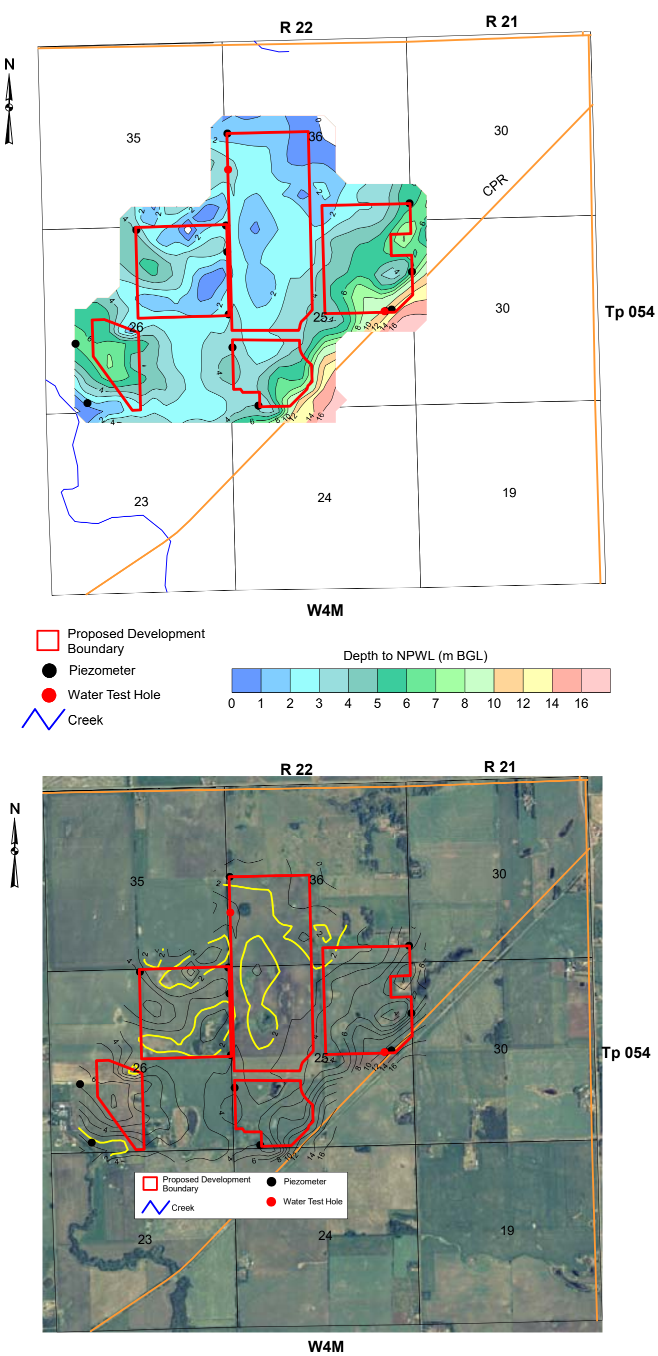
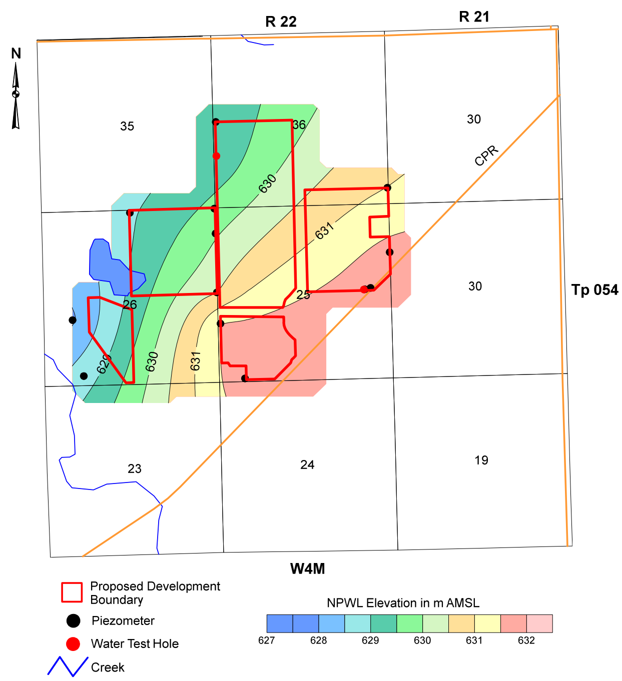
6 Elevations of bedrock at the piezometer and water test hole sites were based on surveyed ground level elevations; elevations at water well and borehole sites were based on the DEM.

### 4.1.2. Non-Pumping Water Level

The adjacent map shows the non-pumping water-level (NPWL) elevation based on measured NPWLs in the 14 piezometers and two water test holes that have been completed in the sand and gravel aquifer as part of the present program. The map shows that the NPWL surface generally follows the topographic surface, with a gradient to the northwest of approximately 0.0015 (which is 1.5 metres per kilometre).



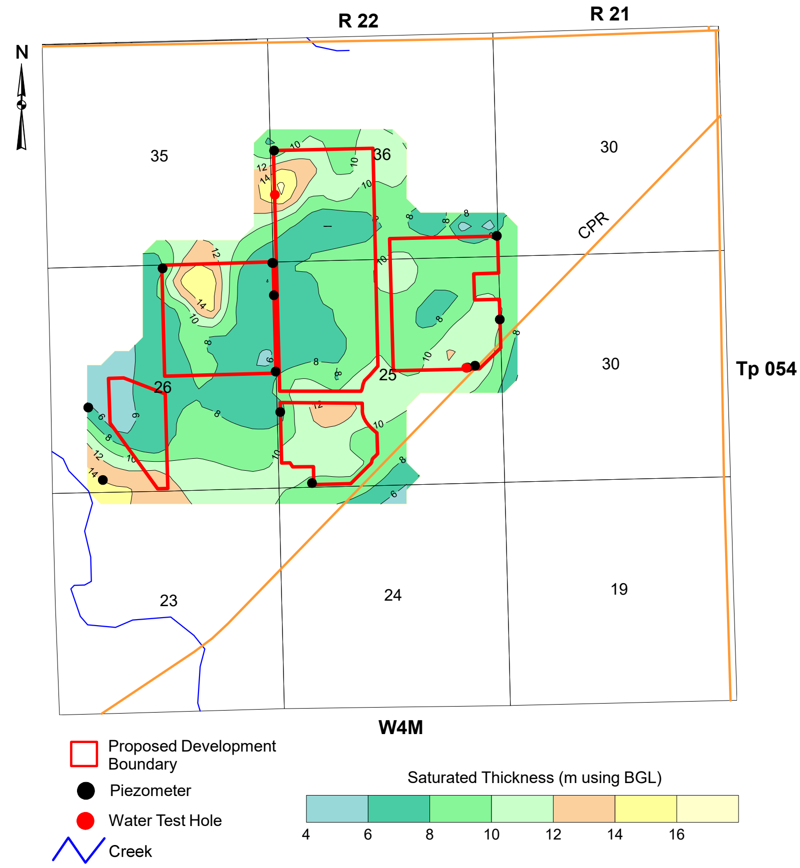

*Depth to NPWL*




*NPWL Elevation*

The two maps to the left show the depth to NPWL created by subtracting the NPWL surface from ground surface. The upper map shows that the depth to the NPWL is generally between two and six metres below ground level (BGL). Depths to NPWL are greater in the topographically higher areas in SW 26, and along the southeastern edges of the development area. Depths to NPWL are less than two metres in the topographically low areas in NE 26, NW 25 and near the centre of Section 36. The lower map to the left shows the two-metre depth-to-water contour highlighted with a yellow line; the map shows that the areas where groundwater is within two metres of ground surface are associated with land features that appear to indicate wet areas, and could be areas of groundwater discharge.

The adjacent map shows the saturated thickness of the surficial deposits, calculated by subtracting the bedrock surface from the NPWL surface. The map shows that the saturated thickness in the proposed development area is generally in the order of six to eight metres. The saturated thickness is the thinnest in the area of the linear bedrock high in SW 36, NW 25 and NE 26. The thickest areas are associated with a linear bedrock low in the southeastern part of the development area, in the southwestern part of Section 26, and in two localized bedrock depressions in NE 26 and SW 36, where the saturated thickness exceeds 14 metres.




***Saturated Thickness***

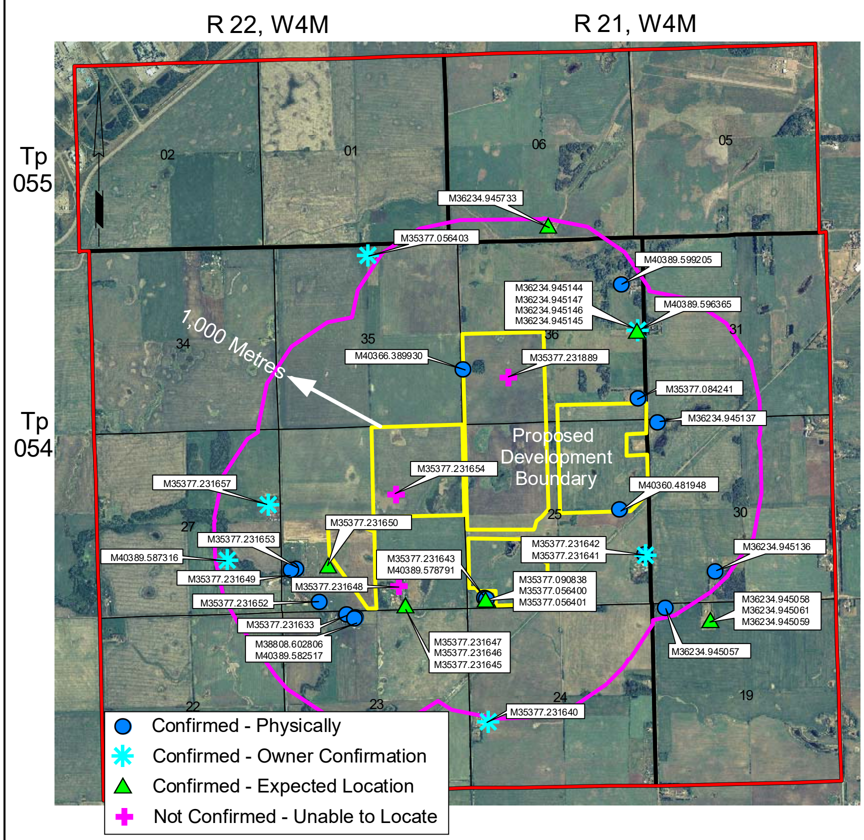
## 4.2. Field-Verified Water Well Survey

HCL personnel conducted a water well survey within the AOI on May 31 to July 03, 2010. The purpose of the field-verified water well survey was to locate as many of the 40 water wells in the AOI as practical, and to update records accordingly. A field survey includes four criteria for identification of a feature:

1. Physically confirmed - this means the feature was observed, and horizontal coordinates were obtained after receiving authorization to do so by the owner/user.
2. The feature is confirmed by the owner/user, and horizontal coordinates were obtained based on information provided.
3. The feature could be expected based on information that is not provided by the owner/user.
4. No evidence of the feature could be observed in the field.

The map below shows the spatial distribution of the 40 water wells within the AOI. Of these 40 water wells:

- 16 water wells were physically confirmed in the field (identified with ●; these include WTH Nos. 1-10 and 2-10)
- Six water wells were confirmed based on information provided by the owner (identified with ✱)
- 15 water wells were not located, but their location was moved from the centre of the legal location to the most likely site in the land location (identified with ▲)
- Three water wells were not located in the field and no evidence of the feature could be observed in the field (identified with ✚)




***Feild-Verified Water Well Survey***

A larger version of the field survey map is in Appendix D. Water well details for the water wells within the field survey area are also included in Appendix D.

## 4.3. Piezometers

### 4.3.1. Completion

Piezometer Nos. 1-10, 2-10 and 3-10 were augered and completed by Sun-Alta with field supervision by Mow-Tech Ltd. The holes were drilled deep enough to ensure bedrock was encountered and the piezometers have a completion interval that extends from the top to the bottom of the sand and gravel deposit encountered at each site; none of the holes has a depth of greater than 11.4 metres. There were issues with completing Piezometer Nos. 2-10 and 3-10 due to material sloughing into the holes; therefore, these two piezometers could not be completed to the bottom of the sand or gravel deposit; Pz No. 4-10 was subsequently completed by Lakeland approximately five metres northwest of Pz No. 3-10. During extended aquifer tests, water levels were not monitored in Pz No. 3-10.

Piezometer Nos. 4-10 to 14-10 were drilled by Lakeland with a mud rotary rig with field supervision by Mow-Tech Ltd. The holes were drilled deep enough to ensure bedrock was encountered and the piezometers have a completion interval that extends from the top to the bottom of the sand and gravel deposit encountered at each site; none of the holes has a depth of greater than 24.9 metres.

All of the piezometers were completed using 51-mm-diameter plastic (PVC) casing. The detailed lithologic description for each site and the completion details for each piezometer are included in Appendix B.

### 4.3.2. Aquifer Testing

Short aquifer tests were conducted with each of the piezometers. Aquifer test results are shown in the table below. The table shows that transmissivity values determined from the aquifer tests range from 8.0 to 353 metres squared per day (m²/day).

The aquifer test results are included in Appendix B.

| Piezometer No. | Aquifer Test | Date Test Started | Pumping Rate (lpm) | NPWL (m BTOC) | Pumping Interval (min) | Recovery Interval (min) | Transmissivity (m²/day) |
|---|---|---|---|---|---|---|---|
| 1-10 | I | 23-Jun-10 | 5.5 | 4.59 | 67 | 72 | 37.3 |
| 4-10 | I | 29-Jun-10 | 13.2 | 3.56 | 63 | 69 | 40.5 |
| 5-10 | I | 29-Jun-10 | 13.5 | 7.39 | 63 | 22 | 238.0 |
| 6-10 | I | 29-Jun-10 | 12.6 | 5.50 | 63 | 60 | 58.6 |
| 7-10 | I | 29-Jun-10 | 1.4 | 2.34 | 63 | 89 | 8.0 |
| 8-10 | I | 30-Jun-10 | 13.6 | 5.55 | 60 | 60 | 121.0 |
| 9-10 | I | 30-Jun-10 | 12.9 | 5.95 | 62 | 49 | 353.0 |
| 10-10 | I | 02-Jul-10 | 1.3 | 6.87 | 62 | 60 | 18.2 |
| 11-10 | I | 02-Jul-10 | 14.4 | 3.25 | 61 | 61 | 47.8 |
| 12-10 | I | 30-Jun-10 | 13.9 | 2.75 | 63 | 67 | 124.0 |

***Piezometer Aquifer Test Results***

## 4.4. Water Test Holes

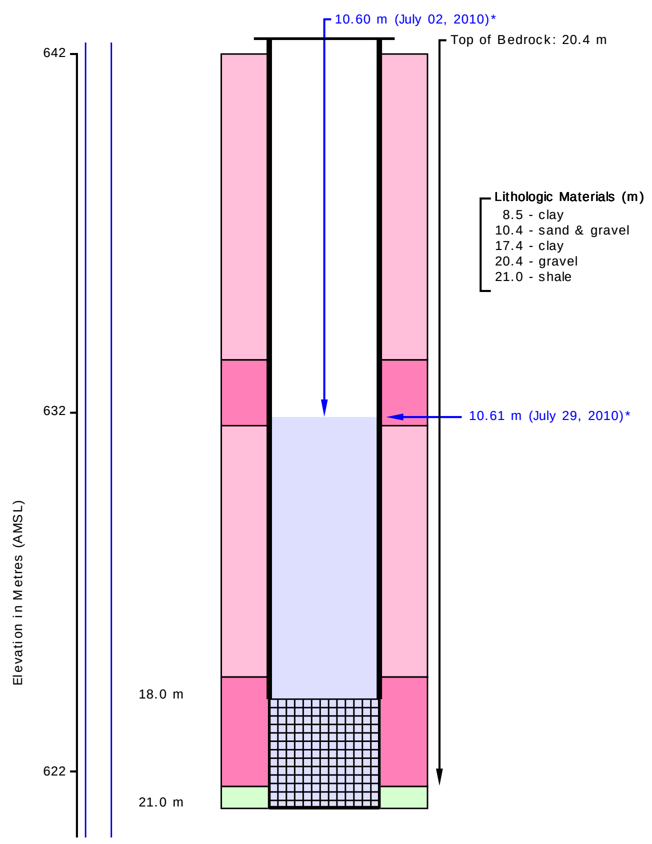
### 4.4.1. Drilling and Completion

Water Test Hole Nos. 1-10 and 2-10 were drilled and completed by Lakeland, under the supervision of Mow-Tech Ltd. personnel.

#### *4.4.1.1. WTH No. 1-10*

Water Test Hole No. 1-10 was completed by Lakeland on July 01, 2010 in 09-25-054-22 W4M. Lithologies encountered during drilling included 8.5 metres of clay underlain by sand, gravel and clay layers. The water test hole was completed with 178-millimetre (mm) outside diameter (OD) steel surface casing set to a depth of 18.0 metres BGL, and a 200-slot[7] stainless steel water well screen in the depth interval between 18.0 and 21.0 metres BGL, as shown in the adjacent figure. The water well screen was developed with water and compressed air. The NPWL measured on July 2, 2010 was 10.60 metres below top of casing (BTOC).

Water test hole details are included in Appendix B.




**_Well Diagram, WTH No. 1-10_**

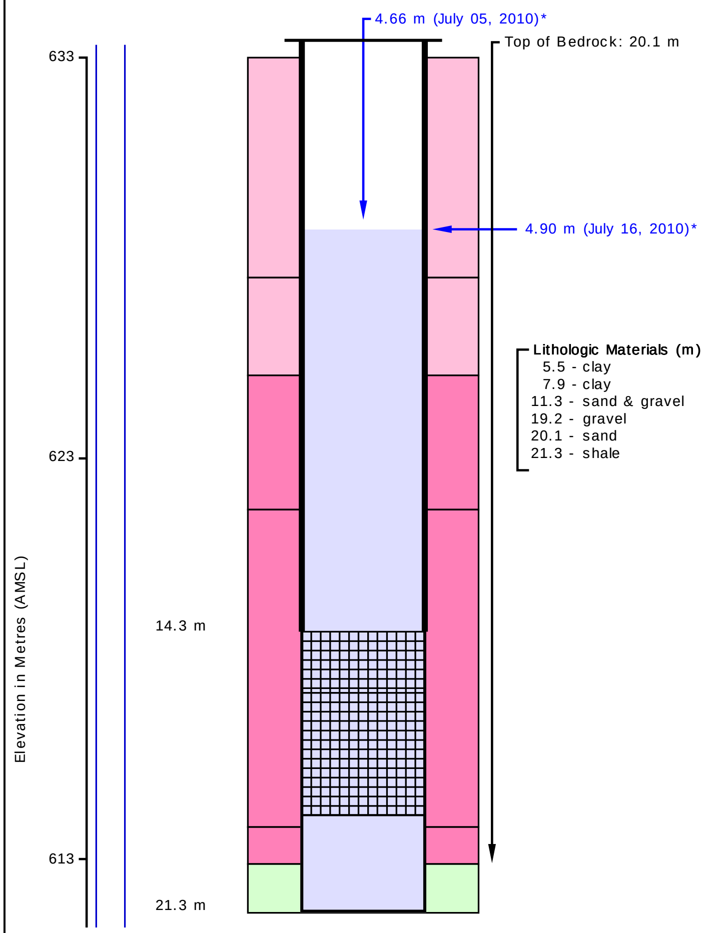
[7] 200-slot refers to the screen size opening of 200 thousandths of an inch, which is equivalent to a 5.1-mm opening.

#### *4.4.1.2. WTH No. 2-10*

Water Test Hole No. 2-10 was completed by Lakeland on July 3, 2010 in 05-36-054-22 W4M. Lithologies encountered during drilling included 7.9 metres of clay underlain by sand and gravel layers; shale bedrock was encountered at a depth of 21.3 metres BGL. The water test hole was completed with 178-mm OD steel surface casing set to a depth of 14.3 metres BGL, and stainless steel water well screen in the depth interval between 14.3 and 18.9 metres BGL, as shown in the adjacent well diagram. From 14.3 to 15.9 metres BGL, the water well screen has 40-slot openings, and from 15.9 to 18.9 metres BGL, the water well screen has 200-slot openings. [8]

The water well screen was developed with water and compressed air. The NPWL measured on July 5, 2010 was 4.66 metres BTOC.

Water test hole details are included in Appendix B.



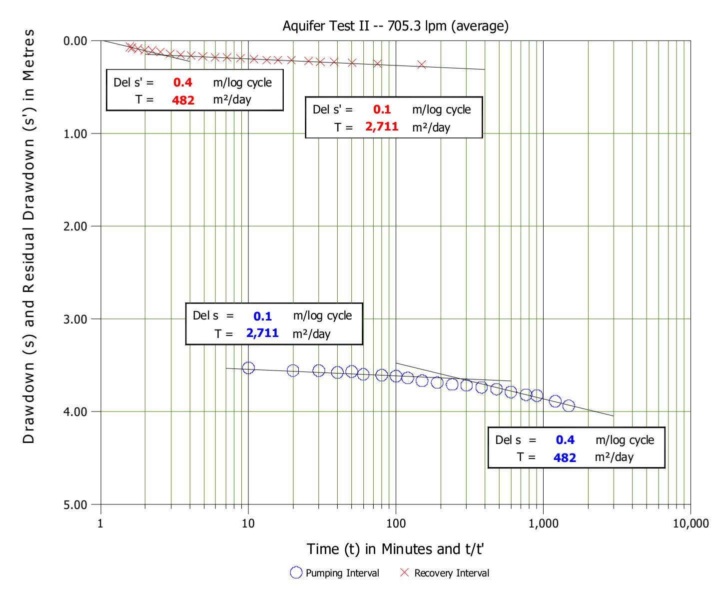

***Well Diagram, WTH No. 2-10***

[8] A 40-slot screen refers to the screen size opening of 40 thousandths of an inch, which is equivalent to a 1.0-mm opening; a 200-slot screen has openings of 5.1 mm.

### 4.4.2. Aquifer Testing

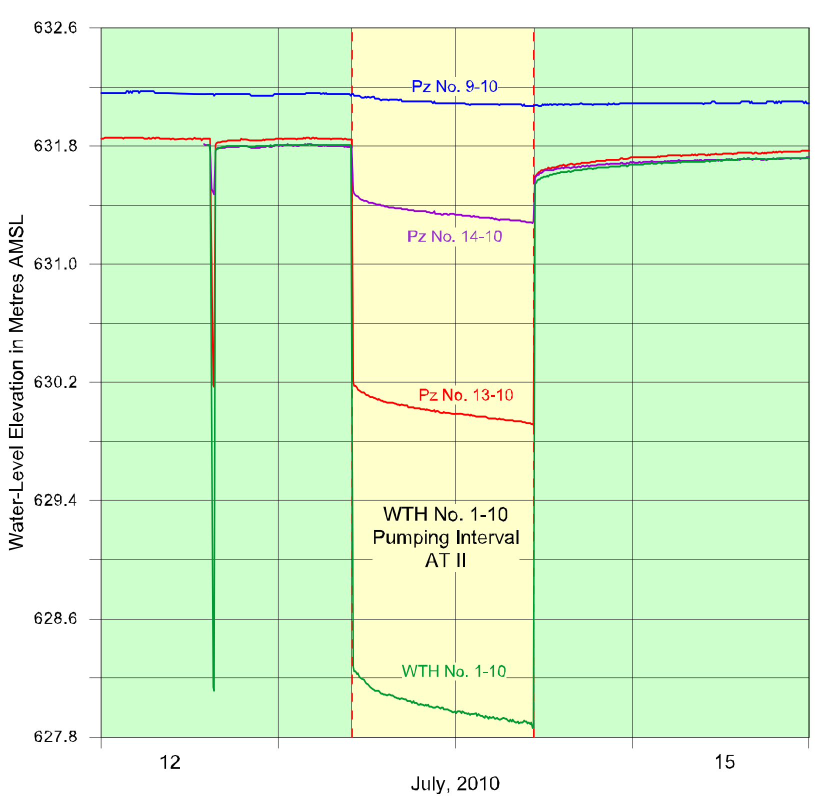
#### *4.4.2.1. WTH No. 1-10*

Aquifer Test I with WTH No. 1-10 was conducted on July 02, 2020 and consisted of 65 minutes of pumping at an average of 11.5 lpm followed by 12 minutes of recovery. The calculated apparent transmissivity was 598 m²/day, based on a drawdown of 0.04 metres. The water level recovered to the pre-test level within the first minute of recovery.




***WTH No. 1-10, AT II***

Aquifer Test II with WTH No. 1-10 began on July 13, 2010 and consisted of 1,480 minutes of pumping at an average of 705 lpm followed by 2,610 minutes of recovery. The adjacent graph shows that the early pumping data and early recovery data indicate an aquifer transmissivity of 2,711 m²/day, and the late pumping data and late recovery data indicate an effective transmissivity of 482 m²/day. The recovery data project to the pre-test water level at t/t' = 1.



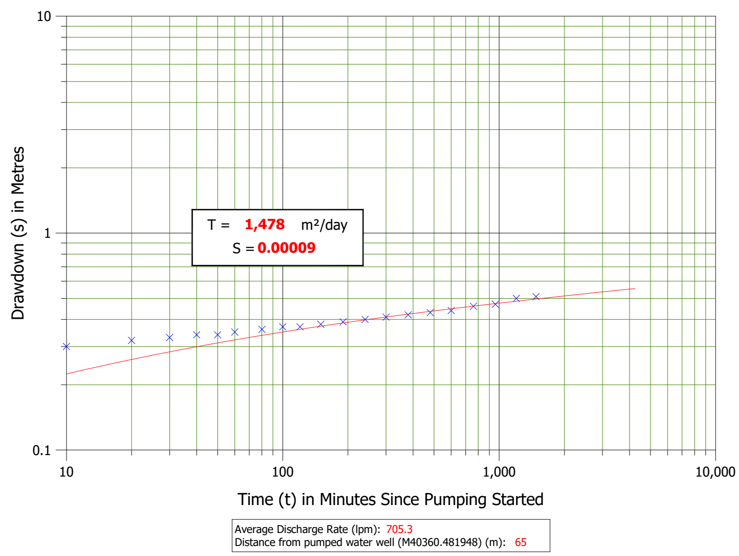

***Piezometers that Showed Drawdown during AT II with WTH No. 1-10***

The data from AT II with WTH No. 1-10 are in Appendix C.

During AT II, water levels were also measured and recorded in 12 of the 14 piezometers;[9] drawdown that could be attributed to pumping from WTH No. 1-10 was measured in three of the 12 piezometers during the pumping interval of AT II, as shown in the figure to the left.[10]

[9] Water levels were not measured in Pz Nos. 3-10 or 4-10.
[10] The drawdown shown on July 12, 2010 occurred during testing of the submersible pump the day before starting the extended aquifer test.

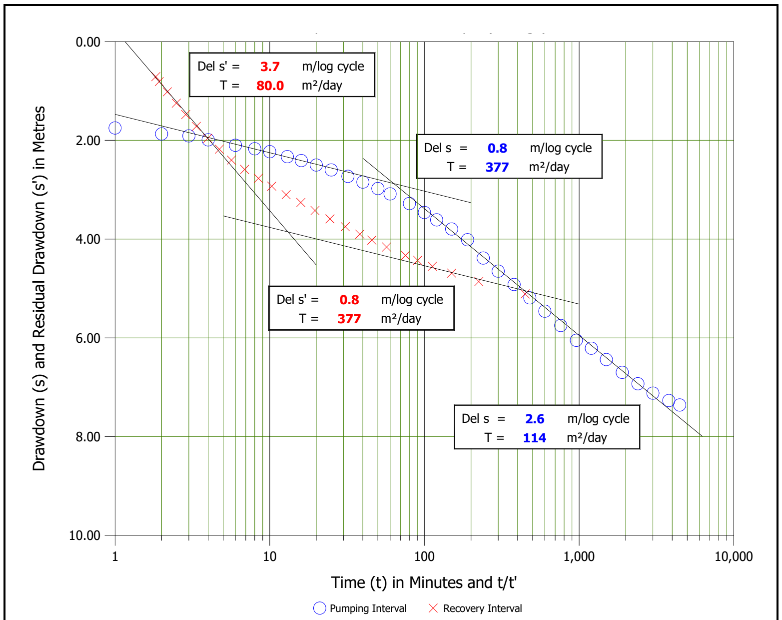
Log-log plots of the water-level data from the three piezometers that showed drawdown due to pumping from WTH No. 1-10 are included in Appendix C. The adjacent figure is an example of one of the log-log plots. The figure shows that the water level in Pz No. 14-10 drew down 0.51 metres during the pumping interval of AT II with WTH No. 1-10. When the drawdown data are analyzed on a log-log plot using a Theis type-curve, the data indicate that the aquifer in which WTH No. 1-10 and Pz No. 14-10 are completed has an effective transmissivity of 1,478 m²/day with a corresponding storativity of 0.00009.




***Pz No. 14-10 used as an Obs WW during AT II with WTH No. 1-10***

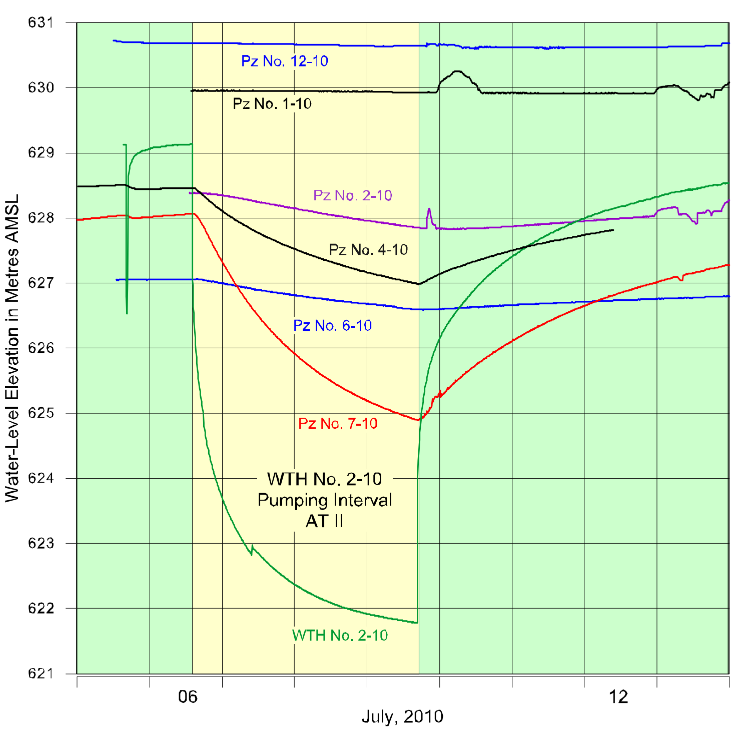
### *4.4.2.2. WTH No. 2-10*

Aquifer Test I with WTH No. 2-10 was conducted on July 05, 2010 and consisted of 30 minutes of pumping at an average of 1,137 lpm followed by 1,290 minutes of recovery. The analysis of AT I shows that the early recovery data indicate an aquifer transmissivity of 383 m²/day, while the late recovery data indicate an effective transmissivity of 107 m²/day. The water level recovered to the pre-test level after 1,000 minutes of recovery.




***WTH No. 2-10, AT II***

Aquifer Test II with WTH No. 2-10 began on July 6, 2010 and consisted of 4,470 minutes of pumping at an average of 1,109 lpm followed by 5,350 minutes of recovery. The adjacent graph shows that the early pumping data and early recovery data indicate an aquifer transmissivity of 377 m²/day, the late pumping data indicate an effective transmissivity of 114 m²/day, and the late recovery data indicate an effective transmissivity of 80.0 m²/day. The recovery data project above the pre-test water level at t/t' = 1.




***Piezometers that Showed Drawdown during AT II with WTH No. 2-10***

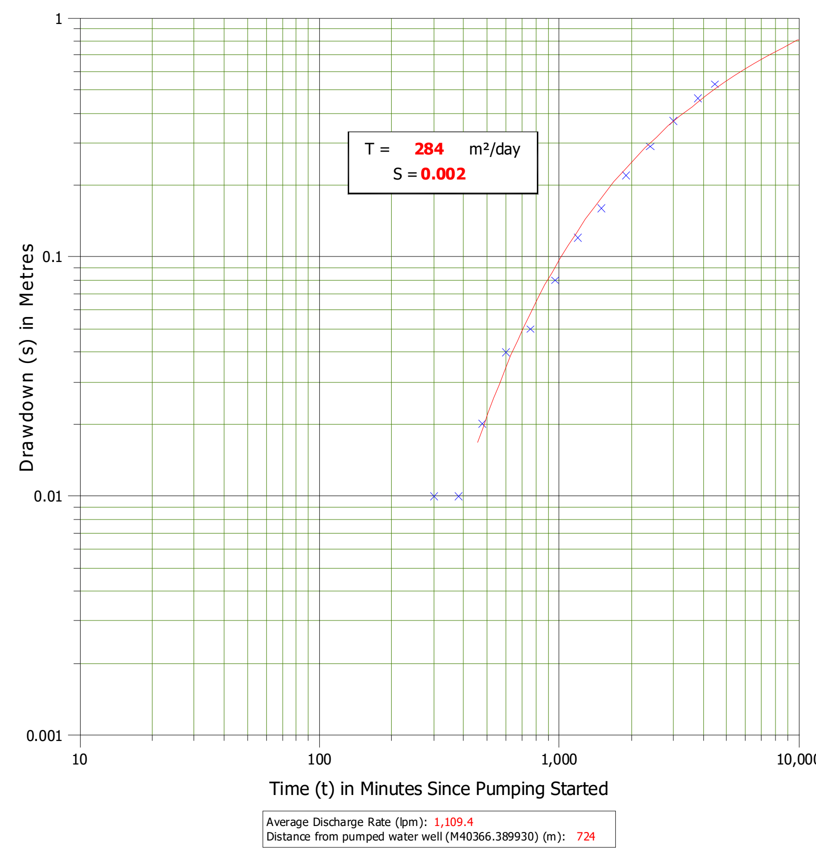
The data from AT II with WTH No. 2-10 are in Appendix C.

During AT II, water levels were also measured and recorded in 13 of the 14 piezometers;[11] drawdown that could be attributed to pumping from WTH No. 2-10 was measured in six of the 13 piezometers during the pumping interval of AT II, as shown in the figure to the left.

[11] Water levels were not measured in Pz No. 3-10.

Log-log plots of the water-level data from the six piezometers that showed drawdown that could be attributed to pumping from WTH No. 2-10 are included in Appendix C. The adjacent figure is an example of one of the log-log plots. The figure shows that the water level in Pz No. 2-10 drew down 0.53 metres during the pumping interval of AT II with WTH No. 2-10. When the drawdown data are analyzed on a log-log plot using a Theis type-curve, the data indicate that the aquifer in which WTH No. 2-10 and Pz No. 2-10 are completed has an effective transmissivity of 284 m²/day with a corresponding storativity of 0.002.

The table below summarizes the transmissivities and corresponding storativities determined from aquifer tests conducted with the two Joburg water test holes as part of the present project.




*Pz No. 2-10 used as an Obs WW during AT II with WTH No. 2-10*

| Pumping Water Test Hole | Aquifer Test | Pumping Rate (lpm) | Pumping Interval (min) | Recovery Interval (min) | Specific Capacity at 10 minutes (lpm/m) | Transmissivity (m²/day) | | | | | | Storativity | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pumping Water Well | | | | Observation Water Well | | Observation Water Well | | |
| | | | | | | Pumping Interval | | Recovery Interval | | Pumping Interval | | Pumping Interval | | |
| | | | | | | Early | Late | Early | Late | Early | Late | Early | Late | Obs WW |
| WTH No. 1-10 | I | 11.5 | 65 | 12 | 288 | - | - | - | - | - | - | - | - | - |
| | II | 705 | 1480 | 2610 | 198 | 2711 | 482 | 2711 | 482 | - | 407 | - | 0.0005 | Pz No. 13-10 |
| | | | | | | | | | | - | 1,478 | - | 0.00009 | Pz No. 14-10 |
| | | | | | | | | | | - | 3,237 | - | 0.002 | Pz No. 9-10 |
| WTH No. 2-10 | I | 1137 | 30 | 1290 | 488 | - | - | 383 | 107 | - | - | - | - | - |
| | II | 1109 | 4470 | 5350 | 493 | 377 | 114 | 377 | 80 | 249 | 84 | 0.001 | 0.0008 | Pz No. 7-10 |
| | | | | | | | | | | 993 | 179 | 0.00009 | 0.0008 | Pz No. 4-10 |
| | | | | | | | | | | 384 | 284 | 0.002 | 0.002 | Pz No. 2-10 |
| | | | | | | | | | | 787 | 353 | 0.001 | 0.0009 | Pz No. 6-10 |
| | | | | | | | | | | - | 202 | - | 0.0005 | Pz No. 12-10 |
| | | | | | | | | | | - | 711 | - | 0.004 | Pz No. 1-10 |

## 4.5. Groundwater Quality

Groundwater samples from ten of the Joburg piezometers and from the two Joburg water test holes were collected as part of the present program and submitted to Exova for analysis; the analyses results are included in Appendix B. Of the 12 analyses, parameters that exceeded the aesthetic objectives (AO) for potable water[12] included TDS (12 samples), manganese (11 samples), iron (ten samples), and sulfate (three samples). Two samples contained parameters (arsenic and uranium) that equalled or exceeded the maximum acceptable concentration (MAC) for health reasons; the adjacent table includes the analyses results for these two samples. Copies of the complete chemical analyses are in Appendix B.

Both uranium and arsenic are naturally-occurring elements in groundwater, typically derived from the weathering of rock or soil. In TGWC database for Alberta, there are 745 results that include an analysis for dissolved arsenic. Of these 745 results, 162 were below the laboratory's detection limit, 499 were below the 0.01 MAC, and 84 equalled or exceeded the MAC. There are 679 results that include an analysis for dissolved uranium. Of these 679 results, 249 were below the laboratory's detection limit, 376 were below the 0.02 MAC, and 55 equalled or exceeded the MAC.

**Comparison Between Recommended Limits For Concentrations of Chemical Constituents in Potable Water and in Groundwater from Pz No. 5-10 and WTH No. 1-10**

| Constituent | Pz No. 5-10<br>29 Jun 10<br>mg/L | WTH No. 1-10<br>02 Jul 10<br>mg/L | GCDWQ-ST Recommended Concentration<br>AO | MAC |
|---|---|---|---|---|
| pH | 7.67 | 7.6 | 6.5-8.5 | --- |
| Conductivity (µS/cm) | 1280 | 2010 | --- | --- |
| Total Dissolved Solids | **861** | **1580** | 500 | --- |
| Sodium | 62.6 | **238** | 200 | --- |
| Potassium | 4.9 | 5.9 | --- | --- |
| Calcium | 174 | 238 | --- | --- |
| Magnesium | 50.7 | 60.2 | --- | --- |
| Total Hardness | 643 | 841 | --- | --- |
| Carbonate | < 6 | < 6 | --- | --- |
| Bicarbonate | 608 | 701 | --- | --- |
| Total Alkalinity | 498 | 575 | --- | --- |
| Sulfate | 268 | **695** | 500 | --- |
| Hydroxide | < 5 | < 5 | | |
| Chloride | 1.8 | 2.3 | 250 | --- |
| Fluoride | | | --- | 1.5 |
| Iron | **2.7** | **4.37** | 0.3 | |
| Manganese | **1.60** | **1.34** | 0.05 | |
| Nitrate + Nitrite (as N) | 0.06 | < 0.07 | --- | 10 |
| Ionic Balance (%) | 101 | 105 | --- | --- |
| Chromium | 0.0025 | 0.0024 | | 0.05 |
| Mercury | < 0.0001 | < 0.0001 | | 0.001 |
| Aluminum | 0.003 | < 0.004 | 0.1 | |
| Antimony | 0.0004 | 0.0005 | | 0.006 |
| Arsenic | **0.013** | **0.011** | | 0.01 |
| Barium | 0.066 | 0.022 | | 1 |
| Boron | 0.142 | 0.18 | | 5 |
| Cadmium | 0.00005 | < 0.00002 | | 0.005 |
| Copper | 0.001 | 0.004 | 1 | |
| Lead | < 0.0001 | < 0.0002 | | 0.01 |
| Selenium | < 0.0002 | < 0.0004 | | 0.01 |
| Uranium | 0.0089 | **0.02** | | 0.02 |
| Zinc | 0.006 | 0.01 | 5 | |

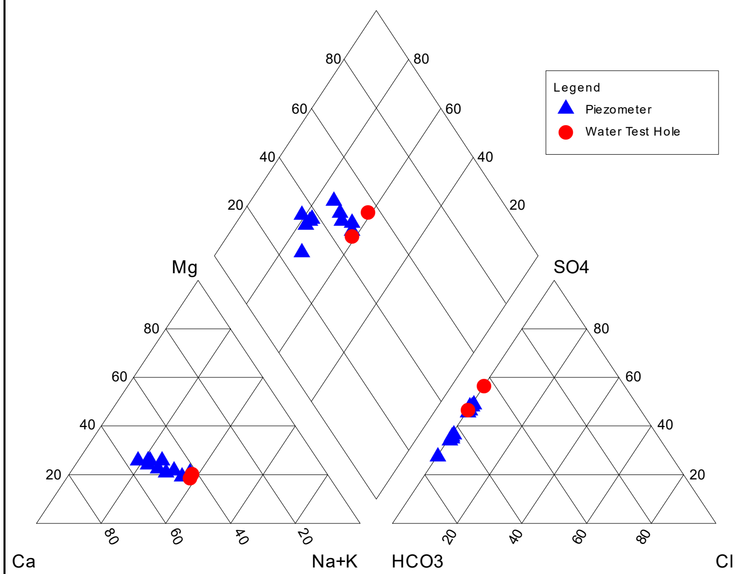
Concentrations are in milligrams per litre unless otherwise stated; extractable results are in brackets
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
**GCDWQ-ST - Guidelines for Canadian Drinking Water Quality – Summary Table, Health Canada, 2012**

***Groundwater Quality Results***

The results of a study of heavy metal concentrations associated with a gravel wash plant currently operated by Lafarge in the Onoway area showed that, after being in operation for over 40 years, gravel washing was not found to cause the concentration of heavy metals to increase in either sediment or water (Hemmera Envirochem Inc., 2002).

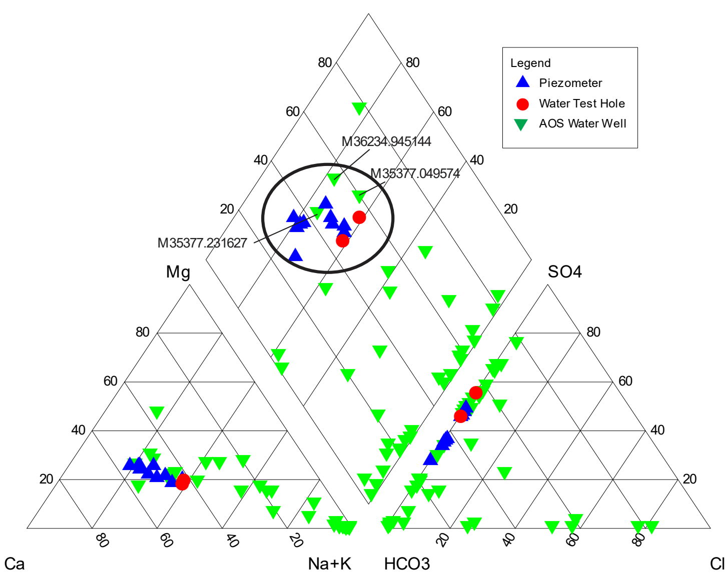
12 Health Canada. 2012. Guidelines for Canadian Drinking Water Quality – Summary Table. The water quality in this discussion compares the groundwater chemistry to those of a drinking water standard. However, the groundwater from the piezometers and water test holes will not be used for public consumption, but could be used in stormwater drainage facilities. The exceedences to the AO and MAC standards would not cause any negative impact on these conveyance systems.

A Piper tri-linear diagram of the routine chemical analyses conducted as part of the present program is shown in the adjacent figure. The diagram shows that the quality of the groundwaters from the Joburg piezometers and water test holes is chemically similar, although the classifications range from calcium-bicarbonate-type waters to calcium-sodium-bicarbonate-sulfate-type waters. The high calcium to sodium+potassium ratio is typical for groundwaters from surficial deposits.



***Piper Tri-Linear Diagram - Piezometers and Water Test Holes***

The Piper diagram below includes the analyses shown on the adjacent figure, with the addition of the 36[13] analyses of groundwaters from water wells in the AOS for which there are sufficient analyzed parameters. The figure below shows a wide range in chemical quality of groundwaters from area water wells, with most of the results indicating a sodium-bicarbonate-type water quality, which is typical for groundwaters from bedrock aquifers. Intermediate results between those analyzed for the Joburg piezometers and water test holes, and the sodium-bicarbonate-type groundwaters may indicate mixing of groundwaters from surficial and bedrock sources.



***Piper Tri-Linear Diagram - All AOS Results***

The groundwaters from three water wells in the AOS have a chemical quality that is similar to the groundwaters from the Joburg piezometers and water test holes, which suggests the three water wells may be completed in an aquifer(s) that is hydraulically connected to the gravel aquifer that is to be mined. The three water wells are GCID Nos. M36234.945144, M35377.049574 and M35377.231627.

13 Four analyses were associated with abandoned water wells, so are not included on the diagram.

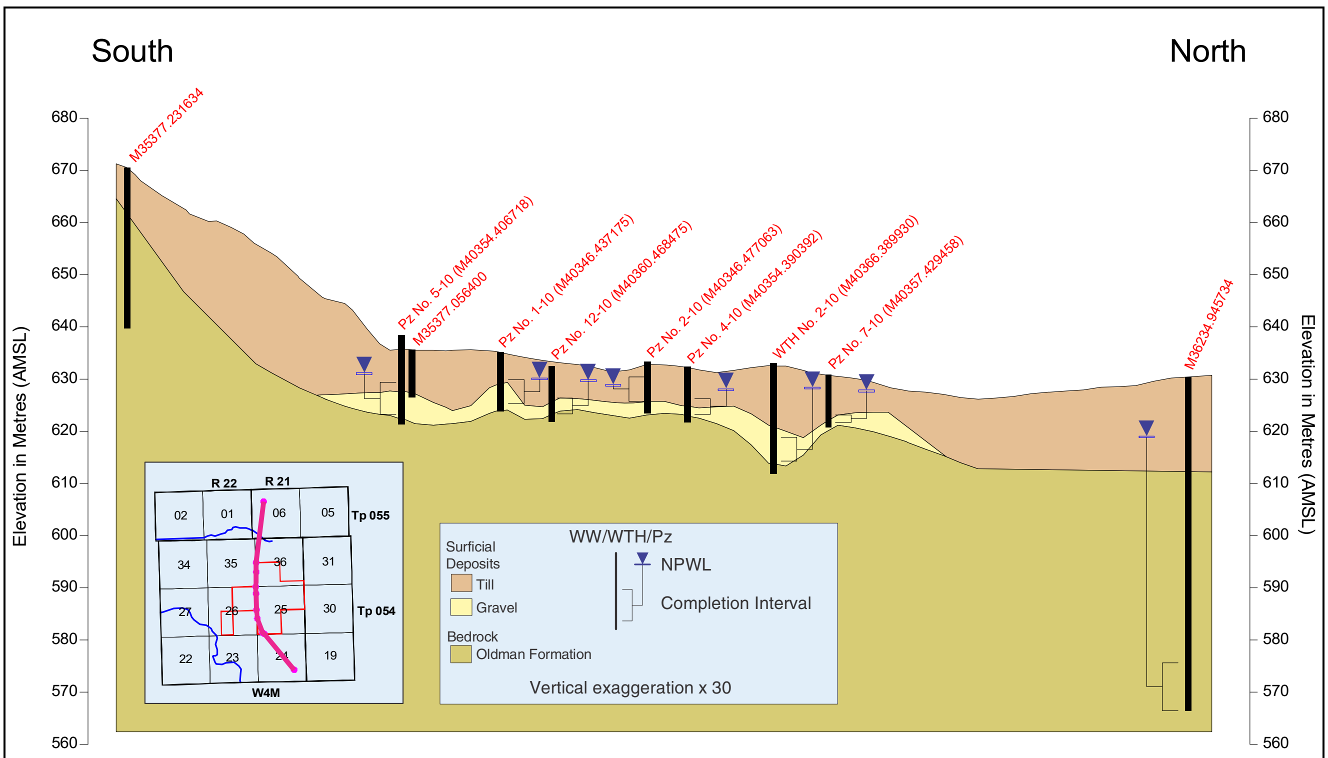
# 5. Interpretation

## 5.1. Gravel Aquifer Extent

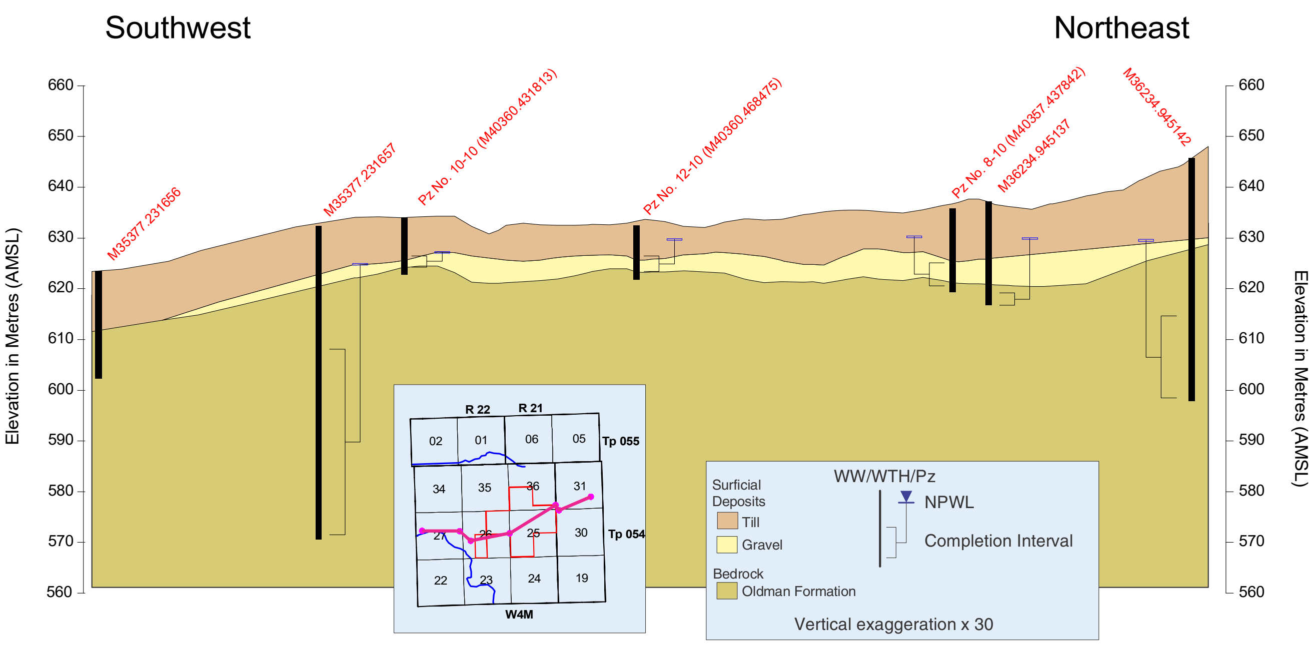
The lithologic information from borehole, piezometer and water test hole drilling indicates that a sand and gravel aquifer underlies the entire proposed development area. Gravel thickness encountered in the 139 control points ranged from 0.1 to 15.5 metres, with an average of 3.9 metres; the gravel was identified in the elevation interval between 612 and 636 metres AMSL.

Two cross-sections have been prepared through part of the AOS. Both cross-sections show the piezometers and water test holes completed as part of the present program, and nearby domestic or stock water wells. Significant information presented on the cross-sections includes:

- a topographic gradient and bedrock surface that generally slopes down from the southeast to the northwest
- the gravel layer typically lying directly on the bedrock surface
- the gravel layer is not reported in many of the water well records outside the proposed development area
- residential or stock water wells are typically completed in bedrock aquifers
- an NPWL in the piezometers and water test holes that is above the top of the gravel, which indicates the sand and gravel deposits and part of the overlying till layers are saturated.




***South - North Cross-Section***




***Southwest - Northeast Cross-Section***

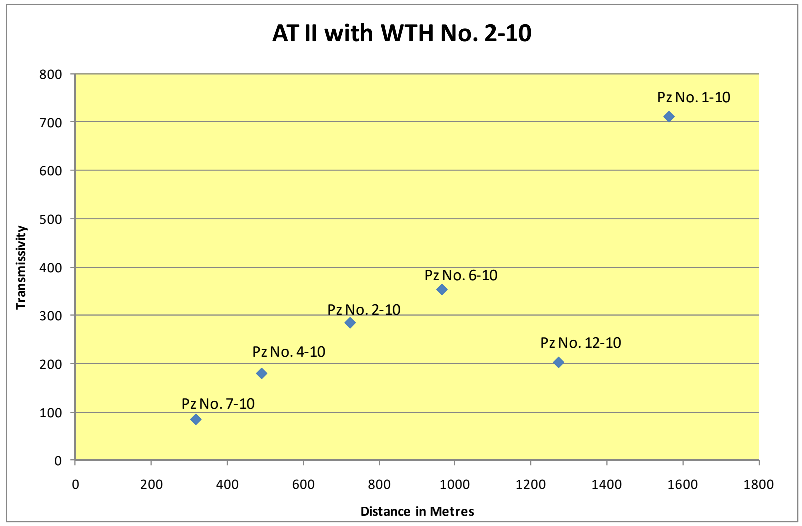
## 5.2. Gravel Aquifer Parameters

| Pz / WTH | Aquifer T (m²/day) | Effective T (m²/day) |
|---|---|---|
| Pz No. 1-10 | 4.9 to 37.3 | 711 |
| Pz No. 2-10 | - | 284 |
| Pz No. 4-10 | 40.5 | 179 |
| Pz No. 5-10 | 238 | - |
| Pz No. 6-10 | 49.3 to 58.6 | 353 |
| Pz No. 7-10 | 1.1 to 8.0 | 84 |
| Pz No. 8-10 | 110 to 121 | - |
| Pz No. 9-10 | 353 | 3,237 |
| Pz No. 10-10 | 5.7 to 18.2 | - |
| Pz No. 11-10 | 47.8 to 54.3 | - |
| Pz No. 12-10 | 124 | 202 |
| Pz No. 13-10 | - | 407 |
| Pz No. 14-10 | - | 1,478 |
| WTH No. 1-10 | 598 | 482 |
| | | 482 |
| WTH No. 2-10 | 107 | 114 |
| | | 80 |

***Calculated Transmissivities***

The calculated transmissivities determined from the short aquifer tests conducted with the piezometers range from 8.0 to 353 m²/day, with an average of 105 m²/day. More realistic values of effective transmissivity were obtained from analyzing the results of the extended aquifer tests with the two water test holes. The adjacent table compares the calculated aquifer transmissivities obtained from short individual aquifer tests with the effective transmissivities based on the late drawdown data for the piezometers, and the late drawdown and late recovery data for the two water test holes. The table shows that the calculated aquifer transmissivities from individual piezometers are significantly lower than the effective transmissivities determined from the extended aquifer tests that used the piezometers as observation water wells. Of the results shown in the table, the effective transmissivity results for Pz Nos. 7-10 and 9-10 should be discounted, because these two piezometers are located in close proximity to groundwater discharge sites during aquifer testing, and could therefore be influenced by artificial aquifer recharge. The influence of artificial recharge would be to cause less drawdown than would otherwise have taken place, which results in erroneously large calculations of transmissivity and storativity. Of the remaining 11 results, the effective transmissivity ranges from 80 to 1,478 m²/day, with an average of 434 m²/day. The calculated storativity determined from the late drawdown data of the piezometers (excluding Pz Nos. 7-10 and 9-10) ranges from 0.00009 to 0.004, with an average of 0.001. The range in calculated aquifer parameters reflects the heterogeneity of the gravel aquifer. Based on a review of aquifer test results, groundwater calculations presented in the remainder of this report will be based on a range in effective transmissivity, from 80 m²/day to 500 m²/day, with an accompanying storativity of 0.001 and an aquifer thickness of 3.9 metres.

In order to refine the estimate of effective transmissivity of the gravel aquifer, the relationship between distance from the pumping water test hole and observation water well was analyzed. The adjacent graph shows that, in general, the calculated effective transmissivity increases with increased distance from the pumping water test hole. At this time, the significance of the relationship is unclear, although one possibility is that the observation water wells located at greater distances from the pumped water test hole exhibited less drawdown and therefore larger effective transmissivities because a greater percentage of the groundwater flowing into the piezometer is derived from storage. If this is the case, the more realistic effective transmissivity of the gravel aquifer would be at the lower end of the 80 to 500 m²/day range reported above.




***Effective Transmissivity versus Distance***

It should be noted that these aquifer parameters are based on data collected in the summer of 2010, and may not accurately reflect conditions throughout the year.

## 5.3. Groundwater Flow

The groundwater flow through the sand or gravel aquifer that would be mined is calculated to be in the order of 360 to 2,250 m³/day. This flow is based on the measured hydraulic gradient of 0.0015 metres per metre, an effective transmissivity ranging from 80 to 500 m²/day and an effective width of 3,000 metres. The flow would be through the aquifer from the southeast to the northwest. It should be noted that the calculated flow velocities do not take into account spring recharge events.

## 5.4. Calculated Dewatering Volumes

As part of the mining operation, groundwater flowing through the aquifer would be captured and used for gravel washing. Based on an effective porosity of 0.1 and an average saturated thickness of approximately 7.0 metres, the volume of groundwater that would be stored in the gravel deposit in the 200 x 200-metre pit would be 28,000 m³. This volume of groundwater would be removed in order to extract the gravel and a small portion would also be used for gravel washing.

A mathematical model was used to calculate the water levels in the gravel aquifer at locations in and near a typical dewatering pit. The model, developed by Mow-Tech Ltd., is called the Infinite Artesian Aquifer Model (IAAM) and is used to calculate water levels at specific locations in the aquifer; the model can be used to simulate boundary conditions and interference from nearby pumping water wells. Each aquifer is considered to be homogeneous and isotropic, and behaves as an aquifer of infinite areal extent; the calculations do not account for recharge to the aquifer.

| Based on T = 80 m²/day | | | Based on T = 500 m²/day | | |
|---|---|---|---|---|---|
| Pumping Rate (m³/day) | No. of Days | Total Diversion (m³) | Pumping Rate (m³/day) | No. of Days | Total Diversion (m³) |
| 1,200 | 21 | 25,200 | 5,400 | 21 | 113,400 |
| 1,100 | 9 | 9,900 | 5,300 | 9 | 47,700 |
| 1,000 | 20 | 20,000 | 5,150 | 10 | 51,500 |
| 970 | 20 | 19,400 | 4,950 | 10 | 49,500 |
| 940 | 20 | 18,800 | 4,750 | 20 | 95,000 |
| 910 | 30 | 27,300 | 4,550 | 20 | 91,000 |
| 880 | 30 | 26,400 | 4,350 | 60 | 261,000 |
| 860 | 90 | 77,400 | 4,200 | 90 | 378,000 |
| | **Total:** | **224,400** | | **Total:** | **1,087,100** |

***Estimated Annual Dewatering***

The adjacent table shows the estimated groundwater diversions required to keep a typical extraction pit dewatered for an eight-month (240-day) extraction season. The calculations are based on:

- effective transmissivities of 80 m²/day and 500 m²/day
- a corresponding storativity of 0.001
- a diversion site assumed to be in the centre of a 200 metre x 200 metre pit
- maintaining a drawdown of approximately 7.0 metres at the edges of the pit
- no aquifer recharge

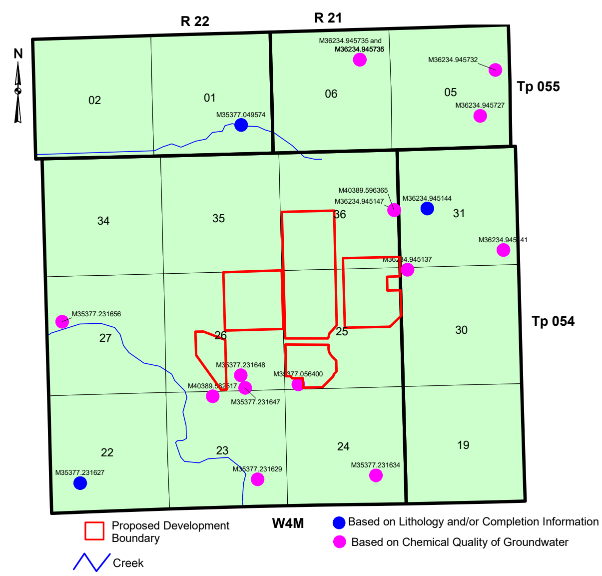
The table shows that an expected dewatering rate could vary from approximately a quarter of a million cubic metres to one million cubic metres per season.[14] Variables associated with the above calculations could result in significant differences to the calculations; these variables include:

- transmissivity and storativity
- saturated thickness (the thickness varies by up to ten metres in the development area)
- aquifer recharge (early spring groundwater levels may be significantly higher than those measured during the present program)
- recirculation; depending on how close the infiltration pond is located to the dewatering site, a significant percentage of groundwater being pumped from a pit could be recirculated.

Since most of the variables mentioned above would result in more groundwater having to be pumped than what is calculated, operations should consider that at least 1,000,000 m³/year would have to be pumped from an extraction pit during an operating season.

[14] The table shows a declining pumping rate over time, which is a result of the expanding water-level cone of depression as pumping continues.

The proposed development plan is to pump the groundwater from an extraction pit to a dewatering pond (or recharge pond) from which the water is pumped to a clean water pond and then to the wash plant(s). Any excess groundwater pumped from the gravel pits that is not used for gravel washing will be allowed to drain into the recharge pond. The water that fills the recharge pond will recharge the shallow aquifer by infiltration through the pond floor and pond walls; there will be no net loss of groundwater other than through evaporation and adhesion to the aggregate. In general a recharge pond needs to be two to three times the size of the pit being dewatered in order to accept the volume of groundwater being dewatered without overflowing the recharge pond. This means that, if the total size of the pits being dewatered is the same size as the recharge ponds, up to two-thirds of the groundwater may have to be diverted off site. Because the permeability of material around recharge ponds may be less than near the dewatering pits, and because deposition of silt in the recharge pond may reduce permeability over time, a development plan should consider alternate water containment or diversion practices. These practices could include having bermed recharge ponds, having more than one recharge pond, situating the recharge ponds on topographically high areas downgradient from extraction sites, using recharge wells, or allowing overflow from recharge ponds into a surface drainage channel.




***Water Wells of Interest***

## 5.5. Water Wells of Interest

There are 99 water well records for the AOS. Water wells that may be affected by dewatering or removal of the gravel aquifer would be those water wells that are completed in the same gravel aquifer that is to be mined. The map above shows the locations of the 18 water wells in the AOS that are determined to be completed in an aquifer in the surficial deposits. The water wells with the symbol "●" are selected based on reported lithology, drilled depth or completion information. The water wells with the symbol "●" are selected based on reported chemical quality of groundwater[15]. Some information related to the 18 water wells is included in the table below:[16]

**Water Wells of Interest**

| GCID | Owner | Legal Location | Field Action* | Depth Drilled (m) | Well Status | Reported Use | Date Completed | Criteria |
|---|---|---|---|---|---|---|---|---|
| M36234.945727 | Snow, Dennis | SE 05 | | 7.3 | Producing | Domestic | | Lithology and/or Completion |
| M36234.945732 | Pickett, Jack | 09-05 | | 4.3 | Producing | Domestic | | |
| M36234.945735 | Schneider, Earl A. | NE 06 | | 18.3 | Producing | Domestic | | |
| M36234.945736 | Alberta Environment | NE 06 | | 15.2 | Observation | Observation | 08-Apr-88 | |
| M35377.231629 | Wright, Karl | SE 23 | | 24.7 | Producing | Domestic | 16-Dec-77 | |
| M40389.582517 | McEachern, Matilda | NW 23 | 1 | | Not In Use | Stock | | |
| M35377.231634 | Whitson, Arnold | SE 24 | | 30.8 | Producing | Domestic & Stock | 27-Mar-81 | |
| M35377.056400 | Whitson, A. B. | 04-25 | 3 | 9.1 | Producing | Domestic & Stock | 01-Jan-11 | |
| M35377.231647 | Slater, Grace | 02-26 | 3 | 70.1 | Producing | Domestic & Stock | 12-Dec-66 | |
| M35377.231648 | Mid Western Industrial Gas Ltd | 02-26 | 4 | 22.9 | Producing | [unknown] | 18-Sep-64 | |
| M35377.231656 | Robertson, F.A. | 12-27 | | 21.3 | Producing | Domestic & Stock | | |
| M36234.945137 | Martin, Evan | NW 30 | 1 | 20.4 | Producing | Domestic (outdoor) | 02-Oct-74 | |
| M36234.945141 | Perry, Al | 01-31 | | 42.7 | Producing | Stock | 01-Apr-74 | |
| M36234.945147 | Smith, F. | 12-31 | 3 | 8.5 | Producing | Domestic & Stock | 01-Jan-20 | |
| M40389.596365 | Mohr, Jim | SE 36 | 2 | | Producing | Not in Use | | |
| M35377.049574 | Wallace, J | SE 01 | | | Producing | Domestic | | Chemical Quality |
| M35377.231627 | Shackleton, Stu | SW 22 | | 9.1 | Producing | [unknown] | | |
| M36234.945144 | Smith, Gloria | WH 31 | 3 | 8.5 | Producing | Domestic | | |

* 1 means physically located, 2 means location provided by owner, 3 means location assumed to be nearest building site, 4 means not located and no evidence of site, no number means the water well is outside the AOI

15 The chemical analyses results for these three groundwater samples are included in the Piper diagram in Section 4.5.
16 Additional information can be obtained from TGWC website at: http://www.tgwc.ca/

Of the 18 water wells shown on the map and table of the previous page, eight water wells shown in the adjacent table are within the AOI. Of these eight water wells, three were located during the water well survey, based on a Field Action of 1 or 2. Of these three water wells, GCID Nos. M40389.582517 and M40389.596365 are not in use. Therefore, GCID No. M36234.945137 in NW 30 is the only in-use water well located within the AOI that could be completed in an aquifer that is hydraulically connected to the gravel that is to be mined. The owner of GCID No. M36234.945137 relies on piped City of Edmonton water for domestic supply, but occasionally uses the water well for outdoor purposes. An attempt was made to conduct a short aquifer test with the water well, but problems with the pump prevented the test from being started, or a groundwater sample from being collected. The owner has not responded to an offer to attempt a new test.

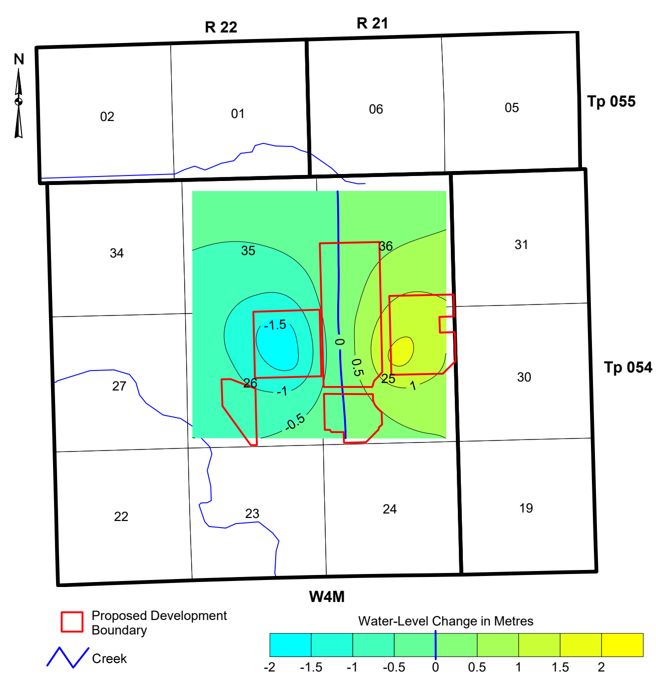
| GCID | Legal Location | Field Action |
|---|---|---|
| M35377.056400 | 04-25 | 3 |
| M35377.231647 | 02-26 | 3 |
| M35377.231648 | 02-26 | 4 |
| M36234.945137 | NW 30 | 1 |
| M36234.945147 | 12-31 | 3 |
| M40389.582517 | NW 23 | 1 |
| M40389.596365 | SE 36 | 2 |
| M36234.945144 | WH 31 | 3 |

***Water Wells of Interest in AOI***

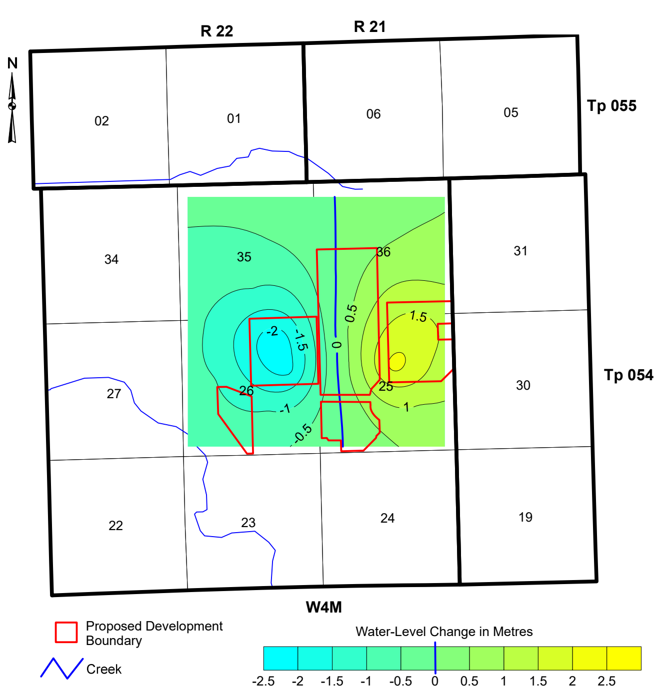
## 5.6. Predicted Impact due to Dewatering

Dewatering and re-introduction of groundwater would result in a localized cone of depression around the dewatering site, and a localized mounding around the recharge site. The two maps on this page show the calculated drawdown and mounding in the Joburg development area based on two different scenarios:

- Scenario 1
  - based on pumping 1,087,100 $m^3$ during the dewatering season, as shown in the table in Section 5.4
  - an effective transmissivity of 500 $m^2$/day and a corresponding storativity of 0.001
- Scenario 2
  - based on pumping 224,400 $m^3$ during the dewatering season, as shown in the table in Section 5.4
  - an effective transmissivity of 80 $m^2$/day and a corresponding storativity of 0.001




**Scenario 1**

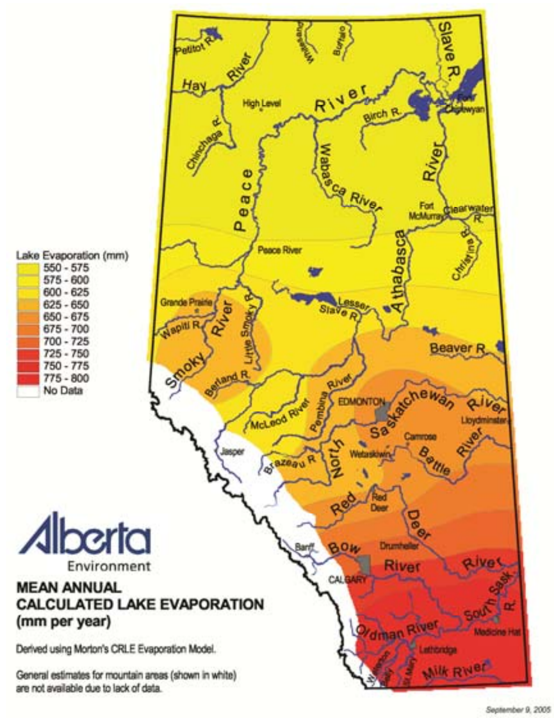



**Scenario 2**

There is little difference between the two maps, because a gravel aquifer with high permeability would require a high pumping rate to dewater, while a gravel aquifer with a lower permeability would require a correspondingly lower dewatering rate.

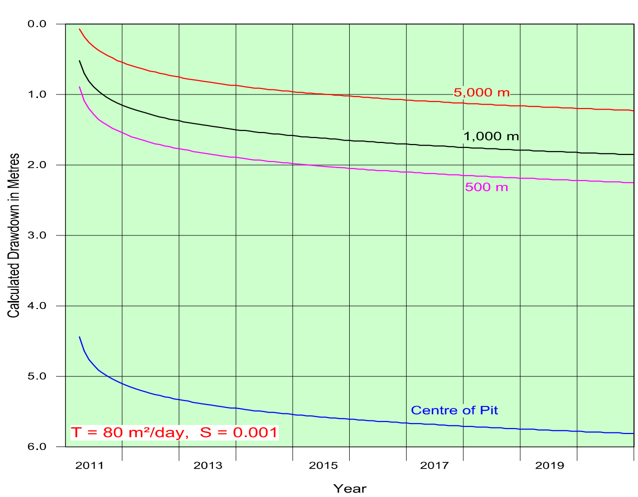
For Scenario 1, calculations indicate that the drawdown and mounding conditions would recover to within 0.06 metres of pre-dewatering conditions within one month of cessation of dewatering. For Scenario 2, calculations indicate that the drawdown and mounding conditions would recover to within 0.06 metres of pre-dewatering conditions after approximately three months of cessation of dewatering.

Pit to pit dewatering results in no net loss of groundwater except for the groundwater removed due to adhesion and evaporation. The annual evaporation from a water body in the Joburg development area is expected to be approximately 680 millimetres, as shown on the adjacent map.[17] Alberta Agriculture data indicate that annual precipitation in the area is expected to be 480 millimetres, which results in a net loss of 200 millimetres per year from any surface-water bodies in the AOS. If it is assumed that there will be two recharge pits and two dewatering pits exposed in any given year, each 200 metres by 200 metres in area, the expected net loss would be in the order of 32,000 m³/year, which is 88 m³/day. If an additional estimated 200 m³/day of groundwater would be removed from the aquifer via adhesion, the net loss of groundwater would be 288 m³/day.

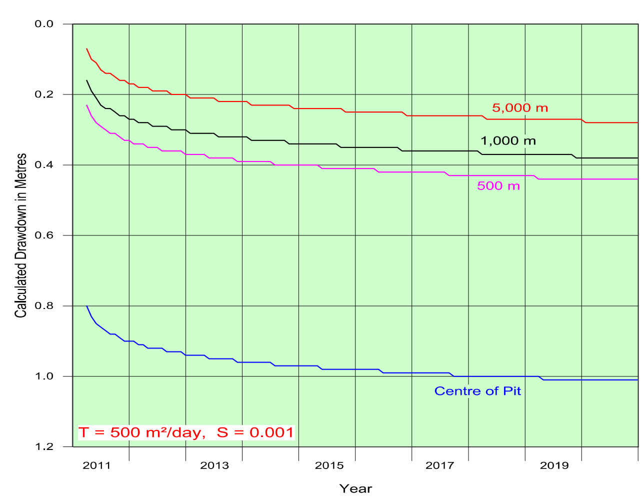



***Annual Evaporation***

The two graphs below show the calculated drawdowns based on a daily net loss of groundwater of 288 m³/day for ten years; the first graph uses an effective transmissivity of 80 m²/day, and the second graph uses an effective transmissivity of 500 m²/day. The first graph shows that there would be a calculated drawdown of 2.3 metres in the gravel aquifer 500 metres from the centre of a dewatering pit after ten years, and the second graph shows that there would be a calculated drawdown of less than 0.5 metres at the same distance. A drawdown of 2.3 metres represents 33% of the average saturated thickness of 7.0 metres in the development area; a drawdown of this magnitude would not represent an adverse effect, and is considered to be conservative, because the calculations do not include aquifer recharge.




***Calculated Drawdown After Ten Years of Operation***
***T = 80 m²/day***




***Calculated Drawdown After Ten Years of Operation***
***T = 500 m²/day***

[17] http://www3.gov.ab.ca/env/water/GWSW/quantity/learn/What/CLM_Climate/CLM_PDF/CLM1_evap_lake.pdf

## 5.7. Predicted Post-Mining Impact

The proposed gravel mining will remove the sand and gravel aquifer from the area that is mined. At the present time, the groundwater flow is from the southeast to the northwest. Once the sand and gravel aquifer is removed and replaced with a minimum one-metre-thick layer of sand material, groundwater flow through the area may be reduced, which may result in the mounding of groundwater upgradient from the mined area. The effective transmissivity of the sand and gravel aquifer is variable based on data collected from extended aquifer tests; calculations included in this report are based on a range from 80 to 500 $m^2$/day, resulting in a calculated flow through the sand and gravel aquifer of 360 to 2,250 $m^3$/day[18]. Because the July 2010 NPWL of the gravel aquifer is within two metres of ground surface in some topographically low areas within the proposed development area, a rise in groundwater levels may result in groundwater coming to surface in these areas. These topographically low areas should be taken into consideration as potential sites for end pit lakes, as part of the reclamation plans. Because the ground surface upgradient of the proposed development area is generally more than ten metres higher in elevation than within the development area, mounding is not expected to result in water levels rising above ground surface outside the development area.

During the mining operation, a small portion of the groundwater pumped from dewatering pits may be used for gravel washing. This wash water is recycled and not returned to the shallow aquifer. The remaining groundwater that is pumped from dewatering pits will be reintroduced to the shallow aquifer via recharge ponds. If the quantity of groundwater produced from dewatering of the mining block is more than the achievable rate of recharge, the excess water will be pumped to the Josephburg WMP.

[18] Calculations include a gradient of 0.0015 and an effective width of 3.000 metres

## 6. Conclusions

ESRD does not require a Licence to be issued for a dewatering project associated with a gravel pit, when the groundwater is allowed to be re-introduced into the aquifer. ESRD has indicated that dewatering the pits must be "on-site", which means that groundwater re-introduced to the aquifer must be on the same quarter section or parcel of land or within a contiguous pit operation. However, gravel washing is a licensable use of groundwater, according to ESRD’s Regulatory Assurance.

Dewatering of the gravel from a typical pit to allow for the mining of the gravel will require in the order of 900 to 4,500 m³/day to be removed from the aquifer. As part of this transferring of groundwater, it is estimated that up to 288 m³/day of the groundwater that is pumped from dewatering pits will be lost to evaporation and adhesion, with the remainder of the groundwater returned to the aquifer via recharge ponds; this net loss of 288 m³/day of groundwater will not have an adverse effect on the aquifer or any nearby water wells located outside the mining area.

Recharge ponds may not be able to contain the volumes of water being removed from extraction pits in the short-term, and it may be necessary to construct alternate solutions for groundwater containment and diversion. These solutions may include having more than one recharge pond, creating bermed recharge ponds, situating the recharge ponds on topographically high areas downgradient from extraction sites, using recharge wells, or allowing overflow from recharge ponds into a surface-drainage channel. Joburg intends to divert any excess groundwater into the Josephburg Water Management Project.

The removal of the gravel has the potential to create a water-related problem as the result of the mounding of groundwater that is expected to occur upgradient of the interface between the mined and unmined areas. In these areas, the natural groundwater flow is impeded where the sand and gravel layer has been removed and replaced with a minimum one-metre-thick layer of sand material. Aquifer test results indicate a flow of groundwater through the aquifer of 360 to 2,250 m³/day. A water-level rise may result in groundwater rising above ground surface in some topographically low areas within the development area. However, because the end pit lakes will be located in these topographically low areas, and because the ground surface upgradient of the proposed development area is generally more than ten metres higher in elevation than within the development area, groundwater mounding is not expected to cause any adverse effects outside the development area.

## 7. Recommendations

An operator wishing to proceed with a proposed gravel-washing operation requires an Application Under the Water Act to be submitted to ESRD for the desired volume of groundwater. The present report can be used as technical support for a groundwater Licence application.

Although the proposed mining activity is unlikely to have negative impacts on the surrounding groundwater users, it is recommended that a meaningful groundwater monitoring program be established. The program would include the at least daily measuring of water levels in at least five of the piezometers installed as part of the present program[19], and at least monthly water levels in the other eight piezometers. There is no need at this time to add any additional piezometers or water wells to the monitoring program. Water levels should be measured to the nearest 0.01 metres. It is also recommended that monitoring data include measurement of daily groundwater diversions; the information should show the volumes of water pumped from specific sites, and the location where the groundwater is discharged. It is also recommended that groundwater samples be collected annually from each of the 13 piezometers completed as part of the present program, and submitted to an accredited laboratory for dissolved metals and routine chemical analysis. After one year of mining, the monitoring data should be analyzed; if there are significant discrepancies to the preliminary review, an updated hydrogeological analysis will be required.

Because groundwater pumped from mining pits may be more than what can infiltrate into recharge ponds, an investigation should be made into the feasibility of diverting any excess water into the Josephburg Water Management Project.

Local groundwater users may be concerned that the operation may impact their groundwater supply. It is recommended that the operator(s) make a commitment to enact a procedure similar to the following:

- When any nearby water well user indicates to the operator(s) that they believe their water supply has been negatively impacted due to the gravel mining operation, the operator(s) will:
    - Provide a temporary alternate water supply within 24 hours, if the resident is without water.
    - Hire an outside consultant to determine the cause of the problem within 14 days.
    - Provide a permanent alternate water supply if the problem is due to the operator's mining operation.

The types of action listed above could provide a comfort to local groundwater users.

Jim Touw, P.Geol
Senior Hydrogeologist

[19] Because Pz No. 4-10 was completed as a replacement for Pz No. 3-10, a water-level recorder would not be necessary for Pz No. 3-10. The selection of piezometers for daily water-level measurements would be based on proximity to the initial extraction pits.

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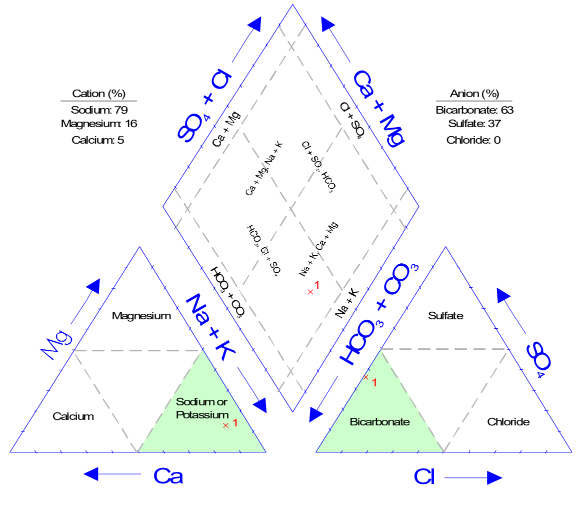
# 9. Glossary

| | |
|---|---|
| AMSL | above mean sea level |
| AO | aesthetic objectives |
| AOI | area of interest (within 1,000 metres of proposed development area) |
| AOS | area of study (four by four section area as shown on page 2) |
| Aquifer | a formation, group of formations, or part of a formation that contains saturated permeable rocks capable of transmitting groundwater to water wells or springs in economical quantities |
| Available Drawdown | in a confined aquifer, the distance between the non-pumping water level and the top of the aquifer<br>in an unconfined aquifer (water table aquifer), two thirds of the saturated thickness of the aquifer and water level within five metres of the top of the aquifer. |
| BGL | below ground level |
| BTOC | below top of casing |
| ESRD | Alberta Environment and Sustainable Resource Development |
| GCDWQ-ST | Guidelines for Canadian Drinking Water Quality Summary Table |
| GPS | global positioning system |
| Hydraulic Conductivity | the rate of flow of water through a unit cross-section under a unit hydraulic gradient; units are length/time |
| Kriging | a geo-statistical method for gridding irregularly-spaced data (Cressie, 1990) |
| MAC | maximum acceptable concentration |
| mm | millimetres |
| $m^2$/day | metres squared per day |
| $m^3$ | cubic metres |
| $m^3$/day | cubic metres per day |
| mg/L | milligrams per litre |
| NPWL | non-pumping water level |
| Obs WW | Observation Water Well |

| | |
|---|---|
| Piper tri-linear diagram | a method that permits the major cation and anion compositions of single or multiple samples to be represented on a single graph. This presentation allows groupings or trends in the data to be identified. From the Piper tri-linear diagram, it can be seen that the groundwater from this sample water well is a sodium-bicarbonate-type. The chemical type has been determined by graphically calculating the dominant cation and anion. For a more detailed explanation, please refer to Freeze and Cherry, 1979 |




***Piper tri-linear diagram***

| | |
|---|---|
| RGA | regional groundwater assessment |
| Surficial Deposits | includes all sediments above the bedrock |
| TDS | total dissolved solids |
| Till | a sediment deposited directly by a glacier that is unsorted and consisting of any grain size ranging from clay to boulders |
| Transmissivity | the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient: a measure of the ease with which groundwater can move through the aquifer<br><br>Apparent Transmissivity: the value determined from a summary of aquifer test data, usually involving only two water-level readings<br><br>Effective Transmissivity: the value determined from late pumping and/or late recovery water-level data from an aquifer test<br><br>Aquifer Transmissivity: the value determined by multiplying the hydraulic conductivity of an aquifer by the thickness of the aquifer |
| WTH | Water Test Hole |
| WW | Water Well |
| VE | vertical exaggeration |
| Yield | a regional analysis term referring to the rate a properly completed water well could be pumped, if fully penetrating the aquifer<br><br>Apparent Yield: based mainly on apparent transmissivity<br><br>Long-Term Yield: based on effective transmissivity |

# Stratigraphy of the "Undisturbed" Geology of Alberta as used by Hydrogeological Consultants Ltd.

upper surficial
lower surficial
Cypress Hills Fm
Dalehurst Member
upper part of Lacombe Member
lower part of Lacombe Member
Haynes Member
upper part of Scollard Fm
lower part of Scollard Fm
Battle/Whitemud Fms
upper part of Horseshoe Canyon Fm
middle part of Horseshoe Canyon Fm
lower part of Horseshoe Canyon Fm
Bearpaw Fm
Oldman Fm
Foremost Fm
Lea Park Fm
Milk River Fm
Colorado Shale
Cardium Fm
Kaskapau Fm
Dunvegan Fm
Shaftesbury Fm
Viking Fm
Joli Fou Fm
upper part of Mannville Grp
middle part of Mannville Grp
lower part of Mannville Grp
Jurassic
Triassic
upper part of Paleozoic
Banff Fm
Wabamun Group
Winterburn Group
Woodbend Group
Beaverhill Lake Group
Elk Point Group
Precambrian

## 10. Conversions

| Multiply | by | To Obtain |
|---|---|---|
| **Length/Area** | | |
| feet | 0.304 785 | metres |
| metres | 3.281 000 | feet |
| hectares | 2.471 054 | acres |
| centimetre | 0.032 808 | feet |
| centimetre | 0.393 701 | inches |
| acres | 0.404 686 | hectares |
| inches | 25.400 000 | millimetres |
| miles (statute) | 1.609 344 | kilometres |
| kilometres | 0.621 370 | miles (statute) |
| square feet ($ft^2$) | 0.092 903 | square metres ($m^2$) |
| square metres ($m^2$) | 10.763 910 | square feet ($ft^2$) |
| square metres ($m^2$) | 0.000 001 | square kilometres ($km^2$) |
| | | |
| **Concentration** | | |
| grains/gallon (UK) | 14.270 050 | parts per million (ppm) |
| parts per million (ppm) | 0.998 859 | milligrams per litre (mg/L) |
| milligrams per litre (mg/L) | 1.001 142 | parts per million (ppm) |
| | | |
| **Volume (capacity)** | | |
| acre feet | 1233.481 838 | cubic metres |
| cubic feet | 0.028 317 | cubic metres |
| cubic metres | 35.314 667 | cubic feet |
| cubic metres | 219.969 248 | imperial gallons (UK) |
| cubic metres | 264.172 050 | gallons (US liquid) |
| cubic metres | 1000.000 000 | litres |
| imperial gallons (UK) | 0.004 546 | cubic metres |
| imperial gallons (UK) | 4.546 000 | litres |
| | | |
| **Rate** | | |
| litres per minute | 0.219 974 | imperial gallons per minute (ipgm) |
| litres per minute | 1.440 000 | cubic metres/day ($m^3$/day) |
| imperial gallons per minute (igpm) | 6.546 300 | cubic metres/day ($m^3$/day) |
| cubic metres/day ($m^3$/day) | 0.152 759 | imperial gallons per minute (ipgm) |
| | | |
| **Pressure** | | |
| pound per square inch (psi) | 6.894 757 | kilopascal (kpa) |
| kilopascal (kpa) | 0.145 038 | pound per square inch (psi) |
| | | |
| **Miscellaneous** | | |
| Celsius | $F^\circ = 9/5\ (C^\circ + 32)$ | Fahrenheit |
| Fahrenheit | $C^\circ = (F^\circ - 32) * 5/9$ | Celsius |
| degrees | 0.017 453 | radians |

# APPENDIX A

## *ADMINISTRATIVE DETAILS*

*(Alberta Environment File No. not available)*

## TABLE OF CONTENTS

## *Field Survey Letter*

hydrogeological consultants ltd.
investigations involving any aspect of **GROUNDWATER**
www.hcl.ca
17740 - 118 Avenue NW, Edmonton, AB T5S 2W3
Tel: 780.483.7240 Fax: 780.484.9413

____________________
Date Delivered

Our File No.: 10-351

To the Resident:

This visit is to gather background hydrogeological data relative to the proposed gravel pit by Reperio Resources Corp. located in Tp 054 and R 21 and 22 W4M. I visited your residence today to confirm some information about your water well(s) and, with your permission, to measure the depth to water in the water well(s), if physically possible. Unfortunately, no one was home.

I have information for a number of water wells in this ¼ section, which has not been assigned to any specific building location. A summary of the water well(s) for the ¼ section is attached, and perhaps one of these water well(s) is yours. If you wish to view details for the individual water well(s), the available data can be viewed at www.groundwatercentre.com by referring to the GCID number. If you wish to view details for the individual water well(s) and you do not have internet access, please contact me at the numbers below.

**If you would like to have the data for your water well(s) verified, please call me toll-free at 1-800-661-6061 ext. 237, or on cell at 780.886.3423, and I will make arrangements to revisit you at a mutually acceptable time. I can also be reached via email at: ben@hcl.ca.**

Thank you in advance for your time and assistance in the management of the groundwater resource in your area.

Yours truly,

Benjamin Gilham, C.E.T.
Hydrogeological Technologist

Cell: 780.886.3423
Tel: 1-800-661-6061 ext. 237
Email: ben@hcl.ca

Please note: If you choose to have your water well verified, your name, in connection with your water well data, may be made publicly available. For further information, please request a copy of our Privacy Policy from our Privacy Officer, Lori Zastre, at 780.702.6243, or at lori@hcl.ca.

L:\2010\10-351\1_Admin\corresp\Field Survey - Letter.doc

## Appendix B – Piezometer and Water Test Hole Details

TABLE OF CONTENTS

# Piezometer No. 1-10

*(Piezometer No. 12)*

**05-25-054-22 W4M**

*(M40346.437175)*

Well Spatial Location:

Easting: ***123,890***
Northing: ***5,948,463***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***635***
::*(elevation accuracy Ground Survey)*

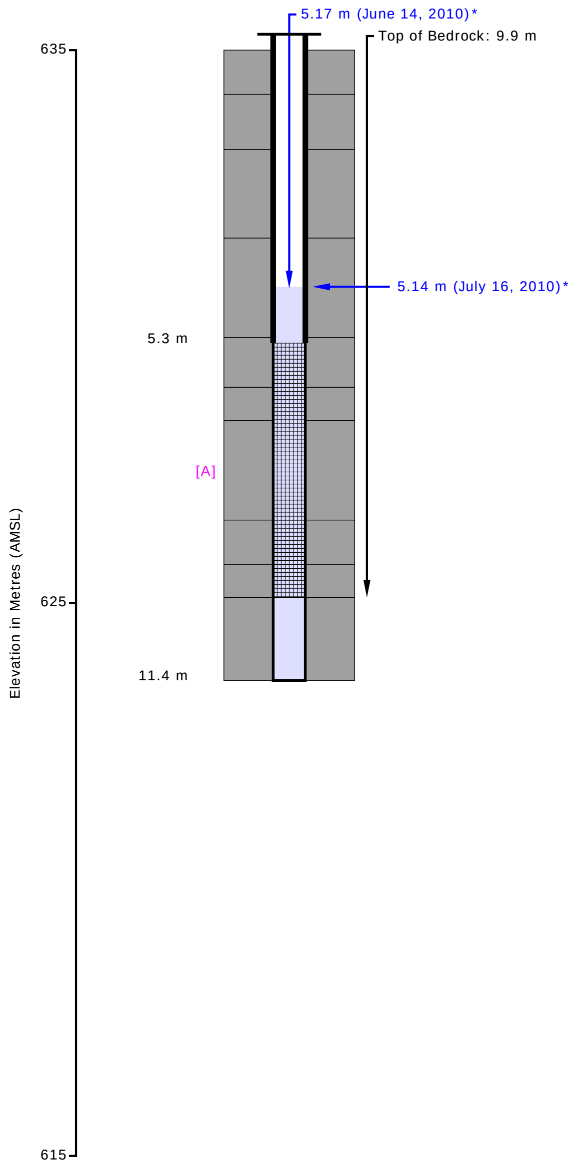
Date Completed: ***June 14, 2010***

Depth Drilled (m): ***11.4***

Completion Interval (m): ***5.3* — *9.9 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***5.14* — *July 16, 2010***
Earliest Water Level (m): ***5.17* — *June 14, 2010***

## *Piezometer No. 1-10*
## *Well Diagram*




**Lithologic Materials (m)**
0.8 - [topsoil]
1.8 - [stiff, brown clay]
3.4 - [brown clay, gravel with iron]
5.2 - [brown clay, larger gravel]
6.1 - [brown clay, gravel, sandstone]
6.7 - [wet brown sand]
8.5 - [sand & clay layers]
9.3 - [brownish grey sand & gravel]
9.9 - [sand]
11.4 - [grey sandstone, bentonite]

**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40346.437175
Well Name: Piezometer No. 1-10
Legal Location: 05-25-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.86 m (not drawn to scale)
Interval [A]: 5.3 to 9.9 m; Screened
*Water Level (recent): 5.14 m on July 16, 2010 @ 11:26 - Reference Point: Top of Casing
*Water Level (oldest): 5.17 m on June 14, 2010 @ 10:42 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: August 11, 2010 14:07 --- http://www.tgwc.ca*

Owner: **Joburg Aggregates Ltd.**
**1610 151 St NW, Edmonton, AB T5M 4E9**

Contractor: **Sun-Alta Drilling Ltd.**
Well Name: **Piezometer No. 1-10**

Field Survey: **June 14, 2010 - Confirmed - Physically**

## METRIC REPORT

Easting (m): **123890.41** ** 75/89
Northing (m): **5948463.02** **
Elevation (m): **635** ***
Google Earth

05-25-054-22 W4M

M40346.437175

189881-1

Work Type: **Piezometer**
Drilling Method: **Auger**
Proposed Use: **Monitoring**
Completion Type: **Screen**

Date Started: **June 14, 2010**
Date Completed: **June 14, 2010**
Well Status: **Observation**
Feature Class: **Piezometer**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.9**
Flowing: **No**

### General Details

Depth Completed (m): **9.9**
Depth Drilled (m): **11.4**
Top of Bedrock (m): **9.9 ***
Completion Interval (m): **5.3 — 9.9 ***

### Completion Details

Surface Casing: **PVC — 50.8 mm (O.D.) x 5.30 m (bottom)**

Screen Material: **PVC — (Attached To Casing)**
Fittings: **Top: Threaded — Bottom: Plug**
Pack: **[unknown]**

### Intervals

*Screen*: **5.3** to **9.9 m - 20 slot**

*Bentonite Chips*: **0.0** to **4.9 m**
*Sand Pack*: **4.9** to **8.5 m**
*Natural Pack*: **8.5** to **9.9 m**

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 634.5 | 0.8 | [topsoil] |
| 633.5 | 1.8 | [stiff, brown clay] |
| 631.9 | 3.4 | [brown clay, gravel with iron] |
| 630.1 | 5.2 | [brown clay, larger gravel] |
| 629.2 | 6.1 | [brown clay, gravel, sandstone] |
| 628.6 | 6.7 | [wet brown sand] |
| 626.8 | 8.5 | [sand & clay layers] |
| 626.0 | 9.3 | [brownish grey sand & gravel] |
| 625.4 | 9.9 | [sand] |
| 623.9 | 11.4 | [grey sandstone, bentonite] |

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: **June 23, 2010**
Analysis Details: **June 28, 2010 - Exova Canada Inc. (748529-1)**

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1240 | Nitrate as N: | < 0.01 | Colour (TCU): | > 60 |
| TDS (Calculated): | 894 | Nitrite as N: | 0.02 | Turbidity (NTU): | 211 |
| Hardness (as CaCO3): | 607 | pH (pH Unit): | 7.75 | Fluoride: | 0.13 |
| T-Alkalinity (as CaCO3): | 520 | Ion Balance (%): | 94 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 634 |
| Nitrate + Nitrite as N: | 0.02 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 22.6 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | 161 | | Mercury: | | |
| Chloride: | | 2.6 | Molybdenum: | | |
| Iron: | 0.38 | | Magnesium: | 49.8 | |
| Manganese: | 2.48 | | Sodium: | 74.6 | |
| Aluminum: | | | Potassium: | 5.2 | |
| Arsenic: | | | Vanadium: | | |
| Barium: | | | Strontium: | | |
| Beryllium: | | | Nickel: | | |
| Cadmium: | | | Zinc: | | |
| Chromium: | | | Copper: | | |
| Cobalt: | | | Lead: | | |
| Sulfate: | 288 | | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: **Sample collected by hydrogeological consultants ltd. (HCL)**

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

### General Comments / Observations

Most Recent Water Level (m): **5.14 m — July 16, 2010**

Oil Present: **No**
Gas Present: **No**

Water Used For Drilling

### Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-23 12:14 | Pump | 5.30 to 9.90 | 67.0 | 72.0 | 5.5 | 4.59 | 2.16 | — | 1.2 | | 4.6 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

### Alias IDs

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

*This report was generated on: November 30, 2012 — Data "AS IS"; no warranty either expressed or implied. [53.691584 -113.122962 (WGS 84)], INT*

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W: www.exova.com

Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **748529** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-963641 |
| | 17740 - 118 Avenue | Name: | Gravel Development-Heartland | Date Received: | Jun 24, 2010 |
| | Edmonton, AB, Canada | Location: | 054-22 W4M | Date Reported: | Jun 28, 2010 |
| | T5S 2W3 | LSD: | 05-25-054-22 W4M | Report Number: | 1336973 |
| Attn: | Tara Parker | P.O.: | 13853 | | |
| Sampled By: | Jen Chomyk | Acct code: | | | |
| Company: | HCL | | | | |

| | |
|---|---|
| **Reference Number** | 748529-1 |
| **Sample Date** | June 23, 2010 |
| **Sample Time** | NA |
| **Sample Location** | |
| **Sample Description** | Piez No. 1-10 M40346.437175 / 05-25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Physical and Aggregate Properties** | | | | | | |
| Colour | Apparent, Potable | Colour units | >60 | 5 | 15 | Above AO |
| Turbidity | | NTU | 211 | 0.1 | 0.1 | Above OG |
| **Routine Water** | | | | | | |
| pH | | | 7.75 | | 6.5 - 8.5 | Within AO |
| Temperature of observed pH | | °C | 22.6 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1240 | 1 | | |
| Calcium | Extractable | mg/L | 161 | 0.2 | | |
| Magnesium | Extractable | mg/L | 49.8 | 0.2 | | |
| Sodium | Extractable | mg/L | 74.6 | 0.4 | 200 | Below AO |
| Potassium | Extractable | mg/L | 5.2 | 0.4 | | |
| Iron | Extractable | mg/L | 0.38 | 0.01 | 0.3 | Above AO |
| Manganese | Extractable | mg/L | 2.48 | 0.005 | 0.05 | Above AO |
| Chloride | Dissolved | mg/L | 2.6 | 0.4 | 250 | Below AO |
| Fluoride | | mg/L | 0.13 | 0.05 | 1.5 | Below MAC |
| Nitrate - N | | mg/L | <0.01 | 0.01 | 10 | Below MAC |
| Nitrite - N | | mg/L | 0.020 | 0.005 | 1 | Below MAC |
| Nitrate and Nitrite - N | | mg/L | 0.02 | 0.01 | 10 | Below MAC |
| Sulfate (SO4) | | mg/L | 288 | 0.9 | 500 | Below AO |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 634 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 520 | 5 | | |
| Total Dissolved Solids | | mg/L | 894 | 1 | 500 | Above AO |
| Hardness | as CaCO3 | mg/L | 607 | | | |
| Ionic Balance | | % | 94 | | | |

Approved by: Anthony Neumann

Anthony Neumann, MSc
Laboratory Operations Manager

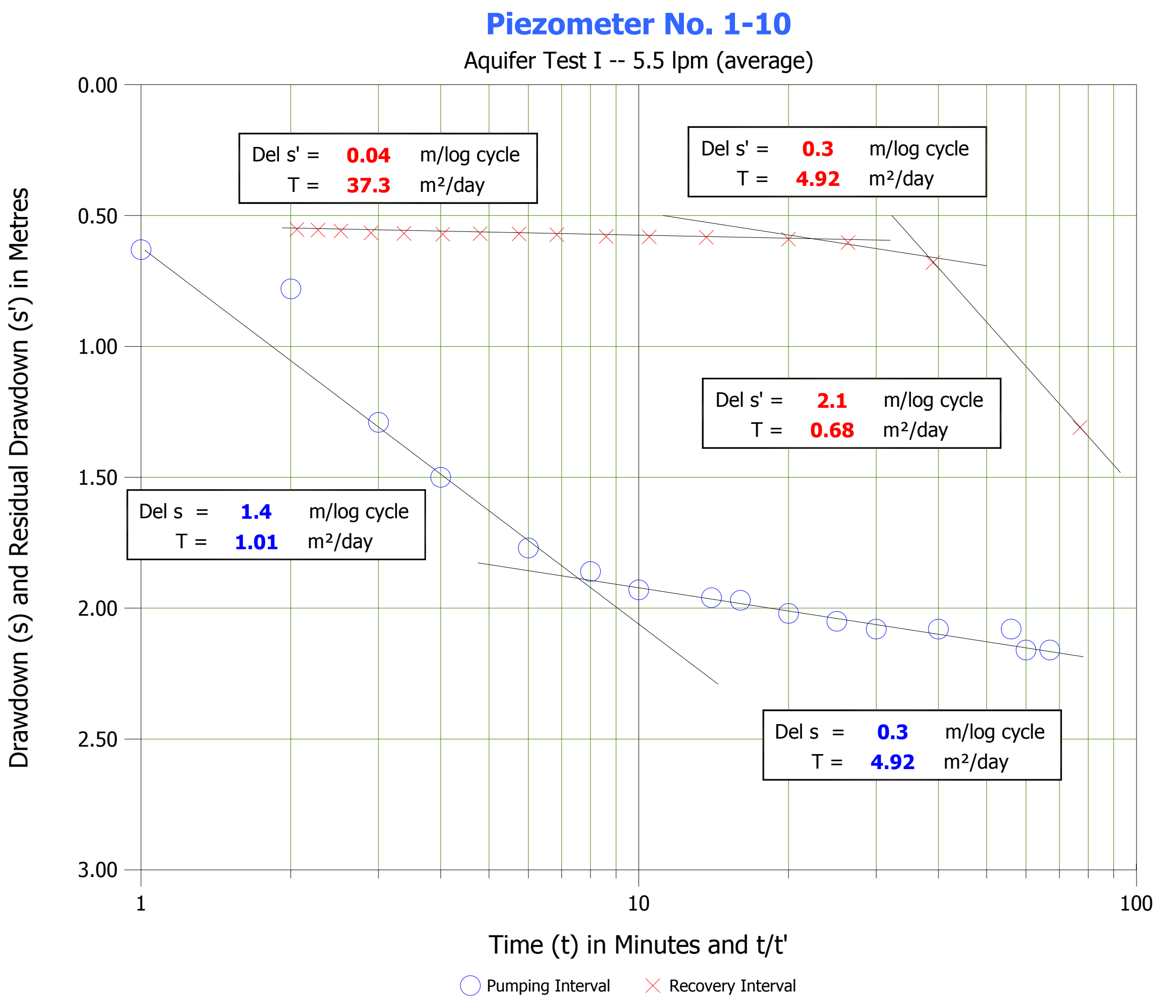
## *Piezometer No. 1-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 1-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 1-10**

*(formerly Piezometer No. 12)*

**05-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **5.5** | Pre-Test Water Level - NPWL (m): | **4.59** |
| Date Test Started: | **June 23, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **12:14** | Test Interval - Top (m): | **5.3** |
| Pumping Interval (minutes): | **67** | Test Interval - Bottom (m): | **9.9** |
| Recovery Interval (minutes): | **72** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40346.437175 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.63 | 5.5 |
| 2 | 0.78 | 5.5 |
| 3 | 1.29 | 5.5 |
| 4 | 1.50 | 5.5 |
| 6 | 1.77 | 5.5 |
| 8 | 1.86 | 5.5 |
| 10 | 1.93 | 5.5 |
| 14 | 1.96 | 5.5 |
| 16 | 1.97 | 5.5 |
| 20 | 2.02 | 5.5 |
| 25 | 2.05 | 5.5 |
| 30 | 2.08 | 5.5 |
| 40 | 2.08 | 5.5 |
| 56 | 2.08 | 5.5 |
| 60 | 2.16 | 5.5 |
| 67 | 2.16 | 5.5 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 68 | 1.31 |
| 2 | 35 | 0.68 |
| 3 | 23 | 0.60 |
| 4 | 17.8 | 0.59 |
| 6 | 12.2 | 0.58 |
| 8 | 9.4 | 0.58 |
| 10 | 7.7 | 0.58 |
| 13 | 6.2 | 0.57 |
| 16 | 5.2 | 0.57 |
| 20 | 4.4 | 0.57 |
| 25 | 3.7 | 0.57 |
| 32 | 3.1 | 0.57 |
| 40 | 2.7 | 0.57 |
| 50 | 2.3 | 0.56 |
| 60 | 2.1 | 0.56 |
| 72 | 1.93 | 0.55 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd. Water levels were measured manually during the pumping interval. Water levels were measured by a Minitroll during the recovery interval.

# Piezometer No. 2-10

*(Piezometer No. 5)*

**16-26-054-22 W4M**

*(M40346.477063)*

Well Spatial Location:

Easting: ***123,845***
Northing: ***5,949,303***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***633***
::*(elevation accuracy Ground Survey)*

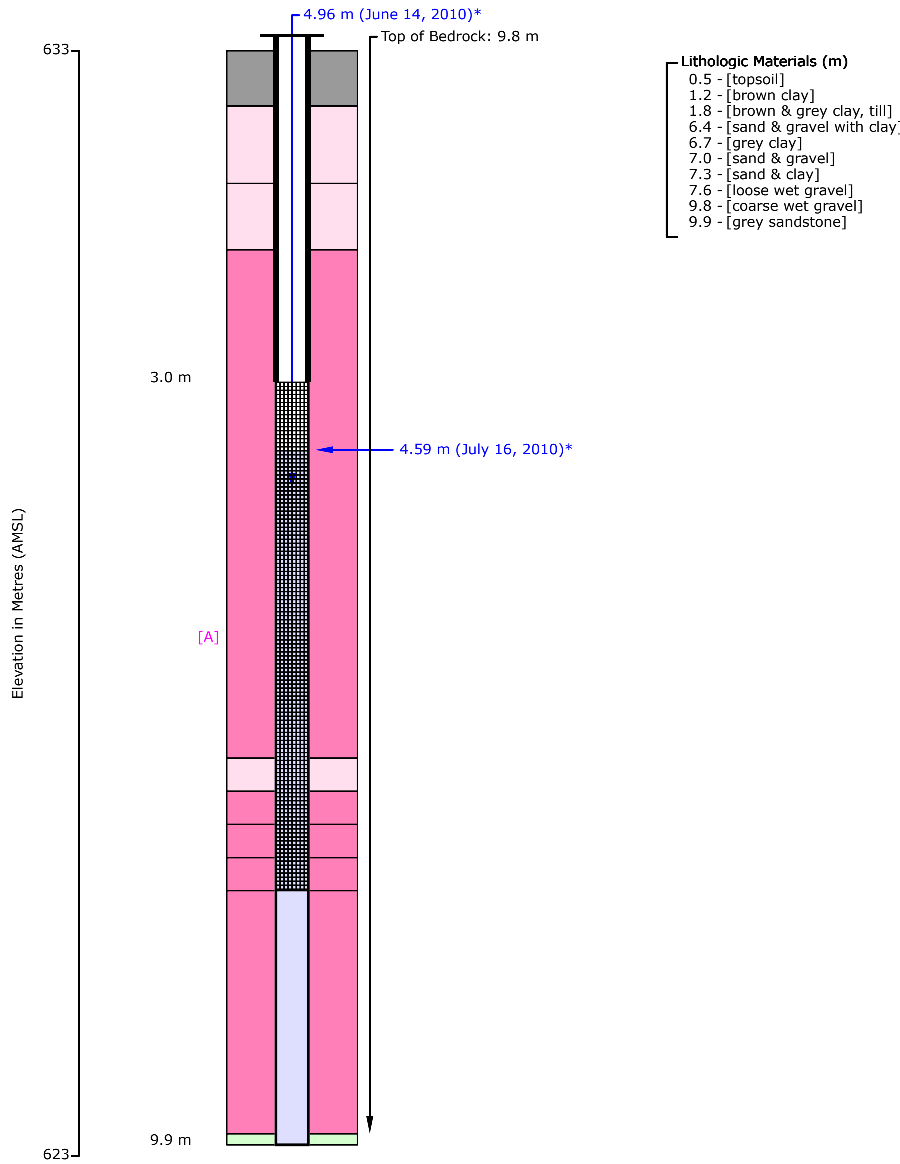
Date Completed: ***June 14, 2010***

Depth Drilled (m): ***9.9***

Completion Interval (m): ***3.0* — *7.6 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***4.59* — *July 16, 2010***
Earliest Water Level (m): ***4.96* — *June 14, 2010***

## *Piezometer No. 2-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted; Fine Grained; Coarse Grained
Bedrock: Fine Grained; Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40346.477063
Well Name: Piezometer No. 2-10
Legal Location: 16-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.98 m (not drawn to scale)
Interval [A]: 3.0 to 7.6 m; Screened
*Water Level (recent): 4.59 m on July 16, 2010 @ 11:45 - Reference Point: Top of Casing
*Water Level (oldest): 4.96 m on June 14, 2010 @ 14:48 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: August 27, 2010 08:06 --- http://www.tgwc.ca*

Owner: *Joburg Aggregates Ltd.*
*1610 151 St NW, Edmonton, AB T5M 4E9*

Contractor: *Sun-Alta Drilling Ltd.*
Well Name: *Piezometer No. 2-10*

Field Survey: *June 14, 2010 - Confirmed - Physically*

**METRIC REPORT**

| | | |
|---|---|---|
| Easting (m): | 123844.52 ** | 75/89 |
| Northing (m): | 5949303.37 ** | |
| Elevation (m): | 633 *** | |

Google Earth

16-26-054-22 W4M

M40346.477063

Work Type: *Piezometer*
Drilling Method: *Auger*
Proposed Use: *Monitoring*
Completion Type: *Screen*
Date Started: *June 14, 2010*
Date Completed: *June 14, 2010*
Well Status: *Observation*
Feature Class: *Piezometer*

Elog Taken: *No*
Gamma Taken: *No*
Stick Up (m): *1.0*
Flowing: *No*

## General Details

Depth Completed (m): *7.6*
Depth Drilled (m): *9.9*
Top of Bedrock (m): *9.8 **
Completion Interval (m): *3.0 — 7.6 **

## Completion Details

Surface Casing: *PVC — 50.8 mm (O.D.) x 3.00 m (bottom)*

Screen Material: *PVC — (Attached To Casing)*
Fittings: *Top: Threaded — Bottom: Plug*
Pack: *[unknown]*

## Intervals

*Screen*: *3.0* to *7.6 m - 20 slot*

*Bentonite Chips*: *0.0* to *2.6 m*
*Sand Pack*: *2.6* to *4.3 m*
*Natural Pack*: *4.3* to *7.6 m*

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 632.9 | 0.5 | [topsoil] |
| 632.2 | 1.2 | [brown clay] |
| 631.6 | 1.8 | [brown & grey clay, till] |
| 627.0 | 6.4 | [sand & gravel with clay] |
| 626.7 | 6.7 | [grey clay] |
| 626.4 | 7.0 | [sand & gravel] |
| 626.1 | 7.3 | [sand & clay] |
| 625.8 | 7.6 | [loose wet gravel] |
| 623.6 | 9.8 | [coarse wet gravel] |
| 623.5 | 9.9 | [grey sandstone] |

## General Comments / Observations

*The total depth drilled was 9.9 metres BGL but due to material sloughing into the hole the casing could only be installed to a depth of 7.6 metres BGL.*

Most Recent Water Level (m): *4.59 m — July 16, 2010*

Oil Present: *No*
Gas Present: *No*

Water Used For Drilling

## Aquifer Tests

| Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

# Piezometer No. 3-10

*(Piezometer No. 4)*

**16-26-054-22 W4M**

*(M40346.495360)*

Well Spatial Location:

Easting: ***123,839***
Northing: ***5,949,535***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***632***
::*(elevation accuracy Ground Survey)*

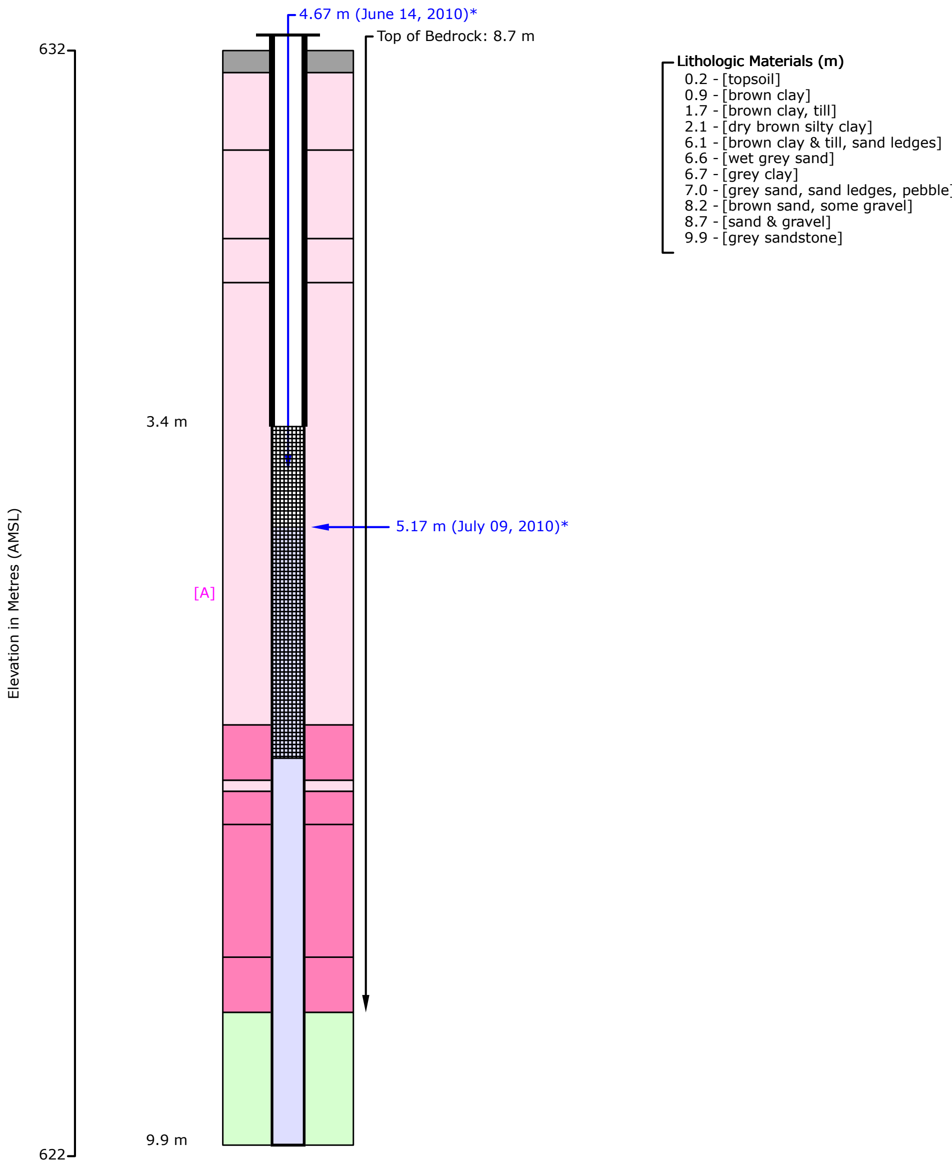
Date Completed: ***June 14, 2010***

Depth Drilled (m): ***9.9***

Completion Interval (m): ***3.4* — *6.4 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***5.17* — *July 09, 2010***
Earliest Water Level (m): ***4.67* — *June 14, 2010***

## *Piezometer No. 3-10*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40346.495360
Well Name: Piezometer No. 3-10
Legal Location: 16-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.86 m (not drawn to scale)
Interval [A]: 3.4 to 6.4 m; Screened
*Water Level (recent): 5.17 m on July 09, 2010 @ 09:14 - Reference Point: Top of Casing
*Water Level (oldest): 4.67 m on June 14, 2010 @ 16:33 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: August 27, 2010 08:06 --- http://www.tgwc.ca*

Owner: **Joburg Aggregates Ltd.**
**1610 151 St NW, Edmonton, AB T5M 4E9**

Contractor: **Sun-Alta Drilling Ltd.**
Well Name: **Piezometer No. 3-10**

Field Survey: **June 14, 2010 - Confirmed - Physically**

## METRIC REPORT

Easting (m): **123838.69** ** 75/89
Northing (m): **5949535.07** **
Elevation (m): **632** ***
Google Earth

16-26-054-22 W4M

M40346.495360

Work Type: **Piezometer**
Drilling Method: **Auger**
Proposed Use: **Monitoring**
Completion Type: **Screen**
Date Started: **June 14, 2010**
Date Completed: **June 14, 2010**
Well Status: **Observation**
Feature Class: **Piezometer**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.9**
Flowing: **No**

### General Details

Depth Completed (m): **6.4**
Depth Drilled (m): **9.9**
Top of Bedrock (m): **8.7 ***
Completion Interval (m): **3.4 — 6.4 ***

### Completion Details

Surface Casing: **PVC — 50.8 mm (O.D.) x 3.40 m (bottom)**

Screen Material: **PVC — (Attached To Casing)**
Fittings: **Top: Threaded — Bottom: Plug**
Pack: **[unknown]**

### Intervals

Screen: **3.4** to **6.4 m - 20 slot**

Bentonite Chips: **0.0** to **3.0 m**
Sand Pack: **3.0** to **4.6 m**
Natural Pack: **4.6** to **6.4 m**

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 632.3 | 0.2 | [topsoil] |
| 631.6 | 0.9 | [brown clay] |
| 630.8 | 1.7 | [brown clay, till] |
| 630.4 | 2.1 | [dry brown silty clay] |
| 626.4 | 6.1 | [brown clay & till, sand ledges] |
| 625.9 | 6.6 | [wet grey sand] |
| 625.8 | 6.7 | [grey clay] |
| 625.5 | 7.0 | [grey sand, sand ledges, pebble] |
| 624.3 | 8.2 | [brown sand, some gravel] |
| 623.8 | 8.7 | [sand & gravel] |
| 622.6 | 9.9 | [grey sandstone] |

### General Comments / Observations

*The total depth drilled was 9.9 metres BGL but due to material sloughing into the hole the casing could only be installed to a depth of 6.4 metres BGL.*

Most Recent Water Level (m): **5.17 m — July 09, 2010**

Oil Present: **No**
Gas Present: **No**

### Water Used For Drilling

### Aquifer Tests

| Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| --- Used as Observation Water Well During Aquifer Test No. 1 with M40354.390392 --- | | | | | | | | | | | | | R C |

### Alias IDs

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

# Piezometer No. 4-10

*(Piezometer No. 4A)*

**16-26-054-22 W4M**

*(M40354.390392)*

Well Spatial Location:

Easting: ***123,833***
Northing: ***5,949,536***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***632***
::*(elevation accuracy Ground Survey)*

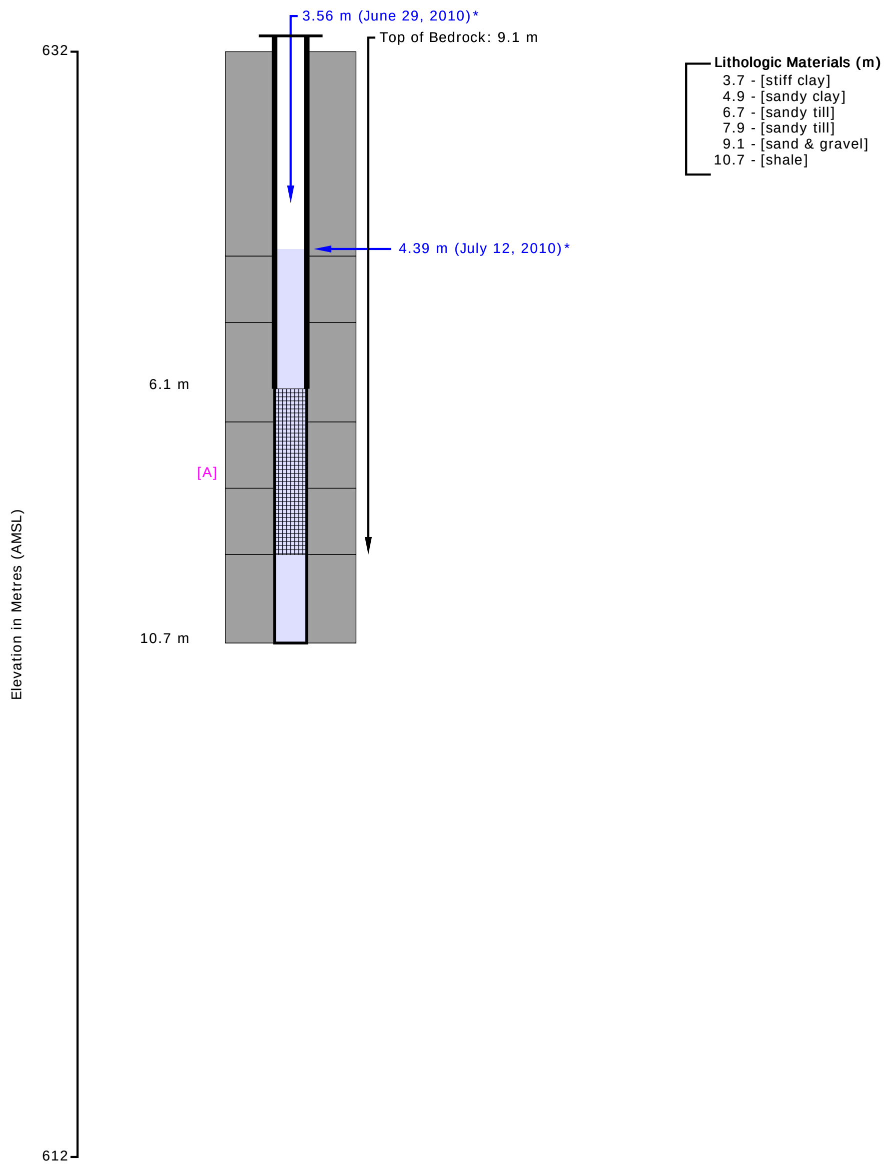
Date Completed: ***June 24, 2010***

Depth Drilled (m): ***10.7***

Completion Interval (m): ***6.1 — 9.1 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***4.39 — July 12, 2010***
Earliest Water Level (m): ***3.56 — June 29, 2010***

## *Piezometer No. 4-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40354.390392
Well Name: Piezometer No. 4-10
Legal Location: 16-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.82 m (not drawn to scale)
Interval [A]: 6.1 to 9.1 m; Screened
*Water Level (recent): 4.39 m on July 12, 2010 @ 09:30 - Reference Point: Top of Casing
*Water Level (oldest): 3.56 m on June 29, 2010 @ 13:35 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: November 30, 2012 16:10 --- http://www.tgwc.ca*

Owner: *Joburg Aggregates Ltd.*
*1610 151 St NW, Edmonton, AB T5M 4E9*

Contractor: *Lakeland Drilling Ltd.*
Well Name: *Piezometer No. 4-10*

Field Survey: *June 24, 2010 - Confirmed - Physically*

## METRIC REPORT

16-26-054-22 W4M

M40354.390392

189905-1

| | | | |
|---|---|---|---|
| Easting (m): | 123833.00 ** | 75/89 |
| Northing (m): | 5949536.00 ** | |
| Elevation (m): | 632 *** | |

Google Earth

| | |
|---|---|
| Work Type: *Piezometer* | Date Started: *June 24, 2010* |
| Drilling Method: *Drilled* | Date Completed: *June 24, 2010* |
| Proposed Use: *Monitoring* | Well Status: *Observation* |
| Completion Type: *Screen* | Feature Class: *Piezometer* |

Elog Taken: *No*
Gamma Taken: *No*
Stick Up (m): *0.8*
Flowing: *No*

### General Details

Depth Completed (m): *9.1*
Depth Drilled (m): *10.7*
Top of Bedrock (m): *9.1 **
Completion Interval (m): *6.1 — 9.1 **

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 628.7 | 3.7 | [stiff clay] |
| 627.5 | 4.9 | [sandy clay] |
| 625.7 | 6.7 | [sandy till] |
| 624.5 | 7.9 | [sandy till] |
| 623.3 | 9.1 | [sand & gravel] |
| 621.7 | 10.7 | [shale] |

### Completion Details

Surface Casing: *PVC — 50.8 mm (O.D.) x 6.10 m (bottom)*

Screen Material: *PVC — (Attached To Casing)*
Fittings: *Top: Threaded — Bottom: Plug*
Pack: *[unknown]*

### Intervals

*Screen*: *6.1* to *9.1 m - 20 slot*

*Bentonite Chips*: *0.0* to *5.5 m*
*Sand Pack*: *5.5* to *10.7 m*

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: *June 29, 2010*
Analysis Details: *July 08, 2010 - Exova Canada Inc. (750102-3)*

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (μS/cm): | 1470 | Nitrate as N: | < 0.01 | Colour (TCU): | |
| TDS (Calculated): | 1030 | Nitrite as N: | 0.027 | Turbidity (NTU): | |
| Hardness (as $CaCO_3$): | 608 | pH (pH Unit): | 7.67 | Fluoride: | |
| T-Alkalinity (as $CaCO_3$): | 479 | Ion Balance (%): | 99 | Carbonate: | < 6 |
| P-Alkalinity (as $CaCO_3$): | < 5 | Total Coliforms**: | | Bicarbonate: | 584 |
| Nitrate + Nitrite as N: | 0.03 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.7 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 166 | Mercury: | | < 0.0001 |
| Chloride: | | 3.4 | Molybdenum: | < 0.001 | < 0.001 |
| Iron: | | 1.04 | Magnesium: | | 47.3 |
| Manganese: | | 1.35 | Sodium: | | 127 |
| Aluminum: | 0.032 | 0.002 | Potassium: | | 5.2 |
| Arsenic: | 0.0033 | 0.003 | Vanadium: | 0.0136 | 0.0054 |
| Barium: | 0.052 | 0.057 | Strontium: | 1.16 | 1.14 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0014 | 0.0009 |
| Cadmium: | 0.00007 | 0.00012 | Zinc: | 0.002 | 0.009 |
| Chromium: | 0.0051 | 0.0022 | Copper: | 0.002 | 0.002 |
| Cobalt: | 0.0018 | 0.0021 | Lead: | < 0.0001 | 0.0002 |
| Sulfate: | | 399 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: *Sample collected by Mow-Tech Ltd.*

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

### General Comments / Observations

*Piezometer was developed for 30 minutes following completion at a rate of approximately 15.9 lpm. Drilled as a replacement piezometer for Piezometer No. 4 (M40346.495360).*

Most Recent Water Level (m): *4.39 m — July 12, 2010*

Oil Present: *No*
Gas Present: *No*

### Water Used For Drilling

### Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-29 13:42 | Pump | 6.10 to 9.10 | 63.0 | 69.0 | 13.2 | 3.56 | 1.71 | — | 14.4 | | 14.9 | | | R C |

*--- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 ---* R C

### Alias IDs

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

*This report was generated on: November 30, 2012 — Data "AS IS"; no warranty either expressed or implied. [53.701241 -113.123403 (WGS 84)], INT*

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339332 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-3 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 14:15 |
| **Sample Location** | |
| **Sample Description** | M40354.390392 (Piezometer No. 4A) / 16-26-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.31 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 133 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.002 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0006 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0030 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.057 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.148 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00012 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0022 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0021 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.002 | 0.001 | | |
| Lead | Dissolved | mg/L | 0.0002 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.124 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0009 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.14 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0086 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0043 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0054 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.009 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.48 | 0.05 | | |
| Sulfur | Extractable | mg/L | 134 | 0.3 | | |
| Aluminum | Extractable | mg/L | 0.032 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0033 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.052 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339332 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-3 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 14:15 |
| **Sample Location** | |
| **Sample Description** | M40354.390392 (Piezometer No. 4A) / 16-26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.164 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00007 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0051 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0018 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.002 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.134 | 0.001 | | |
| Molybdenum | Extractable | mg/L | <0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0014 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.16 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0093 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0045 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0136 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.67 | | | |
| Temperature of observed pH | | °C | 19.7 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1470 | 1 | | |
| Calcium | Dissolved | mg/L | 166 | 0.2 | | |
| Calcium | Extractable | mg/L | 168 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 47.3 | 0.2 | | |
| Magnesium | Extractable | mg/L | 48.6 | 0.2 | | |
| Sodium | Dissolved | mg/L | 127 | 0.4 | | |
| Sodium | Extractable | mg/L | 132 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.2 | 0.4 | | |
| Potassium | Extractable | mg/L | 5.5 | 0.4 | | |
| Iron | Dissolved | mg/L | 1.04 | 0.01 | | |
| Iron | Extractable | mg/L | 0.78 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.35 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.29 | 0.005 | | |

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W: www.exova.com

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339332 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-3 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 14:15 |
| **Sample Location** | |
| **Sample Description** | M40354.390392 (Piezometer No. 4A) / 16-26-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 3.4 | 0.4 | | |
| Nitrate - N | | mg/L | <0.01 | 0.01 | | |
| Nitrite - N | | mg/L | 0.027 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.03 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 399 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 584 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 479 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1030 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 608 | | | |
| Ionic Balance | Dissolved | % | 99 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

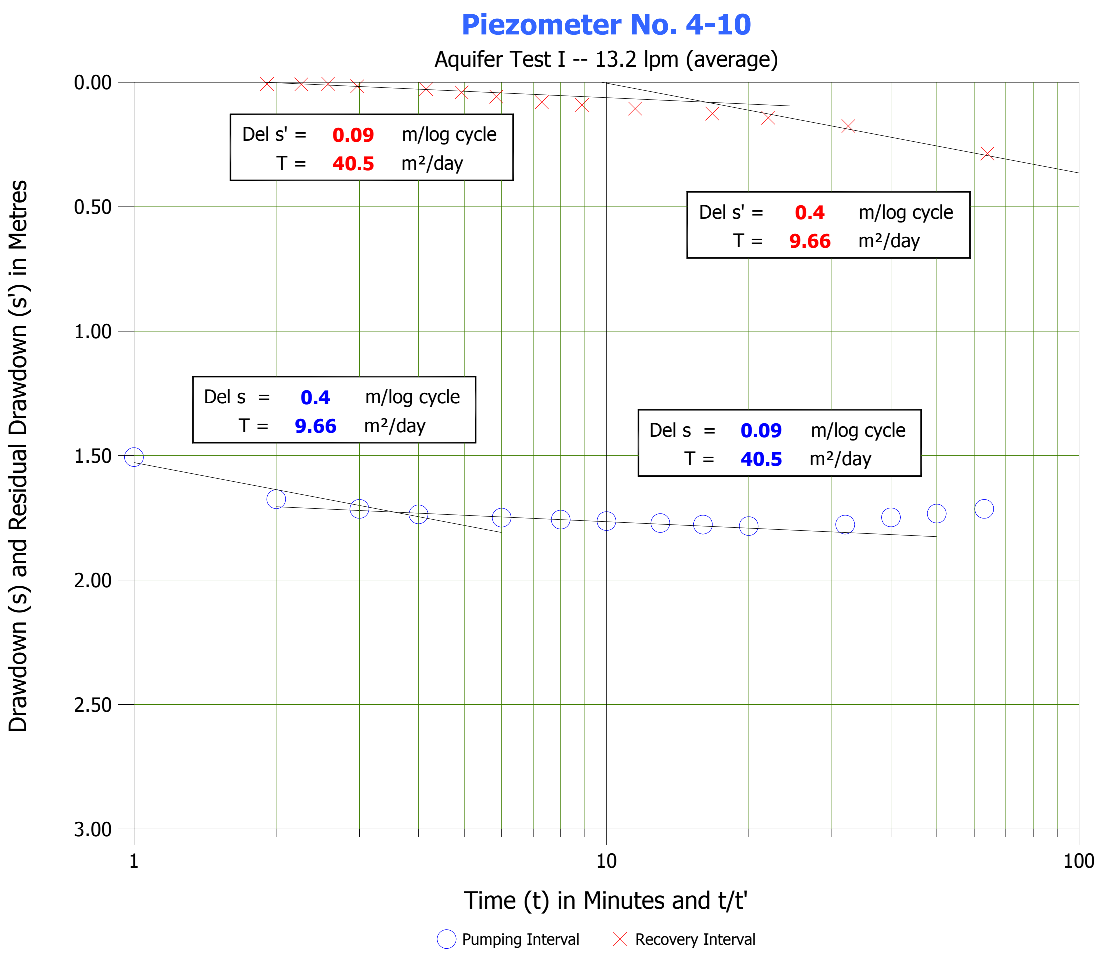
### *Piezometer No. 4-10*
### *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 4-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 4-10**

*(formerly Piezometer No. 4A)*

**16-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **13.2** | Pre-Test Water Level - NPWL (m): | **3.56** |
| Date Test Started: | **June 29, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **13:42** | Test Interval - Top (m): | **6.1** |
| Pumping Interval (minutes): | **63** | Test Interval - Bottom (m): | **9.1** |
| Recovery Interval (minutes): | **69** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40354.390392 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 1.51 | 13.2 |
| 2 | 1.68 | 13.2 |
| 3 | 1.71 | 13.2 |
| 4 | 1.74 | 13.2 |
| 6 | 1.75 | 13.2 |
| 8 | 1.76 | 13.2 |
| 10 | 1.76 | 13.2 |
| 13 | 1.77 | 13.2 |
| 16 | 1.78 | 13.2 |
| 20 | 1.78 | 13.2 |
| 32 | 1.78 | 13.2 |
| 40 | 1.75 | 13.2 |
| 50 | 1.73 | 13.2 |
| 63 | 1.71 | 13.2 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 64 | 0.29 |
| 2 | 33 | 0.18 |
| 3 | 22 | 0.14 |
| 4 | 16.8 | 0.13 |
| 6 | 11.5 | 0.11 |
| 8 | 8.9 | 0.09 |
| 10 | 7.3 | 0.08 |
| 13 | 5.8 | 0.06 |
| 16 | 4.9 | 0.04 |
| 20 | 4.2 | 0.03 |
| 32 | 3.0 | 0.02 |
| 40 | 2.6 | 0.01 |
| 50 | 2.3 | 0.01 |
| 69 | 1.91 | 0.01 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 5-10

*(Piezometer No. 13)*

**04-25-054-22 W4M**

*(M40354.406718)*

Well Spatial Location:

Easting: ***124,119***
Northing: ***5,947,951***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***638***
::*(elevation accuracy Ground Survey)*

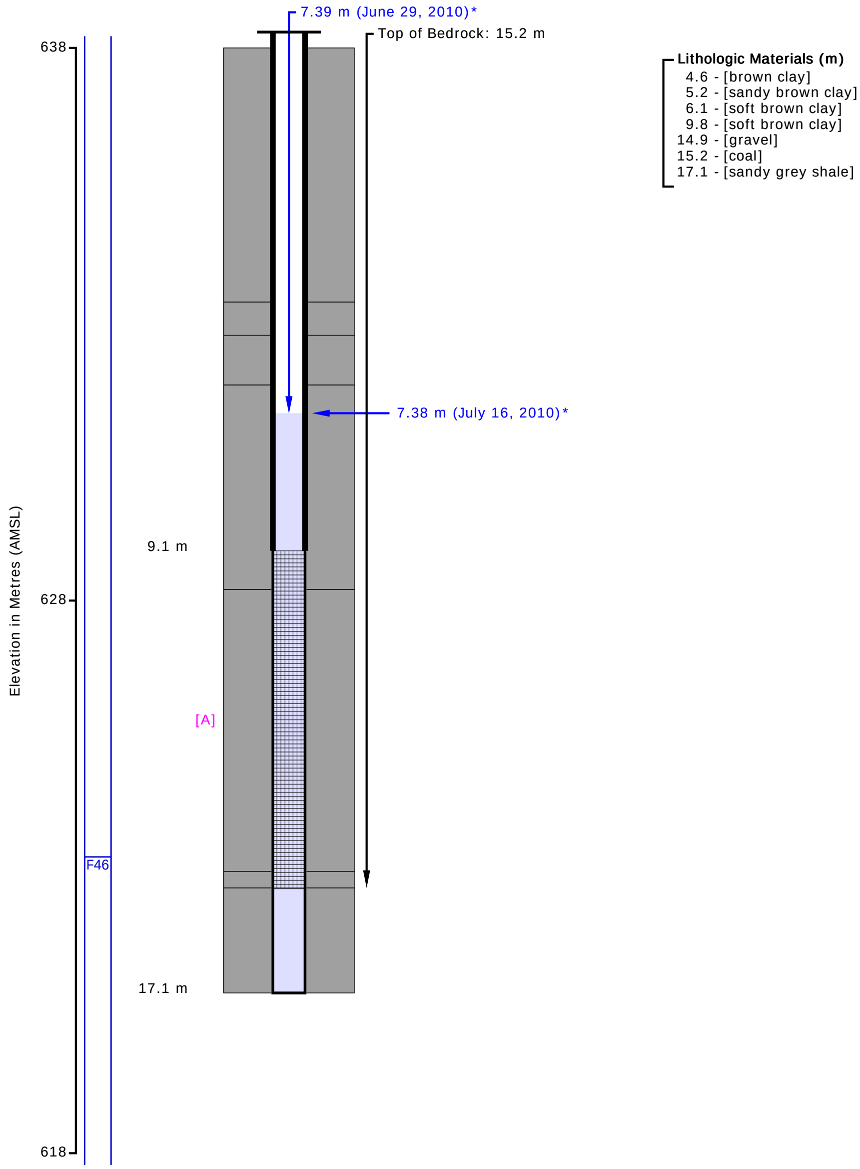
Date Completed: ***June 24, 2010***

Depth Drilled (m): ***17.1***

Completion Interval (m): ***9.1* — *15.2 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***7.38* — *July 16, 2010***
Earliest Water Level (m): ***7.39* — *June 29, 2010***

## Piezometer No. 5-10
## Well Diagram




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained

Bedrock: Fine Grained, Coarse Grained

Other

**Geologic Unit Legend (Top) - Regional Analysis**

F46 - Lower Surficial Deposits

**Summary**

TGWC ID: M40354.406718
Well Name: Piezometer No. 5-10
Legal Location: 04-25-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.77 m (not drawn to scale)
Interval [A]: 9.1 to 15.2 m; Screened
*Water Level (recent): 7.38 m on July 16, 2010 @ 11:18 - Reference Point: Top of Casing
*Water Level (oldest): 7.39 m on June 29, 2010 @ 07:46 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: August 11, 2010 15:24 --- http://www.tgwc.ca*

This report was generated on: August 11, 2010 — Data "AS IS"; no warranty either expressed or implied. [53.68693 -113.11971 (WGS 84)], INT

Owner: *Joburg Aggregates Ltd.*
*1610 151 St NW, Edmonton, AB T5M 4E9*

Contractor: *Lakeland Drilling Ltd.*
Well Name: *Piezometer No. 5-10*

Field Survey: *June 24, 2010 - Confirmed - Physically*

## METRIC REPORT

04-25-054-22 W4M

M40354.406718

189909-1

Easting (m): *124119.00* ** 75/89
Northing (m): *5947951.00* **
Elevation (m): *638* ***
Google Earth

Work Type: *Piezometer*
Drilling Method: *Drilled*
Proposed Use: *Monitoring*
Completion Type: *Screen*

Date Started: *June 24, 2010*
Date Completed: *June 24, 2010*
Well Status: *Observation*

Elog Taken: *No*
Gamma Taken: *No*
Stick Up (m): *0.8*
Flowing: *No*

### General Details

Depth Completed (m): *15.2*
Depth Drilled (m): *17.1*
Top of Bedrock (m): *15.2 **
Completion Interval (m): *9.1 — 15.2 **

### Completion Details

Surface Casing: *PVC — 50.8 mm (O.D.) x 9.10 m (bottom)*

Screen Material: *PVC — (Attached To Casing)*
Fittings: **Top:** *Threaded* — **Bottom:** *Plug*

### Intervals

Completion Interval: *Screen*: *9.1* to *15.2 m - 20 slot*

Construction Interval: *Bentonite Chips*: *0.0* to *8.5 m*
Construction Interval: *Sand Pack*: *8.5* to *17.1 m*

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 633.8 | 4.6 | [brown clay] |
| 633.2 | 5.2 | [sandy brown clay] |
| 632.3 | 6.1 | [soft brown clay] |
| 628.6 | 9.8 | [soft brown clay] |
| 623.5 | 14.9 | [gravel] |
| 623.2 | 15.2 | [coal] |
| 621.3 | 17.1 | [sandy grey shale] |

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: *June 29, 2010*
Analysis Details: *July 08, 2010 - Exova (750102-7)*

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1280 | Nitrate as N: | 0.03 | Colour (TCU): | |
| TDS (Calculated): | 861 | Nitrite as N: | 0.033 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 643 | pH (pH Unit): | 7.67 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 498 | Ion Balance (%): | 101 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 608 |
| Nitrate + Nitrite as N: | 0.06 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.7 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 174 | Mercury: | | < 0.0001 |
| Chloride: | | 1.8 | Molybdenum: | < 0.001 | < 0.001 |
| Iron: | | 2.7 | Magnesium: | | 50.7 |
| Manganese: | | 1.6 | Sodium: | | 62.6 |
| Aluminum: | < 0.002 | 0.003 | Potassium: | | 4.9 |
| Arsenic: | 0.0083 | 0.013 | Vanadium: | 0.0144 | 0.0058 |
| Barium: | 0.063 | 0.066 | Strontium: | 1.18 | 1.13 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.004 | 0.0036 |
| Cadmium: | 0.00004 | 0.00005 | Zinc: | 0.001 | 0.006 |
| Chromium: | 0.0053 | 0.0025 | Copper: | < 0.001 | 0.001 |
| Cobalt: | 0.0055 | 0.0055 | Lead: | < 0.0001 | < 0.0001 |
| Sulfate: | | 268 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: *Sample collected by Mow-Tech Ltd.*

*note: constituents have been compared to the maximum acceptable concentration, as stated in the Summary of Guidelines for Canadian Drinking Water Quality (Federal–Provincial–Territorial Committee on Drinking Water, May 2008)*

### General Comments / Observations

*Piezometer was developed for 30 minutes following completion at a rate of approximately 45 lpm.*

Most Recent Water Level (m): *7.38 m — July 16, 2010*

Oil Present: *No*
Gas Present: *No*

### Water Used For Drilling

### Aquifer Tests

| No. | Date | Testing Method | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Level-End (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-29 07:48 | Pump | 63.0 | 22.0 | 13.5 | 7.39 | 0.15 | 7.54 | — | 128.6 | | 198.6 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

### Alias IDs

* **TGWC** calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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W: www.exova.com

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339336 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-7 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 08:05 |
| **Sample Location** | |
| **Sample Description** | M40354.406718 (Piezometer No. 13) / 04-25-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 8.12 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 89.4 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.003 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0004 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0130 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.066 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.142 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00005 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0025 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0055 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.001 | 0.001 | | |
| Lead | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.101 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0036 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.13 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0059 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0078 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0058 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.006 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 8.25 | 0.05 | | |
| Sulfur | Extractable | mg/L | 91.2 | 0.3 | | |
| Aluminum | Extractable | mg/L | <0.002 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0083 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.063 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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E: Edmonton@exova.com
W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339336 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-7 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 08:05 |
| **Sample Location** | |
| **Sample Description** | M40354.406718 (Piezometer No. 13) / 04-25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.165 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00004 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0053 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0055 | 0.0001 | | |
| Copper | Extractable | mg/L | <0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.116 | 0.001 | | |
| Molybdenum | Extractable | mg/L | <0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0040 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.18 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0056 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0089 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0144 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.001 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.67 | | | |
| Temperature of observed pH | | °C | 19.7 | | | |
| Electrical Conductivity | | µS/cm at 25 C | 1280 | 1 | | |
| Calcium | Dissolved | mg/L | 174 | 0.2 | | |
| Calcium | Extractable | mg/L | 178 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 50.7 | 0.2 | | |
| Magnesium | Extractable | mg/L | 52.6 | 0.2 | | |
| Sodium | Dissolved | mg/L | 62.6 | 0.4 | | |
| Sodium | Extractable | mg/L | 65.1 | 0.4 | | |
| Potassium | Dissolved | mg/L | 4.9 | 0.4 | | |
| Potassium | Extractable | mg/L | 5.2 | 0.4 | | |
| Iron | Dissolved | mg/L | 2.70 | 0.01 | | |
| Iron | Extractable | mg/L | 0.05 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.60 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.58 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339336 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-7 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 08:05 |
| **Sample Location** | |
| **Sample Description** | M40354.406718 (Piezometer No. 13) / 04-25-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 1.8 | 0.4 | | |
| Nitrate - N | | mg/L | 0.03 | 0.01 | | |
| Nitrite - N | | mg/L | 0.033 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.06 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 268 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 608 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 498 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 861 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 643 | | | |
| Ionic Balance | Dissolved | % | 101 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

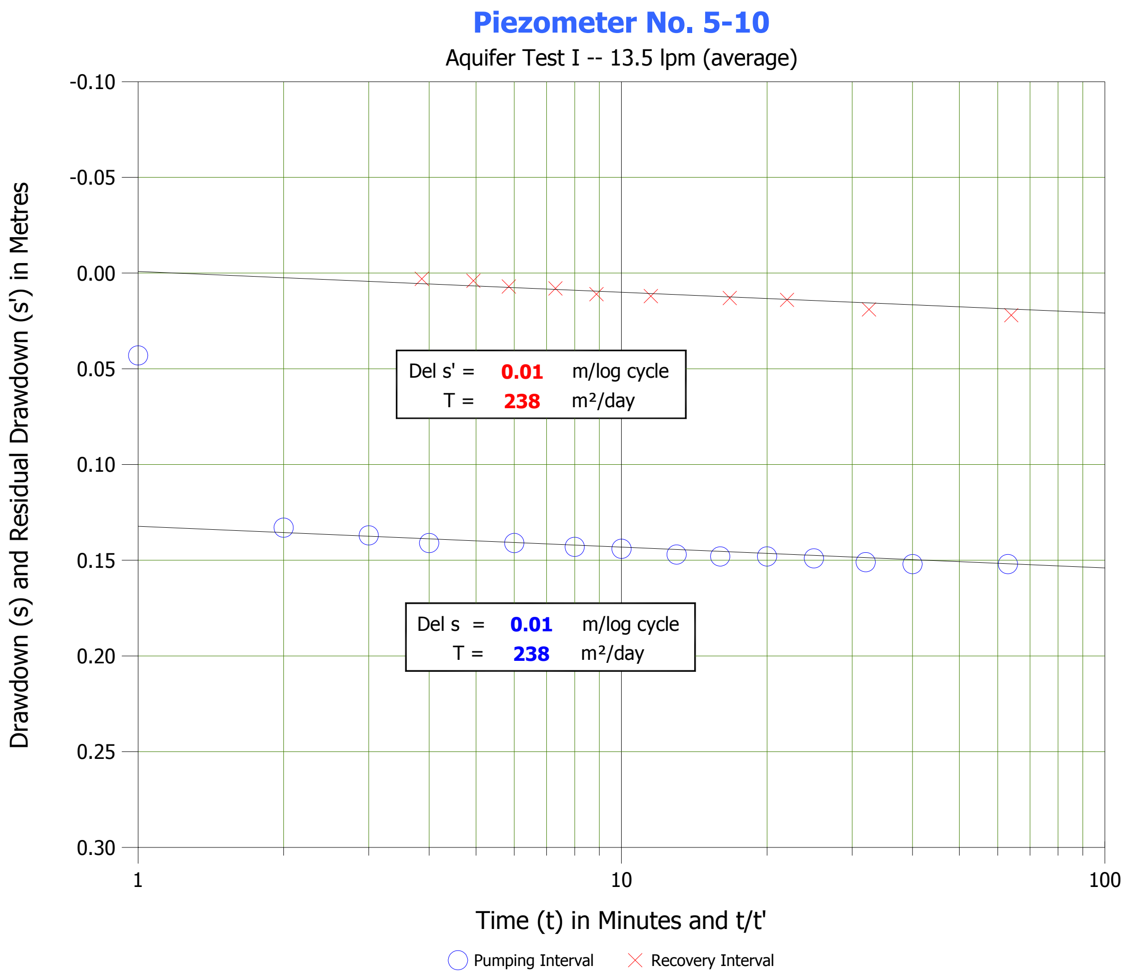
## *Piezometer No. 5-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 5-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 5-10**

*(formerly Piezometer No. 13)*

**04-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **13.5** | Pre-Test Water Level - NPWL (m): | **7.39** |
| Date Test Started: | **June 29, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **07:48** | Test Interval - Top (m): | **9.1** |
| Pumping Interval (minutes): | **63** | Test Interval - Bottom (m): | **15.2** |
| Recovery Interval (minutes): | **22** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40354.406718 (AT 1)*

** **TGWC** calculated or determined value.*

*This report was generated on: November 30, 2012 — Data "AS IS"; no warranty either expressed or implied. © TGWC — Page 1 of 1*

## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.04 | 13.5 |
| 2 | 0.13 | 13.5 |
| 3 | 0.14 | 13.5 |
| 4 | 0.14 | 13.5 |
| 6 | 0.14 | 13.5 |
| 8 | 0.14 | 13.5 |
| 10 | 0.14 | 13.5 |
| 13 | 0.15 | 13.5 |
| 16 | 0.15 | 13.5 |
| 20 | 0.15 | 13.5 |
| 25 | 0.15 | 13.5 |
| 32 | 0.15 | 13.5 |
| 40 | 0.15 | 13.5 |
| 63 | 0.15 | 13.5 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 64 | 0.02 |
| 2 | 33 | 0.02 |
| 3 | 22 | 0.01 |
| 4 | 16.8 | 0.01 |
| 6 | 11.5 | 0.01 |
| 8 | 8.9 | 0.01 |
| 10 | 7.3 | 0.01 |
| 13 | 5.8 | 0.01 |
| 16 | 4.9 | 0.00 |
| 22 | 3.9 | 0.00 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 6-10

*(Piezometer No. 6)*

**15-26-054-22 W4M**

*(M40357.413171)*

Well Spatial Location:

Easting: ***123,044***
Northing: ***5,949,497***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***634***
::*(elevation accuracy Ground Survey)*

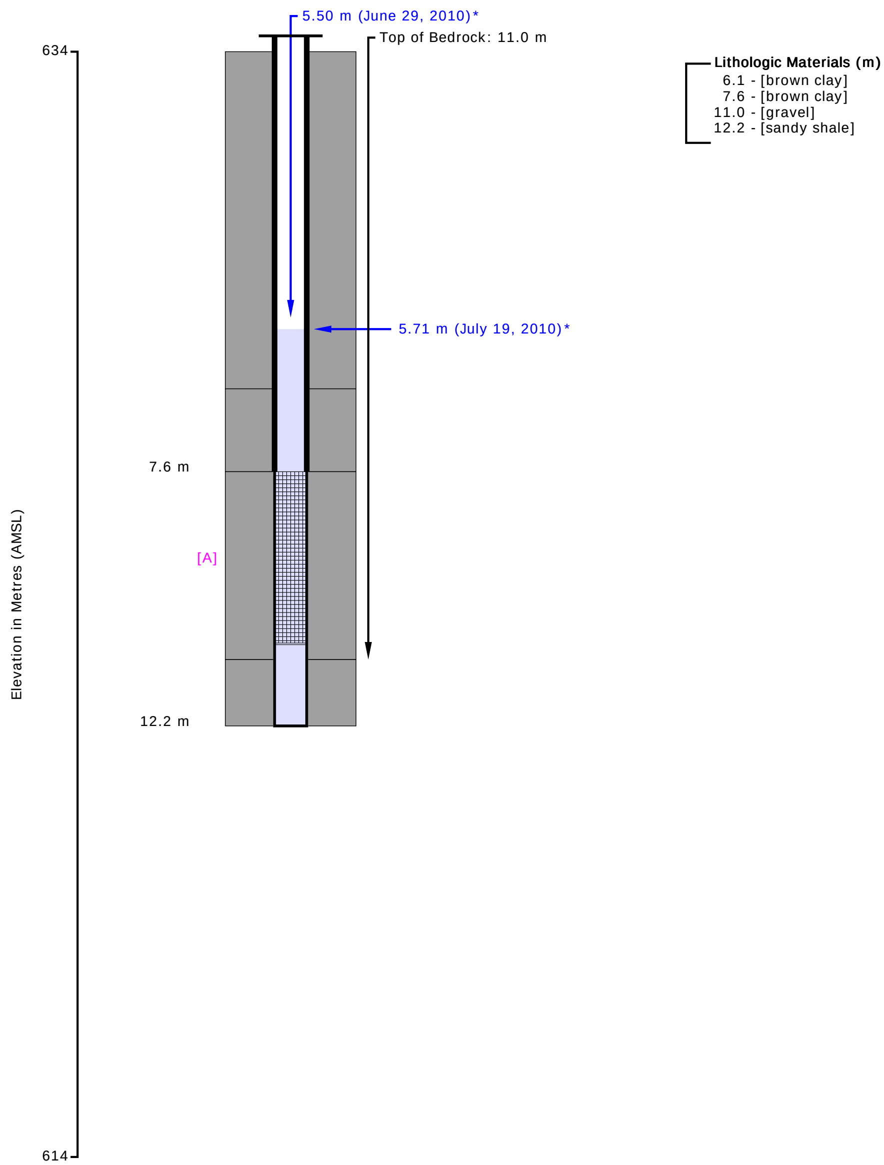
Date Completed: ***June 25, 2010***

Depth Drilled (m): ***12.2***

Completion Interval (m): ***7.6* — *10.7 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***5.71* — *July 19, 2010***
Earliest Water Level (m): ***5.50* — *June 29, 2010***

## *Piezometer No. 6-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted; Fine Grained; Coarse Grained
Bedrock: Fine Grained; Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40357.413171
Well Name: Piezometer No. 6-10
Legal Location: 15-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.69 m (not drawn to scale)
Interval [A]: 7.6 to 10.7 m; Screened
*Water Level (recent): 5.71 m on July 19, 2010 @ 14:22 - Reference Point: Top of Casing
*Water Level (oldest): 5.50 m on June 29, 2010 @ 16:33 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: November 30, 2012 16:17 --- http://www.tgwc.ca*

Owner: **Joburg Aggregates Ltd.**
**1610 151 St NW, Edmonton, AB T5M 4E9**

Contractor: **Lakeland Drilling Ltd.**
Well Name: **Piezometer No. 6-10**

Field Survey: **June 25, 2010 - Confirmed - Physically**

**METRIC REPORT**

Easting (m): **123044.00** ** 75/89
Northing (m): **5949497.00** **
Elevation (m): **634** ***
Google Earth

15-26-054-22 W4M

M40357.413171

189906-1

Work Type: **Piezometer**
Drilling Method: **Drilled**
Proposed Use: **Monitoring**
Completion Type: **Screen**
Date Started: **June 25, 2010**
Date Completed: **June 25, 2010**
Well Status: **Observation**
Feature Class: **Piezometer**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.7**
Flowing: **No**

## General Details

Depth Completed (m): **10.7**
Depth Drilled (m): **12.2**
Top of Bedrock (m): **11.0 ***
Completion Interval (m): **7.6 — 10.7 ***

## Completion Details

Surface Casing: **PVC — 50.8 mm (O.D.) x 7.60 m (bottom)**

Screen Material: **PVC — (Attached To Casing)**
Fittings: **Top: Threaded — Bottom: Plug**
Pack: **[unknown]**

## Intervals

Screen: **7.6** to **10.7 m - 20 slot**

Bentonite: **0.0** to **7.0 m**
Sand Pack: **7.0** to **10.7 m**

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 627.6 | 6.1 | [brown clay] |
| 626.1 | 7.6 | [brown clay] |
| 622.7 | 11.0 | [gravel] |
| 621.5 | 12.2 | [sandy shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: **June 29, 2010**
Analysis Details: **July 08, 2010 - Exova Canada Inc. (750102-4)**

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1620 | Nitrate as N: | < 0.01 | Colour (TCU): | |
| TDS (Calculated): | 1140 | Nitrite as N: | 0.068 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 740 | pH (pH Unit): | 7.62 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 504 | Ion Balance (%): | 101 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 614 |
| Nitrate + Nitrite as N: | 0.07 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 20 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 191 | Mercury: | | < 0.0001 |
| Chloride: | | 1.9 | Molybdenum: | < 0.001 | < 0.001 |
| Iron: | | 2.17 | Magnesium: | | 63.5 |
| Manganese: | | 2.25 | Sodium: | | 112 |
| Aluminum: | < 0.002 | 0.002 | Potassium: | | 7.5 |
| Arsenic: | 0.0028 | 0.0045 | Vanadium: | 0.0148 | 0.0054 |
| Barium: | 0.045 | 0.049 | Strontium: | 1.36 | 1.33 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0005 | < 0.0005 |
| Cadmium: | < 0.00001 | 0.00002 | Zinc: | 0.002 | 0.01 |
| Chromium: | 0.0055 | 0.0025 | Copper: | 0.001 | 0.002 |
| Cobalt: | 0.0012 | 0.0013 | Lead: | < 0.0001 | 0.0008 |
| Sulfate: | | 458 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: **Sample collected by Mow-Tech Ltd.**

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

## General Comments / Observations

*Piezometer was developed following completion at a rate of approximately 18 lpm.*

Most Recent Water Level (m): **5.71 m — July 19, 2010**

Oil Present: **No**
Gas Present: **No**

## Water Used For Drilling

## Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-29 16:35 | Pump | 7.60 to 10.70 | 63.0 | 60.0 | 12.6 | 5.50 | 1.10 | — | 18.1 | | 22.7 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

TGWC: M40364.464826

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339333 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-4 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 17:00 |
| **Sample Location** | |
| **Sample Description** | M40357.413171 (Piezometer No. 6) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 8.06 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 153 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.002 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0005 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0045 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.049 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.154 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00002 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0025 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0013 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.002 | 0.001 | | |
| Lead | Dissolved | mg/L | 0.0008 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.143 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.33 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | 0.002 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0103 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0058 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0054 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.010 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 8.04 | 0.05 | | |
| Sulfur | Extractable | mg/L | 154 | 0.3 | | |
| Aluminum | Extractable | mg/L | <0.002 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0028 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.045 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339333 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-4 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 17:00 |
| **Sample Location** | |
| **Sample Description** | M40357.413171 (Piezometer No. 6) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.166 | 0.002 | | |
| Cadmium | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0055 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0012 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.151 | 0.001 | | |
| Molybdenum | Extractable | mg/L | <0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0005 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.36 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0094 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0062 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0148 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.62 | | | |
| Temperature of observed pH | | °C | 20.0 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1620 | 1 | | |
| Calcium | Dissolved | mg/L | 191 | 0.2 | | |
| Calcium | Extractable | mg/L | 193 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 63.5 | 0.2 | | |
| Magnesium | Extractable | mg/L | 65.3 | 0.2 | | |
| Sodium | Dissolved | mg/L | 112 | 0.4 | | |
| Sodium | Extractable | mg/L | 115 | 0.4 | | |
| Potassium | Dissolved | mg/L | 7.5 | 0.4 | | |
| Potassium | Extractable | mg/L | 7.8 | 0.4 | | |
| Iron | Dissolved | mg/L | 2.17 | 0.01 | | |
| Iron | Extractable | mg/L | 0.04 | 0.01 | | |
| Manganese | Dissolved | mg/L | 2.25 | 0.005 | | |
| Manganese | Extractable | mg/L | 2.17 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339333 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-4 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 17:00 |
| **Sample Location** | |
| **Sample Description** | M40357.413171 (Piezometer No. 6) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 1.9 | 0.4 | | |
| Nitrate - N | | mg/L | <0.01 | 0.01 | | |
| Nitrite - N | | mg/L | 0.068 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.07 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 458 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 614 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 504 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1140 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 740 | | | |
| Ionic Balance | Dissolved | % | 101 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

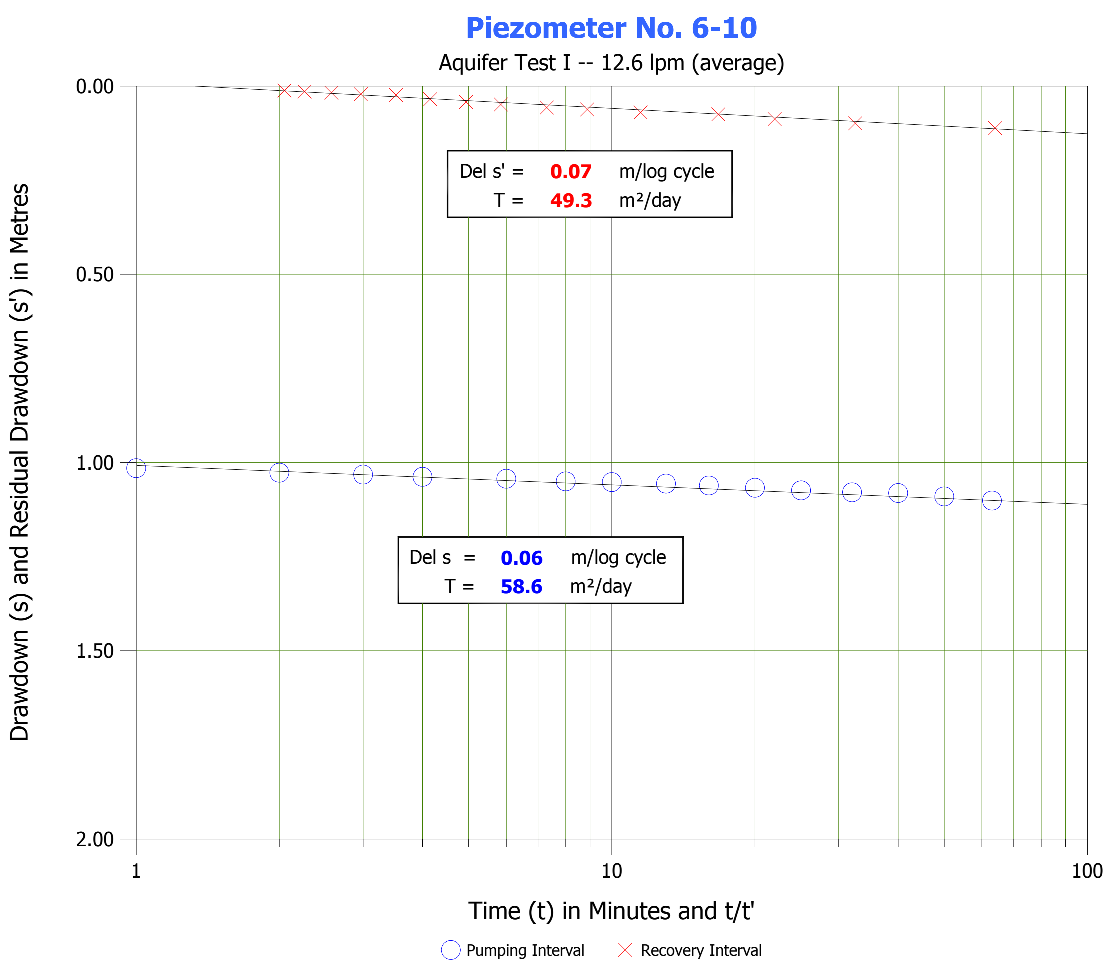
***Piezometer No. 6-10***
***Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations***

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 6-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 6-10**

*(formerly Piezometer No. 6)*

**15-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **12.6** | Pre-Test Water Level - NPWL (m): | **5.50** |
| Date Test Started: | **June 29, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **16:35** | Test Interval - Top (m): | **7.6** |
| Pumping Interval (minutes): | **63** | Test Interval - Bottom (m): | **10.7** |
| Recovery Interval (minutes): | **60** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40357.413171 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 1.02 | 12.6 |
| 2 | 1.03 | 12.6 |
| 3 | 1.03 | 12.6 |
| 4 | 1.04 | 12.6 |
| 6 | 1.04 | 12.6 |
| 8 | 1.05 | 12.6 |
| 10 | 1.05 | 12.6 |
| 13 | 1.06 | 12.6 |
| 16 | 1.06 | 12.6 |
| 20 | 1.07 | 12.6 |
| 25 | 1.07 | 12.6 |
| 32 | 1.08 | 12.6 |
| 40 | 1.08 | 12.6 |
| 50 | 1.09 | 12.6 |
| 63 | 1.10 | 12.6 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 64 | 0.11 |
| 2 | 33 | 0.10 |
| 3 | 22 | 0.09 |
| 4 | 16.8 | 0.08 |
| 6 | 11.5 | 0.07 |
| 8 | 8.9 | 0.06 |
| 10 | 7.3 | 0.06 |
| 13 | 5.8 | 0.05 |
| 16 | 4.9 | 0.04 |
| 20 | 4.2 | 0.04 |
| 25 | 3.5 | 0.02 |
| 32 | 3.0 | 0.02 |
| 40 | 2.6 | 0.02 |
| 50 | 2.3 | 0.02 |
| 60 | 2.1 | 0.01 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 7-10

*(Piezometer No. 3)*

**05-36-054-22 W4M**

*(M40357.429458)*

Well Spatial Location:

Easting: ***123,846***
Northing: ***5,950,345***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***631***
::*(elevation accuracy Ground Survey)*

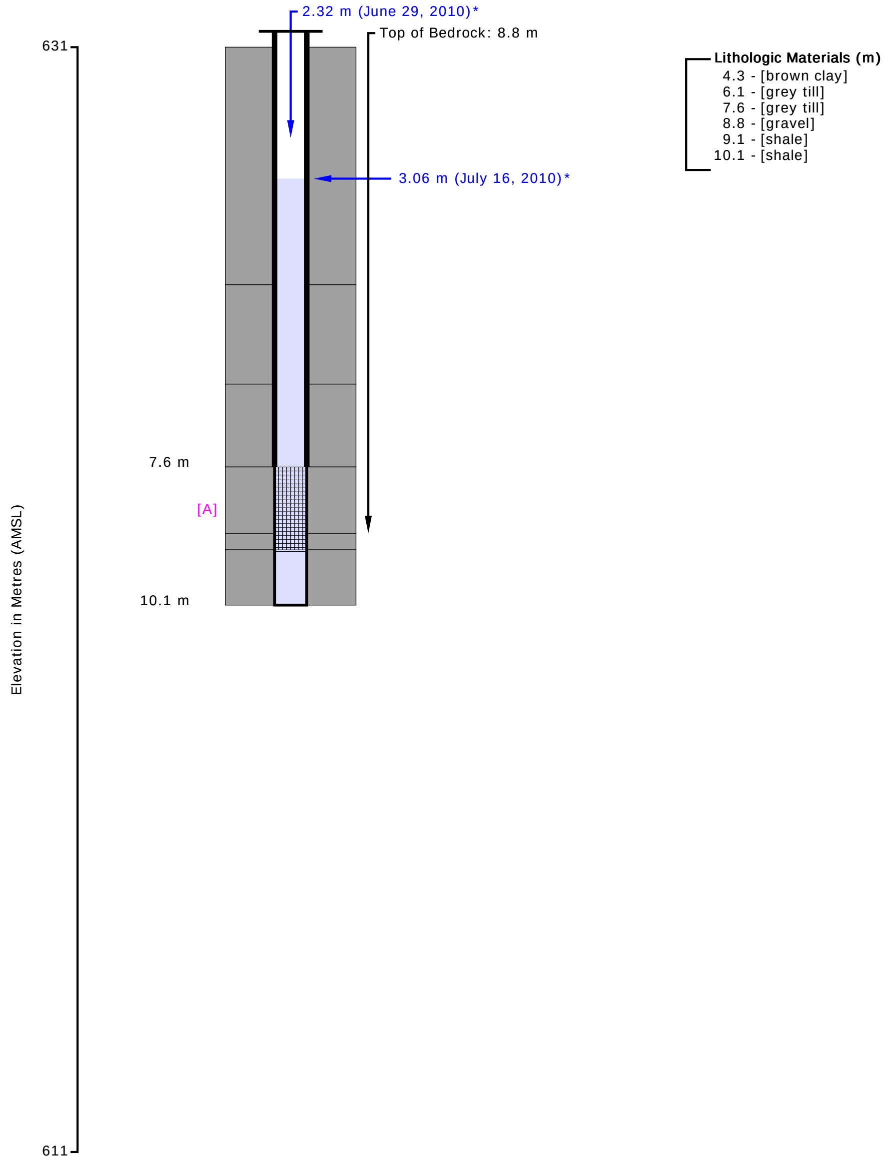
Date Completed: ***June 25, 2010***

Depth Drilled (m): ***10.1***

Completion Interval (m): ***7.6* — *9.1 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***3.06* — *July 16, 2010***
Earliest Water Level (m): ***2.32* — *June 29, 2010***

## *Piezometer No. 7-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40357.429458
Well Name: Piezometer No. 7-10
Legal Location: 05-36-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.68 m (not drawn to scale)
Interval [A]: 7.6 to 9.1 m; Screened
*Water Level (recent): 3.06 m on July 16, 2010 @ 12:10 - Reference Point: Top of Casing
*Water Level (oldest): 2.32 m on June 29, 2010 @ 10:09 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: November 30, 2012 16:18 --- http://www.tgwc.ca*

Owner: Joburg Aggregates Ltd.
1610 151 St NW, Edmonton, AB T5M 4E9

Contractor: Lakeland Drilling Ltd.
Well Name: Piezometer No. 7-10

Field Survey: June 25, 2010 - Confirmed - Physically

## METRIC REPORT

Easting (m): 123846.00 ** 75/89
Northing (m): 5950345.00 **
Elevation (m): 631 ***
Google Earth

05-36-054-22 W4M

M40357.429458

189904-1

| | |
|---|---|
| Work Type: Piezometer | Date Started: June 25, 2010 |
| Drilling Method: Drilled | Date Completed: June 25, 2010 |
| Proposed Use: Monitoring | Well Status: Observation |
| Completion Type: Screen | Feature Class: Piezometer |

Elog Taken: No
Gamma Taken: No
Stick Up (m): 0.7
Flowing: No

### General Details

Depth Completed (m): 9.1
Depth Drilled (m): 10.1
Top of Bedrock (m): 8.8 *
Completion Interval (m): 7.6 — 9.1 *

### Completion Details

Surface Casing: PVC — 50.8 mm (O.D.) x 7.60 m (bottom)

Screen Material: PVC — (Attached To Casing)
Fittings: Top: Threaded — Bottom: Plug
Pack: [unknown]

### Intervals

Screen: 7.6 to 9.1 m - 20 slot

Bentonite: 0.0 to 7.0 m
Sand Pack: 7.0 to 10.1 m

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 626.5 | 4.3 | [brown clay] |
| 624.7 | 6.1 | [grey till] |
| 623.2 | 7.6 | [grey till] |
| 622.0 | 8.8 | [gravel] |
| 621.7 | 9.1 | [shale] |
| 620.7 | 10.1 | [shale] |

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: June 29, 2010
Analysis Details: July 08, 2010 - Exova Canada Inc. (750102-2)

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1760 | Nitrate as N: | < 0.01 | Colour (TCU): | |
| TDS (Calculated): | 1290 | Nitrite as N: | 0.075 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 690 | pH (pH Unit): | 7.64 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 575 | Ion Balance (%): | 98 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 701 |
| Nitrate + Nitrite as N: | 0.08 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.4 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 184 | Mercury: | | < 0.0001 |
| Chloride: | | 1.9 | Molybdenum: | 0.001 | 0.001 |
| Iron: | | 2.4 | Magnesium: | | 56.1 |
| Manganese: | | 1.33 | Sodium: | | 183 |
| Aluminum: | < 0.002 | 0.004 | Potassium: | | 6.7 |
| Arsenic: | 0.0019 | 0.0023 | Vanadium: | 0.0164 | 0.005 |
| Barium: | 0.052 | 0.06 | Strontium: | 1.25 | 1.25 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0012 | 0.0008 |
| Cadmium: | 0.00002 | 0.00003 | Zinc: | 0.002 | 0.009 |
| Chromium: | 0.0058 | 0.0022 | Copper: | 0.002 | 0.002 |
| Cobalt: | 0.0023 | 0.0027 | Lead: | < 0.0001 | < 0.0001 |
| Sulfate: | | 518 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: Sample collected by Mow-Tech Ltd.

note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

### General Comments / Observations

Piezometer was developed following completion at a rate of approximately 2.5 lpm.

Most Recent Water Level (m): 3.06 m — July 16, 2010

Oil Present: No
Gas Present: No

### Water Used For Drilling

### Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-29 10:12 | Pump | 7.60 to 9.70 | 63.0 | 89.0 | 1.4 | 2.34 | 4.13 | — | 1.1 | | 0.5 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

### Alias IDs

TGWC: M40364.460547

* The Groundwater Centre (TGWC) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339331 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-2 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 10:30 |
| **Sample Location** | |
| **Sample Description** | M40357.429458 (Piezometer No. 3) / SW 36-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.93 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 173 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.004 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0005 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0023 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.060 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.150 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00003 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0022 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0027 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.002 | 0.001 | | |
| Lead | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.128 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | 0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0008 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.25 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0109 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0029 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0050 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.009 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 8.00 | 0.05 | | |
| Sulfur | Extractable | mg/L | 173 | 0.3 | | |
| Aluminum | Extractable | mg/L | <0.002 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0019 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.052 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339331 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-2 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 10:30 |
| **Sample Location** | |
| **Sample Description** | M40357.429458 (Piezometer No. 3) / SW 36-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.164 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00002 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0058 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0023 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.002 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.137 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0012 | 0.0005 | | |
| Selenium | Extractable | mg/L | 0.0003 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.25 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.010 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0031 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0164 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.64 | | | |
| Temperature of observed pH | | °C | 19.4 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1760 | 1 | | |
| Calcium | Dissolved | mg/L | 184 | 0.2 | | |
| Calcium | Extractable | mg/L | 187 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 56.1 | 0.2 | | |
| Magnesium | Extractable | mg/L | 57.6 | 0.2 | | |
| Sodium | Dissolved | mg/L | 183 | 0.4 | | |
| Sodium | Extractable | mg/L | 192 | 0.4 | | |
| Potassium | Dissolved | mg/L | 6.7 | 0.4 | | |
| Potassium | Extractable | mg/L | 7.1 | 0.4 | | |
| Iron | Dissolved | mg/L | 2.40 | 0.01 | | |
| Iron | Extractable | mg/L | 0.29 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.33 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.28 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339331 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-2 |
| **Sample Date** | June 29, 2010 |
| **Sample Time** | 10:30 |
| **Sample Location** | |
| **Sample Description** | M40357.429458 (Piezometer No. 3) / SW 36-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 1.9 | 0.4 | | |
| Nitrate - N | | mg/L | <0.01 | 0.01 | | |
| Nitrite - N | | mg/L | 0.075 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.08 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 518 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 701 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 575 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1290 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 690 | | | |
| Ionic Balance | Dissolved | % | 98 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

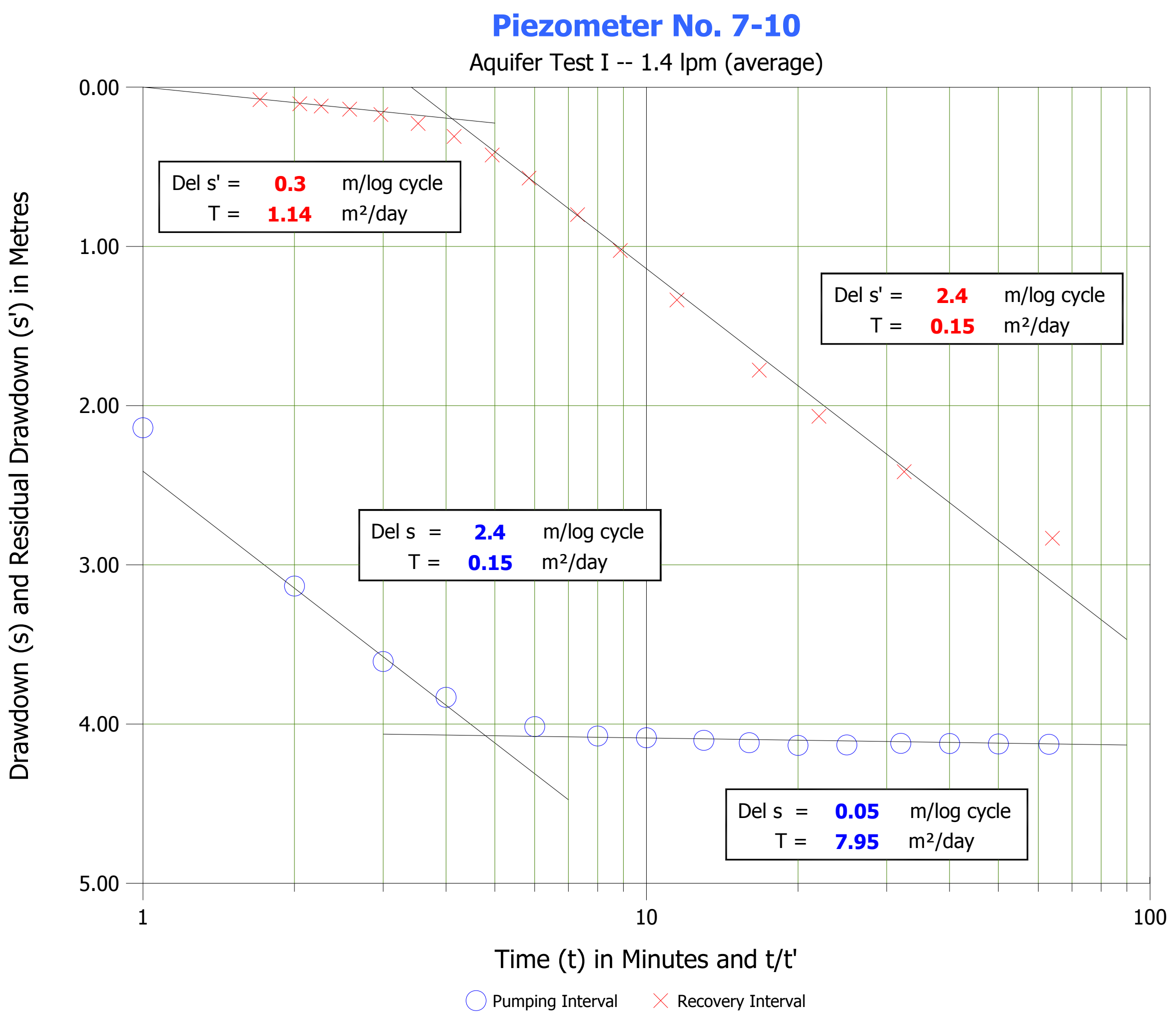
## *Piezometer No. 7-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (μS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 7-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 7-10**

*(formerly Piezometer No. 3)*

**05-36-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **1.4** | Pre-Test Water Level - NPWL (m): | **2.34** |
| Date Test Started: | **June 29, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **10:12** | Test Interval - Top (m): | **7.6** |
| Pumping Interval (minutes): | **63** | Test Interval - Bottom (m): | **9.7** |
| Recovery Interval (minutes): | **89** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40357.429458 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 2.14 | 1.4 |
| 2 | 3.13 | 1.4 |
| 3 | 3.61 | 1.4 |
| 4 | 3.83 | 1.4 |
| 6 | 4.02 | 1.4 |
| 8 | 4.08 | 1.4 |
| 10 | 4.09 | 1.4 |
| 13 | 4.10 | 1.4 |
| 16 | 4.12 | 1.4 |
| 20 | 4.13 | 1.4 |
| 25 | 4.13 | 1.4 |
| 32 | 4.12 | 1.4 |
| 40 | 4.12 | 1.4 |
| 50 | 4.13 | 1.4 |
| 63 | 4.13 | 1.4 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 64 | 2.83 |
| 2 | 33 | 2.42 |
| 3 | 22 | 2.07 |
| 4 | 16.8 | 1.78 |
| 6 | 11.5 | 1.34 |
| 8 | 8.9 | 1.03 |
| 10 | 7.3 | 0.80 |
| 13 | 5.8 | 0.57 |
| 16 | 4.9 | 0.43 |
| 20 | 4.2 | 0.31 |
| 25 | 3.5 | 0.23 |
| 32 | 3.0 | 0.17 |
| 40 | 2.6 | 0.14 |
| 50 | 2.3 | 0.12 |
| 60 | 2.1 | 0.10 |
| 89 | 1.71 | 0.08 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 8-10

*(Piezometer No. 1)*

**01-36-054-22 W4M**

*(M40357.437842)*

Well Spatial Location:

Easting: ***125,449***
Northing: ***5,949,731***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***636***
::*(elevation accuracy Ground Survey)*

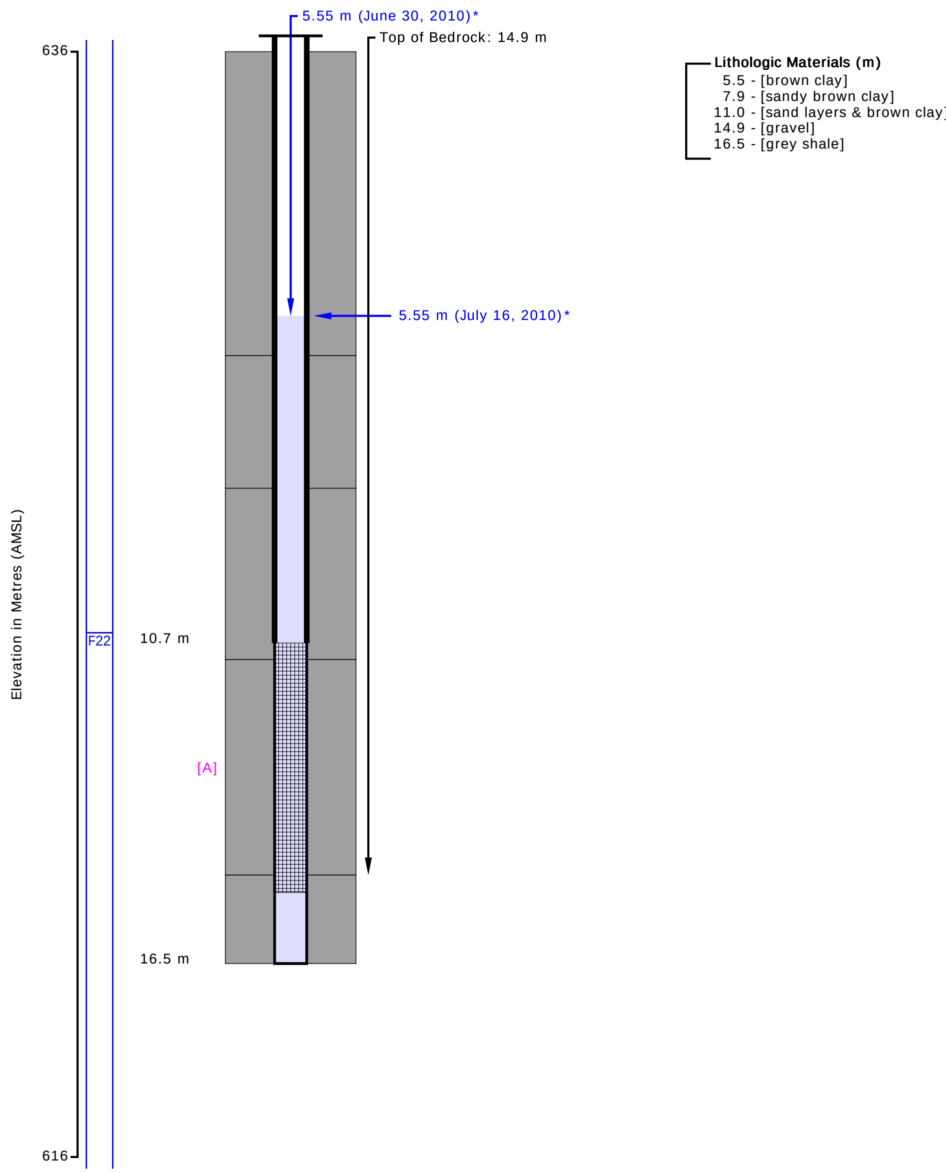
Date Completed: ***June 25, 2010***

Depth Drilled (m): ***16.5***

Completion Interval (m): ***10.7* — *15.2 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***5.55* — *July 16, 2010***
Earliest Water Level (m): ***5.55* — *June 30, 2010***

## *Piezometer No. 8-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

F22 - Oldman Formation

**Summary**

TGWC ID: M40357.437842
Well Name: Piezometer No. 8-10
Legal Location: 01-36-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.77 m (not drawn to scale)
Interval [A]: 10.7 to 15.2 m; Screened
*Water Level (recent): 5.55 m on July 16, 2010 @ 10:40 - Reference Point: Top of Casing
*Water Level (oldest): 5.55 m on June 30, 2010 @ 08:58 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: November 30, 2012 16:21 --- http://www.tgwc.ca*

Owner: Joburg Aggregates Ltd.
1610 151 St NW, Edmonton, AB T5M 4E9

Contractor: Lakeland Drilling Ltd.
Well Name: Piezometer No. 8-10

Field Survey: June 25, 2010 - Confirmed - Physically

# METRIC REPORT

Easting (m): 125449.00 ** 75/89
Northing (m): 5949731.00 **
Elevation (m): 636 ***
Google Earth

01-36-054-22 W4M

M40357.437842

190085-1

Work Type: Piezometer
Drilling Method: Drilled
Proposed Use: Monitoring
Completion Type: Screen

Date Started: June 25, 2010
Date Completed: June 25, 2010
Well Status: Observation

Elog Taken: No
Gamma Taken: No
Stick Up (m): 0.8
Flowing: No

## General Details

Depth Completed (m): 15.2
Depth Drilled (m): 16.5
Top of Bedrock (m): 14.9 *
Completion Interval (m): 10.7 — 15.2 *

## Completion Details

Surface Casing: PVC — 50.8 mm (O.D.) x 10.70 m (bottom)

Screen Material: PVC — (Attached To Casing)
Fittings: Top: Threaded — Bottom: Plug

## Intervals

Completion Interval: Screen: 10.7 to 15.2 m - 20 slot

Construction Interval: Bentonite: 0.0 to 10.1 m
Construction Interval: Sand Pack: 10.1 to 16.5 m

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 630.3 | 5.5 | [brown clay] |
| 627.9 | 7.9 | [sandy brown clay] |
| 624.8 | 11.0 | [sand layers & brown clay] |
| 620.9 | 14.9 | [gravel] |
| 619.3 | 16.5 | [grey shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: June 30, 2010 @ 09:20
Analysis Details: July 08, 2010 - Exova (750102-1)

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1570 | Nitrate as N: | 0.02 | Colour (TCU): | |
| TDS (Calculated): | 1140 | Nitrite as N: | 0.054 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 694 | pH (pH Unit): | 7.56 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 512 | Ion Balance (%): | 100 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 625 |
| Nitrate + Nitrite as N: | 0.07 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.4 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | 196 | 193 | Mercury: | | < 0.0001 |
| Chloride: | | 3.4 | Molybdenum: | 0.001 | < 0.002 |
| Iron: | 0.17 | 3.12 | Magnesium: | 52.8 | 51.2 |
| Manganese: | 1.25 | 1.29 | Sodium: | 135 | 129 |
| Aluminum: | < 0.002 | 0.003 | Potassium: | 6.5 | 6.2 |
| Arsenic: | 0.0026 | 0.0045 | Vanadium: | 0.0154 | 0.0061 |
| Barium: | 0.05 | 0.055 | Strontium: | 1.17 | 1.14 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | < 0.0005 | < 0.0005 |
| Cadmium: | < 0.00001 | 0.00001 | Zinc: | 0.002 | 0.01 |
| Chromium: | 0.0059 | 0.0029 | Copper: | 0.001 | 0.002 |
| Cobalt: | 0.0022 | 0.0023 | Lead: | < 0.0001 | 0.0008 |
| Sulfate: | | 444 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: Sample collected by Mow-Tech Ltd.

note: constituents have been compared to the maximum acceptable concentration, as stated in the Summary of Guidelines for Canadian Drinking Water Quality (Federal–Provincial–Territorial Committee on Drinking Water, May 2008)

## General Comments / Observations

Piezometer was developed following completion at a rate of approximately 45 lpm.

Most Recent Water Level (m): 5.55 m — July 16, 2010

Oil Present: No
Gas Present: No

### Water Used For Drilling

## Aquifer Tests

| No. | Date | Testing Method | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Level-End (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-30 09:00 | Pump | 60.0 | 60.0 | 13.6 | 5.55 | 0.31 | 5.87 | — | 181.2 | | 92.9 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

TGWC: M40364.447533

* TGWC calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339311 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-1 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 09:20 |
| **Sample Location** | |
| **Sample Description** | M40357.437842 (Piezometer No. 1) / SE 36-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.46 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 148 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.003 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0006 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0045 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.055 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.122 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00001 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0029 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0023 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.002 | 0.001 | | |
| Lead | Dissolved | mg/L | 0.0008 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.104 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.14 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0092 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0115 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0061 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.01 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.46 | 0.05 | | |
| Sulfur | Extractable | mg/L | 150 | 0.3 | | |
| Aluminum | Extractable | mg/L | <0.002 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0026 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.050 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339311 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-1 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 09:20 |
| **Sample Location** | |
| **Sample Description** | M40357.437842 (Piezometer No. 1) / SE 36-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.131 | 0.002 | | |
| Cadmium | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0059 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0022 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.112 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.17 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0084 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0124 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0154 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.56 | | | |
| Temperature of observed pH | | °C | 19.4 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1570 | 1 | | |
| Calcium | Dissolved | mg/L | 193 | 0.2 | | |
| Calcium | Extractable | mg/L | 196 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 51.2 | 0.2 | | |
| Magnesium | Extractable | mg/L | 52.8 | 0.2 | | |
| Sodium | Dissolved | mg/L | 129 | 0.4 | | |
| Sodium | Extractable | mg/L | 135 | 0.4 | | |
| Potassium | Dissolved | mg/L | 6.2 | 0.4 | | |
| Potassium | Extractable | mg/L | 6.5 | 0.4 | | |
| Iron | Dissolved | mg/L | 3.12 | 0.01 | | |
| Iron | Extractable | mg/L | 0.17 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.29 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.25 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339311 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-1 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 09:20 |
| **Sample Location** | |
| **Sample Description** | M40357.437842 (Piezometer No. 1) / SE 36-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 3.4 | 0.4 | | |
| Nitrate - N | | mg/L | 0.02 | 0.01 | | |
| Nitrite - N | | mg/L | 0.054 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.07 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 444 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 625 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 512 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1140 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 694 | | | |
| Ionic Balance | Dissolved | % | 100 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

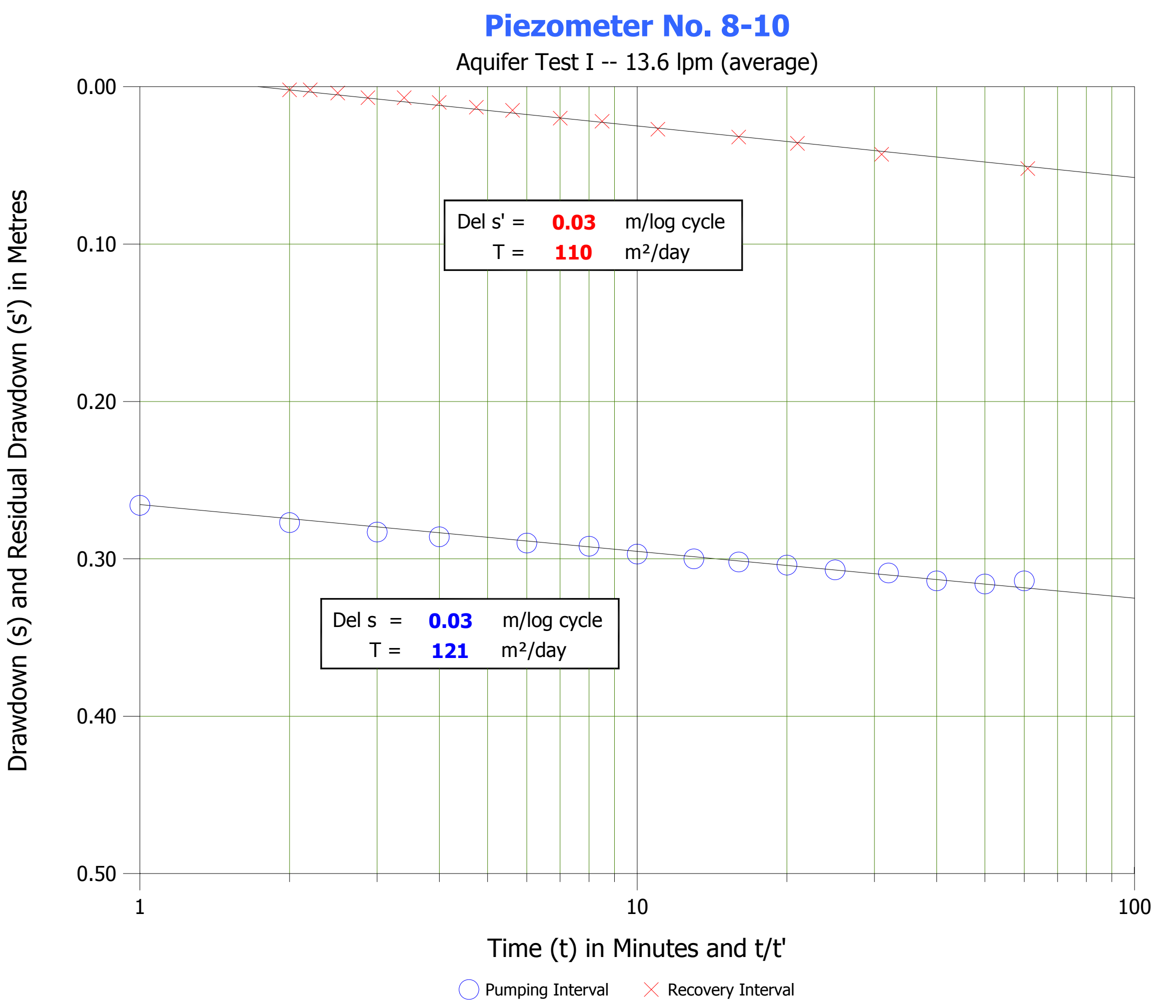
## *Piezometer No. 8-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 8-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 8-10**

*(formerly Piezometer No. 1)*

**01-36-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **13.6** | Pre-Test Water Level - NPWL (m): | **5.55** |
| Date Test Started: | **June 30, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **09:00** | Test Interval - Top (m): | **10.7** |
| Pumping Interval (minutes): | **60** | Test Interval - Bottom (m): | **15.2** |
| Recovery Interval (minutes): | **60** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40357.437842 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.27 | 13.6 |
| 2 | 0.28 | 13.6 |
| 3 | 0.28 | 13.6 |
| 4 | 0.29 | 13.6 |
| 6 | 0.29 | 13.6 |
| 8 | 0.29 | 13.6 |
| 10 | 0.30 | 13.6 |
| 13 | 0.30 | 13.6 |
| 16 | 0.30 | 13.6 |
| 20 | 0.30 | 13.6 |
| 25 | 0.31 | 13.6 |
| 32 | 0.31 | 13.6 |
| 40 | 0.31 | 13.6 |
| 50 | 0.32 | 13.6 |
| 60 | 0.31 | 13.6 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 61 | 0.05 |
| 2 | 31 | 0.04 |
| 3 | 21 | 0.04 |
| 4 | 16.0 | 0.03 |
| 6 | 11.0 | 0.03 |
| 8 | 8.5 | 0.02 |
| 10 | 7.0 | 0.02 |
| 13 | 5.6 | 0.02 |
| 16 | 4.8 | 0.01 |
| 20 | 4.0 | 0.01 |
| 25 | 3.4 | 0.01 |
| 32 | 2.9 | 0.01 |
| 40 | 2.5 | 0.00 |
| 50 | 2.2 | 0.00 |
| 60 | 2.0 | 0.00 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 9-10

*(Piezometer No. 10)*

**09-25-054-22 W4M**

*(M40357.441154)*

Well Spatial Location:

Easting: ***125,470***
Northing: ***5,949,129***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***637***
::*(elevation accuracy Ground Survey)*

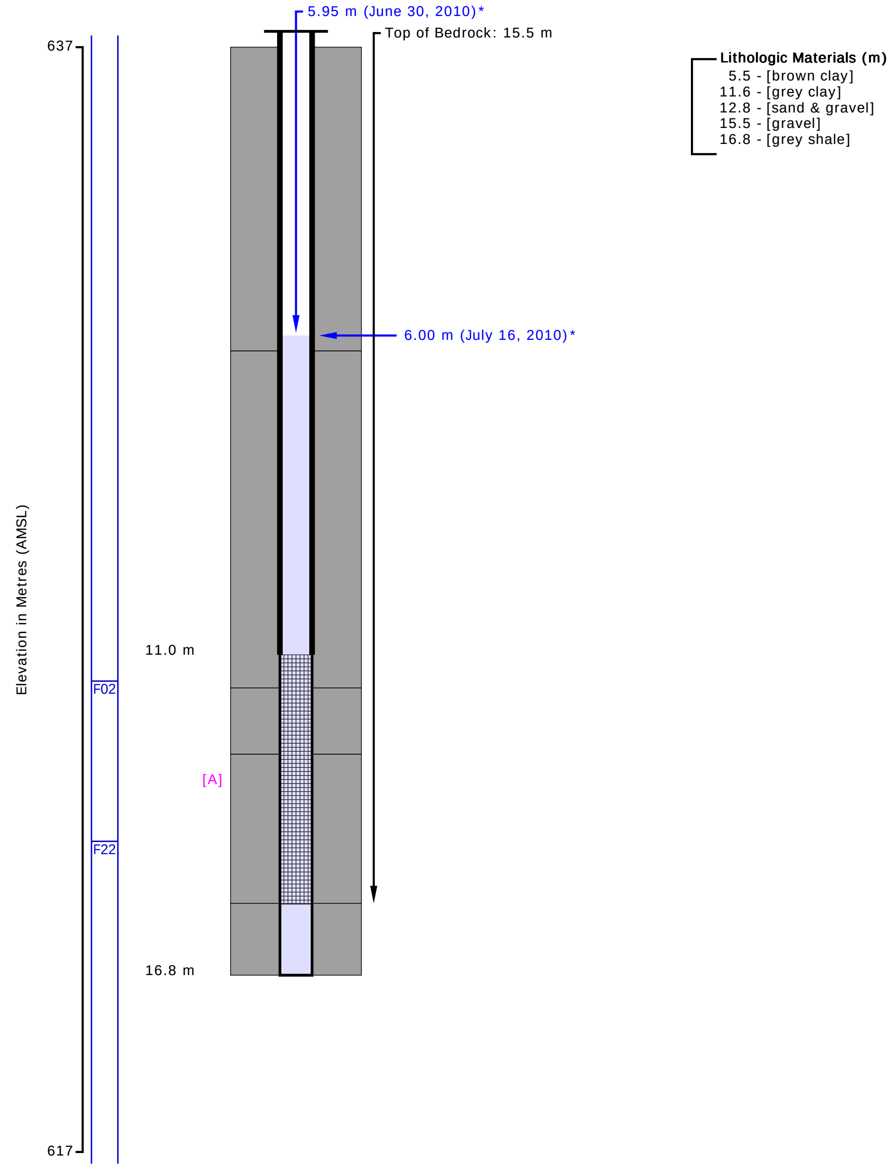
Date Completed: ***June 25, 2010***

Depth Drilled (m): ***16.8***

Completion Interval (m): ***11.0 — 15.5 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***6.00 — July 16, 2010***
Earliest Water Level (m): ***5.95 — June 30, 2010***

# Piezometer No. 9-10
# Well Diagram




**Lithology Legend**

Surficial: Unsorted; Fine Grained; Coarse Grained

Bedrock: Fine Grained; Coarse Grained

Other

**Geologic Unit Legend (Top) - Regional Analysis**

F02 - Bearpaw Formation
F22 - Oldman Formation

**Summary**

TGWC ID: M40357.441154
Well Name: Piezometer No. 9-10
Legal Location: 09-25-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.78 m (not drawn to scale)
Interval [A]: 11.0 to 15.5 m; Screened
*Water Level (recent): 6.00 m on July 16, 2010 @ 10:14 - Reference Point: Top of Casing
*Water Level (oldest): 5.95 m on June 30, 2010 @ 11:39 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: November 30, 2012 16:21 --- http://www.tgwc.ca*

Owner: **Joburg Aggregates Ltd.**
**1610 151 St NW, Edmonton, AB T5M 4E9**

Contractor: **Lakeland Drilling Ltd.**
Well Name: **Piezometer No. 9-10**

Field Survey: **June 25, 2010 - Confirmed - Physically**

## METRIC REPORT

Easting (m): **125470.00** ** 75/89
Northing (m): **5949129.00** **
Elevation (m): **637** ***
Google Earth

09-25-054-22 W4M

M40357.441154

189908-1

Work Type: **Piezometer**
Drilling Method: **Drilled**
Proposed Use: **Monitoring**
Completion Type: **Screen**
Date Started: **June 25, 2010**
Date Completed: **June 25, 2010**
Well Status: **Observation**
Feature Class: **Piezometer**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.8**
Flowing: **No**

### General Details

Depth Completed (m): **15.5**
Depth Drilled (m): **16.8**
Top of Bedrock (m): **15.5 ***
Completion Interval (m): **11.0 — 15.5 ***

### Completion Details

Surface Casing: **PVC — 50.8 mm (O.D.) x 11.00 m (bottom)**

Screen Material: **PVC — (Attached To Casing)**
Fittings: **Top: Threaded — Bottom: Plug**
Pack: **[unknown]**

### Intervals

*Screen*: **11.0** to **15.5 m - 20 slot**

*Bentonite*: **0.0** to **9.8 m**
*Sand Pack*: **9.8** to **16.8 m**

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 631.3 | 5.5 | [brown clay] |
| 625.2 | 11.6 | [grey clay] |
| 624.0 | 12.8 | [sand & gravel] |
| 621.3 | 15.5 | [gravel] |
| 620.0 | 16.8 | [grey shale] |

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: **June 30, 2010**
Analysis Details: **July 08, 2010 - Exova Canada Inc. (750102-6)**

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (μS/cm): | 1780 | Nitrate as N: | 0.02 | Colour (TCU): | |
| TDS (Calculated): | 1300 | Nitrite as N: | 0.043 | Turbidity (NTU): | |
| Hardness (as $CaCO_3$): | 723 | pH (pH Unit): | 7.64 | Fluoride: | |
| T-Alkalinity (as $CaCO_3$): | 553 | Ion Balance (%): | 101 | Carbonate: | < 6 |
| P-Alkalinity (as $CaCO_3$): | < 5 | Total Coliforms**: | | Bicarbonate: | 674 |
| Nitrate + Nitrite as N: | 0.06 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.8 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 202 | Mercury: | | < 0.0001 |
| Chloride: | | 2.6 | Molybdenum: | 0.002 | 0.001 |
| Iron: | | 1.7 | Magnesium: | | 53 |
| Manganese: | | 0.955 | Sodium: | | 176 |
| Aluminum: | 0.006 | 0.002 | Potassium: | | 5.9 |
| Arsenic: | 0.0047 | 0.0059 | Vanadium: | 0.0166 | 0.0062 |
| Barium: | 0.06 | 0.062 | Strontium: | 1.36 | 1.33 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0014 | 0.0009 |
| Cadmium: | 0.00001 | 0.00002 | Zinc: | 0.002 | 0.011 |
| Chromium: | 0.0061 | 0.0027 | Copper: | 0.001 | 0.002 |
| Cobalt: | 0.0028 | 0.0027 | Lead: | < 0.0001 | 0.0003 |
| Sulfate: | | 524 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: **Sample collected by Mow-Tech Ltd.**

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

### General Comments / Observations

*Piezometer was developed following completion at a rate of approximately 41.5 lpm.*

Most Recent Water Level (m): **6.00 m — July 16, 2010**

Oil Present: **No**
Gas Present: **No**

### Water Used For Drilling

### Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 ($m^3$/day)* Apparent | Effective | Transmissivity ($m^2$/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-30 11:43 | Pump | 11.00 to 15.50 | 62.0 | 49.0 | 12.9 | 5.95 | 0.25 | — | 215.5 | | 112.5 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

### Alias IDs

TGWC: M40364.467586

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339335 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-6 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 12:05 |
| **Sample Location** | |
| **Sample Description** | M40357.441154 (Piezometer No. 10) / NE 25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 6.94 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 174 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.002 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0006 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0059 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.062 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.151 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00002 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0027 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0027 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.002 | 0.001 | | |
| Lead | Dissolved | mg/L | 0.0003 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.135 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | 0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0009 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.33 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0114 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0159 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0062 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.011 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.12 | 0.05 | | |
| Sulfur | Extractable | mg/L | 176 | 0.3 | | |
| Aluminum | Extractable | mg/L | 0.006 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0047 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.060 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339335 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-6 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 12:05 |
| **Sample Location** | |
| **Sample Description** | M40357.441154 (Piezometer No. 10) / NE 25-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.163 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0061 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0028 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.147 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.002 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0014 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.36 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0108 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0174 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0166 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.64 | | | |
| Temperature of observed pH | | °C | 19.8 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1780 | 1 | | |
| Calcium | Dissolved | mg/L | 202 | 0.2 | | |
| Calcium | Extractable | mg/L | 206 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 53.0 | 0.2 | | |
| Magnesium | Extractable | mg/L | 54.3 | 0.2 | | |
| Sodium | Dissolved | mg/L | 176 | 0.4 | | |
| Sodium | Extractable | mg/L | 183 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.9 | 0.4 | | |
| Potassium | Extractable | mg/L | 6.2 | 0.4 | | |
| Iron | Dissolved | mg/L | 1.70 | 0.01 | | |
| Iron | Extractable | mg/L | 0.64 | 0.01 | | |
| Manganese | Dissolved | mg/L | 0.955 | 0.005 | | |
| Manganese | Extractable | mg/L | 0.942 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339335 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-6 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 12:05 |
| **Sample Location** | |
| **Sample Description** | M40357.441154 (Piezometer No. 10) / NE 25-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 2.6 | 0.4 | | |
| Nitrate - N | | mg/L | 0.02 | 0.01 | | |
| Nitrite - N | | mg/L | 0.043 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.06 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 524 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 674 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 553 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1300 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 723 | | | |
| Ionic Balance | Dissolved | % | 101 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

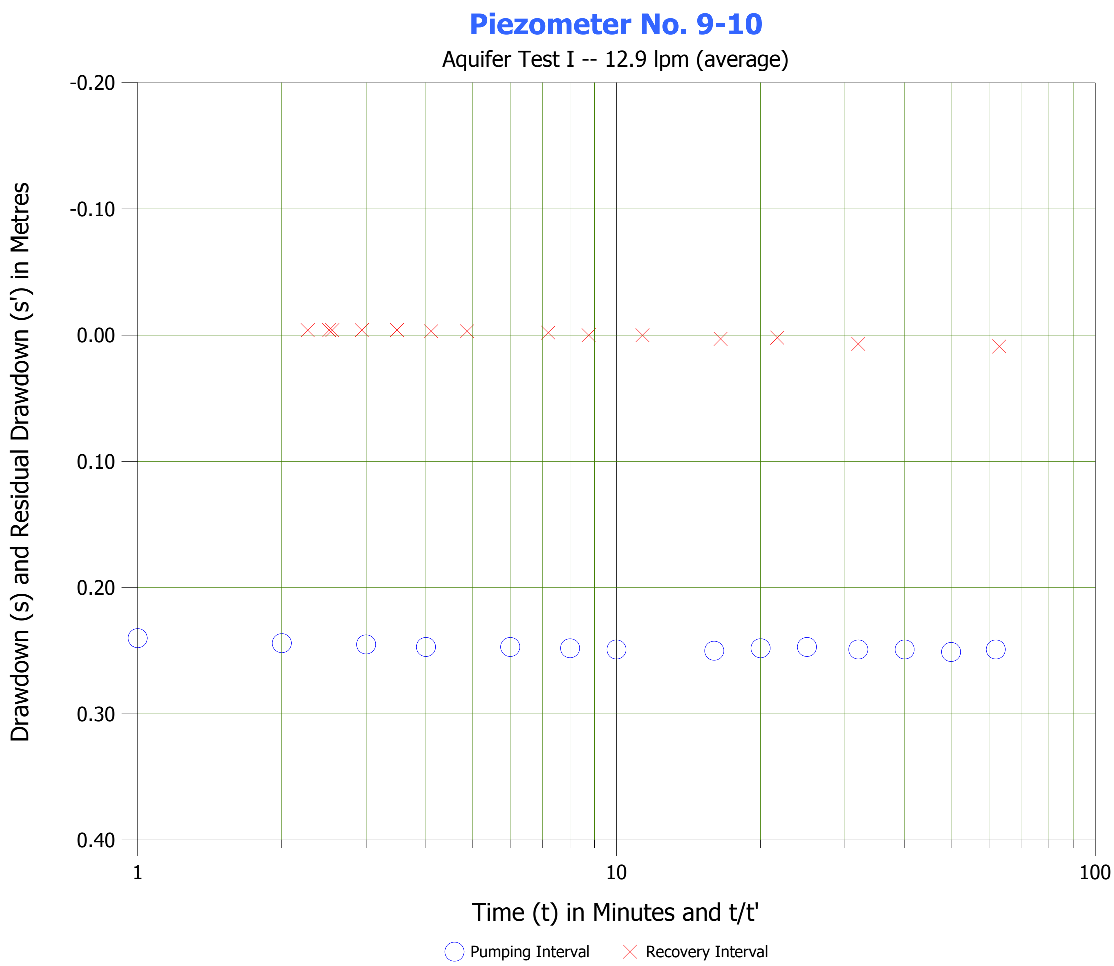
## *Piezometer No. 9-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 9-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 9-10**

*(formerly Piezometer No. 10)*

**09-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **12.9** | Pre-Test Water Level - NPWL (m): | **5.95** |
| Date Test Started: | **June 30, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **11:43** | Test Interval - Top (m): | **11.0** |
| Pumping Interval (minutes): | **62** | Test Interval - Bottom (m): | **15.5** |
| Recovery Interval (minutes): | **49** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40357.441154 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.24 | 12.9 |
| 2 | 0.24 | 12.9 |
| 3 | 0.25 | 12.9 |
| 4 | 0.25 | 12.9 |
| 6 | 0.25 | 12.9 |
| 8 | 0.25 | 12.9 |
| 10 | 0.25 | 12.9 |
| 16 | 0.25 | 12.9 |
| 20 | 0.25 | 12.9 |
| 25 | 0.25 | 12.9 |
| 32 | 0.25 | 12.9 |
| 40 | 0.25 | 12.9 |
| 50 | 0.25 | 12.9 |
| 62 | 0.25 | 12.9 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 63 | 0.01 |
| 2 | 32 | 0.01 |
| 3 | 22 | 0.00 |
| 4 | 16.5 | 0.00 |
| 6 | 11.3 | 0.00 |
| 8 | 8.8 | 0.00 |
| 10 | 7.2 | 0.00 |
| 16 | 4.9 | 0.00 |
| 20 | 4.1 | 0.00 |
| 25 | 3.5 | 0.00 |
| 32 | 2.9 | 0.00 |
| 40 | 2.6 | 0.00 |
| 41 | 2.5 | 0.00 |
| 49 | 2.3 | 0.00 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 10-10

*(Piezometer No. 7)*

**05-26-054-22 W4M**

*(M40360.431813)*

Well Spatial Location:

Easting: ***122,509***
Northing: ***5,948,495***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***634***
::*(elevation accuracy Ground Survey)*

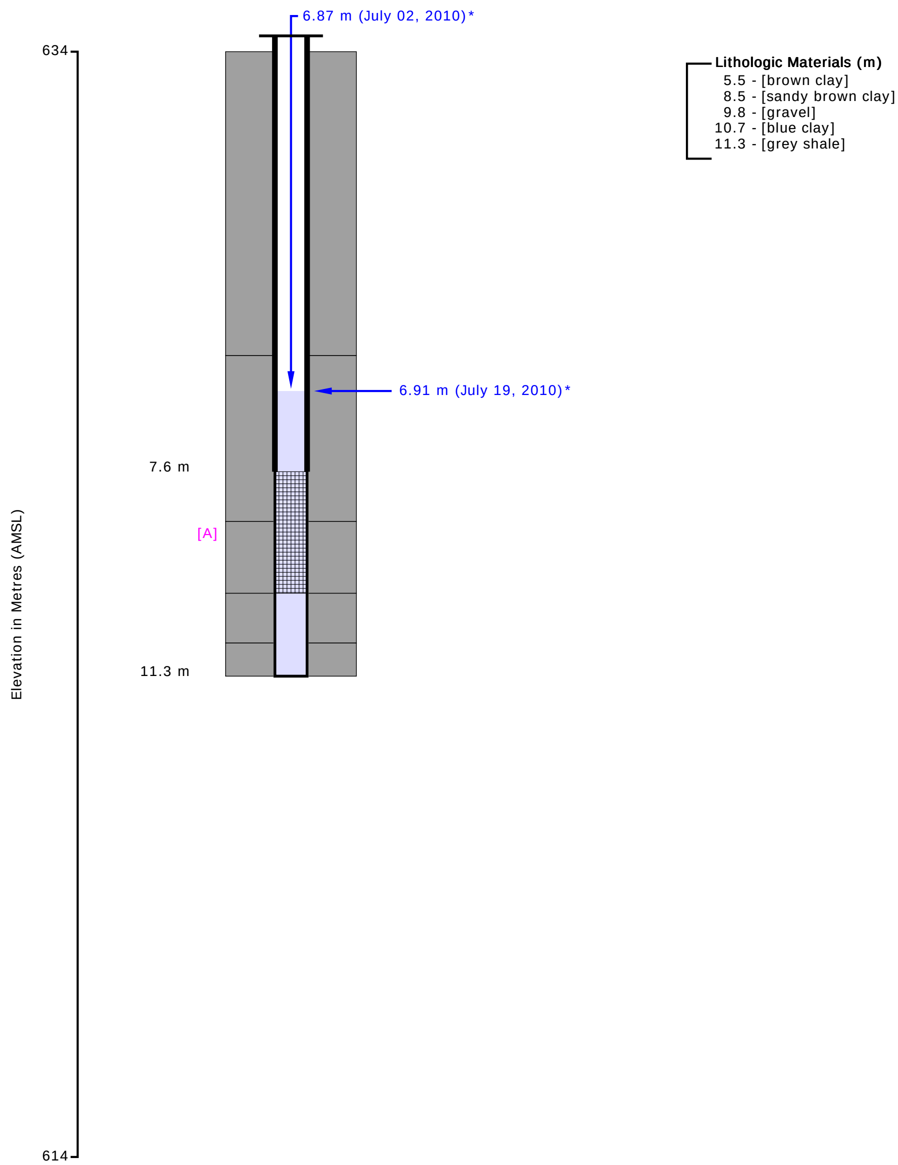
Date Completed: ***June 29, 2010***

Depth Drilled (m): ***11.3***

Completion Interval (m): ***7.6* — *9.8 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***6.91* — *July 19, 2010***
Earliest Water Level (m): ***6.87* — *July 02, 2010***

## *Piezometer No. 10-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

Geologic Unit Details not available for this location

**Summary**

TGWC ID: M40360.431813
Well Name: Piezometer No. 10-10
Legal Location: 05-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.77 m (not drawn to scale)
Interval [A]: 7.6 to 9.8 m; Screened
*Water Level (recent): 6.91 m on July 19, 2010 @ 15:04 - Reference Point: Top of Casing
*Water Level (oldest): 6.87 m on July 02, 2010 @ 14:55 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: November 30, 2012 16:24 --- http://www.tgwc.ca*

Owner: Joburg Aggregates Ltd.
1610 151 St NW, Edmonton, AB T5M 4E9

Contractor: Lakeland Drilling Ltd.
Well Name: Piezometer No. 10-10

Field Survey: June 29, 2010 - Confirmed - Physically

**METRIC REPORT**

Easting (m): 122509.00 ** 75/89
Northing (m): 5948495.00 **
Elevation (m): 634 ***
Google Earth

05-26-054-22 W4M

M40360.431813

189907-1

Work Type: Piezometer
Drilling Method: Drilled
Proposed Use: Monitoring
Completion Type: Screen

Date Started: June 29, 2010
Date Completed: June 29, 2010
Well Status: Observation

Elog Taken: No
Gamma Taken: No
Stick Up (m): 0.8
Flowing: No

## General Details

Depth Completed (m): 9.8
Depth Drilled (m): 11.3

Top of Bedrock: Surficial Water Well *
Completion Interval (m): 7.6 — 9.8 *

## Completion Details

Surface Casing: PVC — 50.8 mm (O.D.) x 7.60 m (bottom)

Screen Material: PVC — (Attached To Casing)
Fittings: Top: Threaded — Bottom: Plug

## Intervals

Completion Interval: Screen: 7.6 to 9.8 m - 20 slot

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 628.6 | 5.5 | [brown clay] |
| 625.6 | 8.5 | [sandy brown clay] |
| 624.3 | 9.8 | [gravel] |
| 623.4 | 10.7 | [blue clay] |
| 622.8 | 11.3 | [grey shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: July 02, 2010
Analysis Details: July 08, 2010 - Exova (750102-5)

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1140 | Nitrate as N: | 0.06 | Colour (TCU): | |
| TDS (Calculated): | 752 | Nitrite as N: | < 0.005 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 543 | pH (pH Unit): | 7.74 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 441 | Ion Balance (%): | 102 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 538 |
| Nitrate + Nitrite as N: | 0.06 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.9 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 145 | Mercury: | | < 0.0001 |
| Chloride: | | 3.8 | Molybdenum: | 0.003 | 0.003 |
| Iron: | | < 0.01 | Magnesium: | | 43.8 |
| Manganese: | | 1.46 | Sodium: | | 64.1 |
| Aluminum: | 0.072 | < 0.002 | Potassium: | | 5.9 |
| Arsenic: | 0.0013 | 0.0011 | Vanadium: | 0.0124 | 0.0047 |
| Barium: | 0.123 | 0.128 | Strontium: | 0.896 | 0.863 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0018 | 0.0019 |
| Cadmium: | 0.00003 | 0.00004 | Zinc: | 0.001 | 0.005 |
| Chromium: | 0.0045 | 0.0017 | Copper: | 0.001 | 0.001 |
| Cobalt: | 0.0014 | 0.0015 | Lead: | < 0.0001 | < 0.0001 |
| Sulfate: | | 224 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: Sample collected by Mow-Tech Ltd.

note: constituents have been compared to the maximum acceptable concentration, as stated in the Summary of Guidelines for Canadian Drinking Water Quality (Federal–Provincial–Territorial Committee on Drinking Water, May 2008)

## General Comments / Observations

Piezometer was developed following completion at a rate of approximately 3.3 lpm.

Most Recent Water Level (m): 6.91 m — July 19, 2010

Oil Present: No
Gas Present: No

## Water Used For Drilling

## Aquifer Tests

| No. | Date | Testing Method | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Level-End (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-07-02 14:58 | Pump | 62.0 | 60.0 | 1.3 | 6.87 | 0.31 | 7.17 | — | 2.2 | | 8.0 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

* **TGWC** calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339334 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-5 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 15:40 |
| **Sample Location** | |
| **Sample Description** | M40360.431813 (Piezometer No. 7) / SW 26-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.38 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 74.7 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | <0.002 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0006 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0011 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.128 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.108 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00004 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0017 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0015 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.001 | 0.001 | | |
| Lead | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.093 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | 0.003 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0019 | 0.0005 | | |
| Selenium | Dissolved | mg/L | 0.0003 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 0.863 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0048 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0090 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0047 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.005 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.76 | 0.05 | | |
| Sulfur | Extractable | mg/L | 76.1 | 0.3 | | |
| Aluminum | Extractable | mg/L | 0.072 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0013 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.123 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339334 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-5 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 15:40 |
| **Sample Location** | |
| **Sample Description** | M40360.431813 (Piezometer No. 7) / SW 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.120 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00003 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0045 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0014 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.103 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.003 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0018 | 0.0005 | | |
| Selenium | Extractable | mg/L | 0.0005 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 0.896 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0064 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0100 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0124 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.001 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.74 | | | |
| Temperature of observed pH | | °C | 19.9 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1140 | 1 | | |
| Calcium | Dissolved | mg/L | 145 | 0.2 | | |
| Calcium | Extractable | mg/L | 146 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 43.8 | 0.2 | | |
| Magnesium | Extractable | mg/L | 45.0 | 0.2 | | |
| Sodium | Dissolved | mg/L | 64.1 | 0.4 | | |
| Sodium | Extractable | mg/L | 66.3 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.9 | 0.4 | | |
| Potassium | Extractable | mg/L | 6.2 | 0.4 | | |
| Iron | Dissolved | mg/L | <0.01 | 0.01 | | |
| Iron | Extractable | mg/L | 0.04 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.46 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.40 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339334 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-5 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 15:40 |
| **Sample Location** | |
| **Sample Description** | M40360.431813 (Piezometer No. 7) / SW 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 3.8 | 0.4 | | |
| Nitrate - N | | mg/L | 0.06 | 0.01 | | |
| Nitrite - N | | mg/L | <0.005 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.06 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 224 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 538 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 441 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 752 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 543 | | | |
| Ionic Balance | Dissolved | % | 102 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

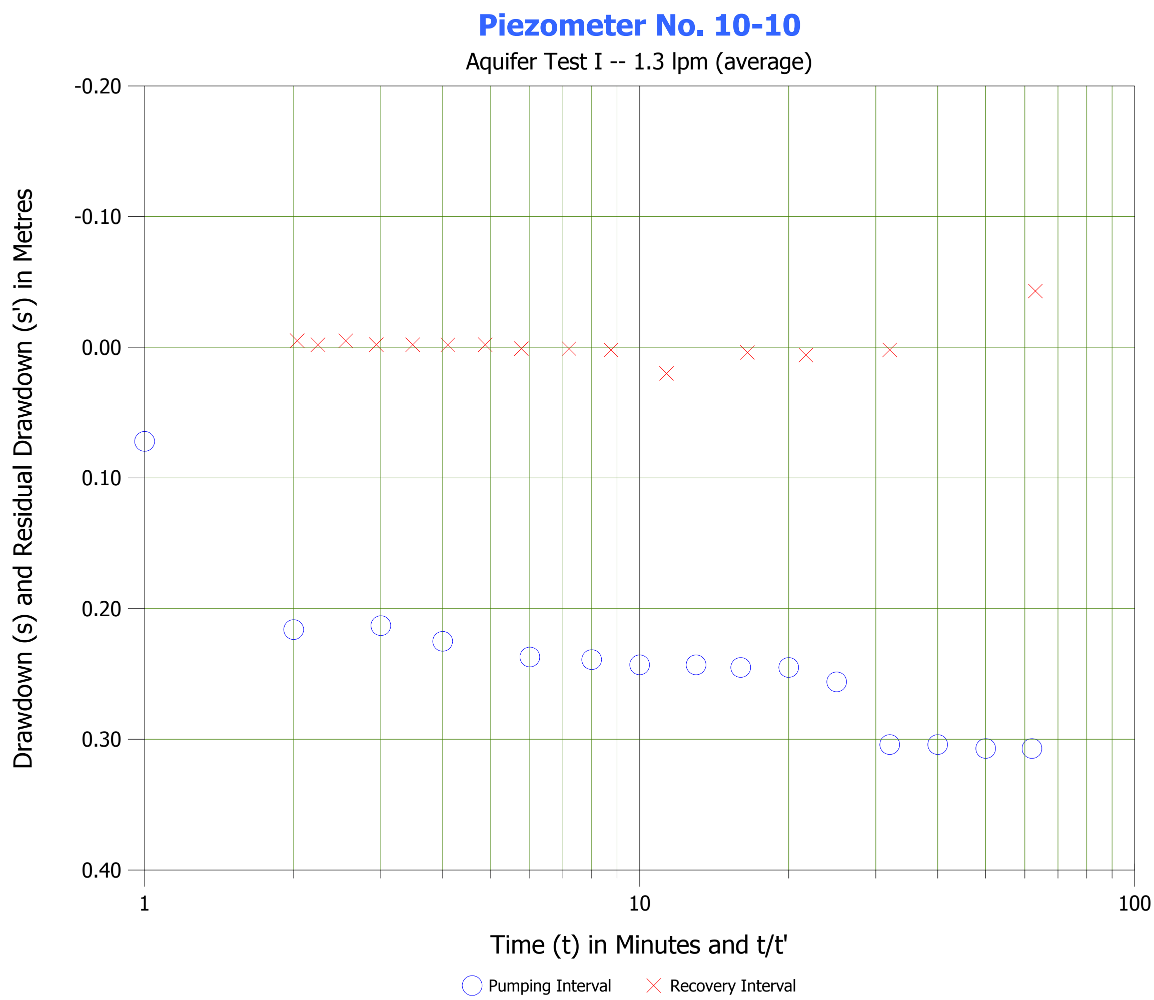
## *Piezometer No. 10-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 10-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 10-10**

*(formerly Piezometer No. 7)*

**05-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **1.3** | Pre-Test Water Level - NPWL (m): | **6.87** |
| Date Test Started: | **July 02, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **14:58** | Test Interval - Top (m): | **7.6** |
| Pumping Interval (minutes): | **62** | Test Interval - Bottom (m): | **9.8** |
| Recovery Interval (minutes): | **60** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40360.431813 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.07 | 1.3 |
| 2 | 0.22 | 1.3 |
| 3 | 0.21 | 1.3 |
| 4 | 0.23 | 1.3 |
| 6 | 0.24 | 1.3 |
| 8 | 0.24 | 1.3 |
| 10 | 0.24 | 1.3 |
| 13 | 0.24 | 1.3 |
| 16 | 0.25 | 1.3 |
| 20 | 0.25 | 1.3 |
| 25 | 0.26 | 1.3 |
| 32 | 0.30 | 1.3 |
| 40 | 0.30 | 1.3 |
| 50 | 0.31 | 1.3 |
| 62 | 0.31 | 1.3 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 63 | -0.04 |
| 2 | 32 | 0.00 |
| 3 | 22 | 0.01 |
| 4 | 16.5 | 0.00 |
| 6 | 11.3 | 0.02 |
| 8 | 8.8 | 0.00 |
| 10 | 7.2 | 0.00 |
| 13 | 5.8 | 0.00 |
| 16 | 4.9 | 0.00 |
| 20 | 4.1 | 0.00 |
| 25 | 3.5 | 0.00 |
| 32 | 2.9 | 0.00 |
| 40 | 2.6 | -0.01 |
| 50 | 2.2 | 0.00 |
| 60 | 2.0 | -0.01 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 11-10

*(Piezometer No. 15)*

**04-26-054-22 W4M**

*(M40360.460504)*

Well Spatial Location:

Easting: ***122,614***
Northing: ***5,947,973***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***631***
::*(elevation accuracy Ground Survey)*

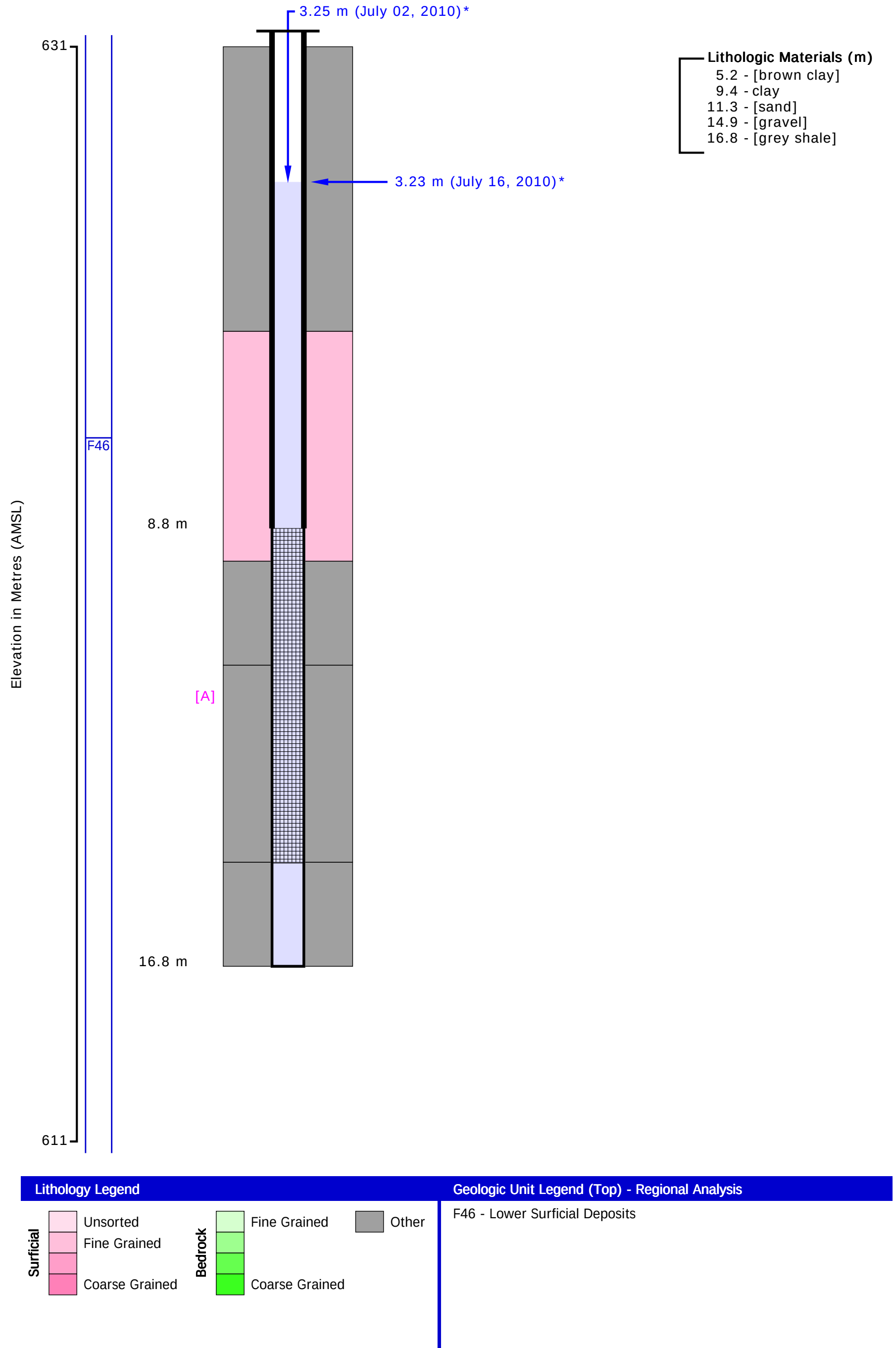
Date Completed: ***June 29, 2010***

Depth Drilled (m): ***16.8***

Completion Interval (m): ***8.8* — *14.9 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***3.23* — *July 16, 2010***
Earliest Water Level (m): ***3.25* — *July 02, 2010***

## *Piezometer No. 11-10*
## *Well Diagram*




**Summary**

TGWC ID: M40360.460504
Well Name: Piezometer No. 11-10
Legal Location: 04-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.76 m (not drawn to scale)
Interval [A]: 8.8 to 14.9 m; Screened
*Water Level (recent): 3.23 m on July 16, 2010 @ 13:10 - Reference Point: Top of Casing
*Water Level (oldest): 3.25 m on July 02, 2010 @ 08:38 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: November 30, 2012 16:26 --- http://www.tgwc.ca*

Owner: **Joburg Aggregates Ltd..**
**1610 151 St NW, Edmonton, AB T5M 4E9**

Contractor: **Lakeland Drilling Ltd.**
Well Name: **Piezometer No. 11-10**

Field Survey: **June 29, 2010 - Confirmed - Physically**

# METRIC REPORT

Easting (m): **122614.00** ** 75/89
Northing (m): **5947973.00** **
Elevation (m): **631** ***
Google Earth

04-26-054-22 W4M

M40360.460504

189910-1

Work Type: **Piezometer**
Drilling Method: **Drilled**
Proposed Use: **Monitoring**
Completion Type: **Screen**

Date Started: **June 29, 2010**
Date Completed: **June 29, 2010**
Well Status: **Observation**

Elog Taken: **No**
Gamma Taken: **No**
Stick Up (m): **0.8**
Flowing: **No**

## General Details

Depth Completed (m): **14.9**
Depth Drilled (m): **16.8**
Top of Bedrock: **Surficial Water Well ***
Completion Interval (m): **8.8 — 14.9 ***

## Completion Details

Surface Casing: **PVC — 50.8 mm (O.D.) x 8.80 m (bottom)**

Screen Material: **PVC — (Attached To Casing)**
Fittings: ***Top:* Threaded — *Bottom:* Plug**

## Intervals

Completion Interval: *Screen*: **8.8** to **14.9 m - 20 slot**

Construction Interval: *Bentonite*: **0.0** to **8.2 m**
Construction Interval: *Sand Pack*: **8.2** to **14.9 m**

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 626.0 | 5.2 | [brown clay] |
| 621.8 | 9.4 | [soft blue clay] |
| 619.9 | 11.3 | [sand] |
| 616.3 | 14.9 | [gravel] |
| 614.4 | 16.8 | [grey shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: **July 02, 2010**
Analysis Details: **July 08, 2010 - Exova (750102-8)**

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1170 | Nitrate as N: | 0.02 | Colour (TCU): | |
| TDS (Calculated): | 777 | Nitrite as N: | 0.055 | Turbidity (NTU): | |
| Hardness (as $CaCO_3$): | 527 | pH (pH Unit): | 7.76 | Fluoride: | |
| T-Alkalinity (as $CaCO_3$): | 513 | Ion Balance (%): | 99 | Carbonate: | < 6 |
| P-Alkalinity (as $CaCO_3$): | < 5 | Total Coliforms**: | | Bicarbonate: | 626 |
| Nitrate + Nitrite as N: | 0.07 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.8 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 145 | Mercury: | | < 0.0001 |
| Chloride: | | 1.1 | Molybdenum: | 0.001 | 0.001 |
| Iron: | | 2.14 | Magnesium: | | 39.7 |
| Manganese: | | 1.39 | Sodium: | | 82.4 |
| Aluminum: | 0.007 | 0.002 | Potassium: | | 5.2 |
| Arsenic: | 0.0025 | 0.0028 | Vanadium: | 0.0141 | 0.0055 |
| Barium: | 0.066 | 0.07 | Strontium: | 1.34 | 1.3 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0012 | 0.0011 |
| Cadmium: | < 0.00001 | 0.00003 | Zinc: | < 0.001 | 0.007 |
| Chromium: | 0.0052 | 0.0023 | Copper: | < 0.001 | 0.001 |
| Cobalt: | 0.0026 | 0.0028 | Lead: | < 0.0001 | < 0.0001 |
| Sulfate: | | 195 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: **Sample collected by Mow-Tech Ltd.**

*note: constituents have been compared to the maximum acceptable concentration, as stated in the Summary of Guidelines for Canadian Drinking Water Quality (Federal–Provincial–Territorial Committee on Drinking Water, May 2008)*

## General Comments / Observations

*Piezometer was developed following completion at a rate of approximately 61.5 lpm.*

Most Recent Water Level (m): **3.23 m — July 16, 2010**

Oil Present: **No**
Gas Present: **No**

## Water Used For Drilling

## Aquifer Tests

| No. | Date | Testing Method | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Level-End (metre) | Pump (metre) | Q20 ($m^3$/day)* Apparent | Effective | Transmissivity ($m^2$/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-07-02 08:42 | Pump | 61.0 | 61.0 | 14.4 | 3.25 | 0.47 | 3.71 | — | 137.6 | | 65.4 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

* **TGWC** calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

*This report was generated on: August 12, 2010 — Data "AS IS"; no warranty either expressed or implied. [53.68748 -113.14248 (WGS 84)], INT*

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## Analytical Report

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|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339338 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-8 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 09:10 |
| **Sample Location** | |
| **Sample Description** | M40360.460504 (Piezometer No. 15) / SW 26-054 |
| **Sample Matrix** | Water |

| **Analyte** | | **Units** | **Result** | **Nominal Detection Limit** | **Guideline Limit** | **Guideline Comments** |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.67 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 65.0 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.002 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0005 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0028 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.070 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.159 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00003 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0023 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0028 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.001 | 0.001 | | |
| Lead | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.112 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | 0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0011 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.30 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0042 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0036 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0055 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.007 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.75 | 0.05 | | |
| Sulfur | Extractable | mg/L | 66.2 | 0.3 | | |
| Aluminum | Extractable | mg/L | 0.007 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0025 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.066 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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W: www.exova.com

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339338 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-8 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 09:10 |
| **Sample Location** | |
| **Sample Description** | M40360.460504 (Piezometer No. 15) / SW 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.184 | 0.002 | | |
| Cadmium | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0052 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0026 | 0.0001 | | |
| Copper | Extractable | mg/L | <0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.127 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0012 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.34 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0042 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0041 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0141 | 0.0001 | | |
| Zinc | Extractable | mg/L | <0.001 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.76 | | | |
| Temperature of observed pH | | °C | 19.8 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 1170 | 1 | | |
| Calcium | Dissolved | mg/L | 145 | 0.2 | | |
| Calcium | Extractable | mg/L | 146 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 39.7 | 0.2 | | |
| Magnesium | Extractable | mg/L | 40.9 | 0.2 | | |
| Sodium | Dissolved | mg/L | 82.4 | 0.4 | | |
| Sodium | Extractable | mg/L | 86.0 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.2 | 0.4 | | |
| Potassium | Extractable | mg/L | 5.5 | 0.4 | | |
| Iron | Dissolved | mg/L | 2.14 | 0.01 | | |
| Iron | Extractable | mg/L | 0.34 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.39 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.32 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339338 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-8 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 09:10 |
| **Sample Location** | |
| **Sample Description** | M40360.460504 (Piezometer No. 15) / SW 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 1.1 | 0.4 | | |
| Nitrate - N | | mg/L | 0.02 | 0.01 | | |
| Nitrite - N | | mg/L | 0.055 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.07 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 195 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 626 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 513 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 777 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 527 | | | |
| Ionic Balance | Dissolved | % | 99 | | | |

Approved by: RLNeumann

Randy Neumann, BSc
General Manager

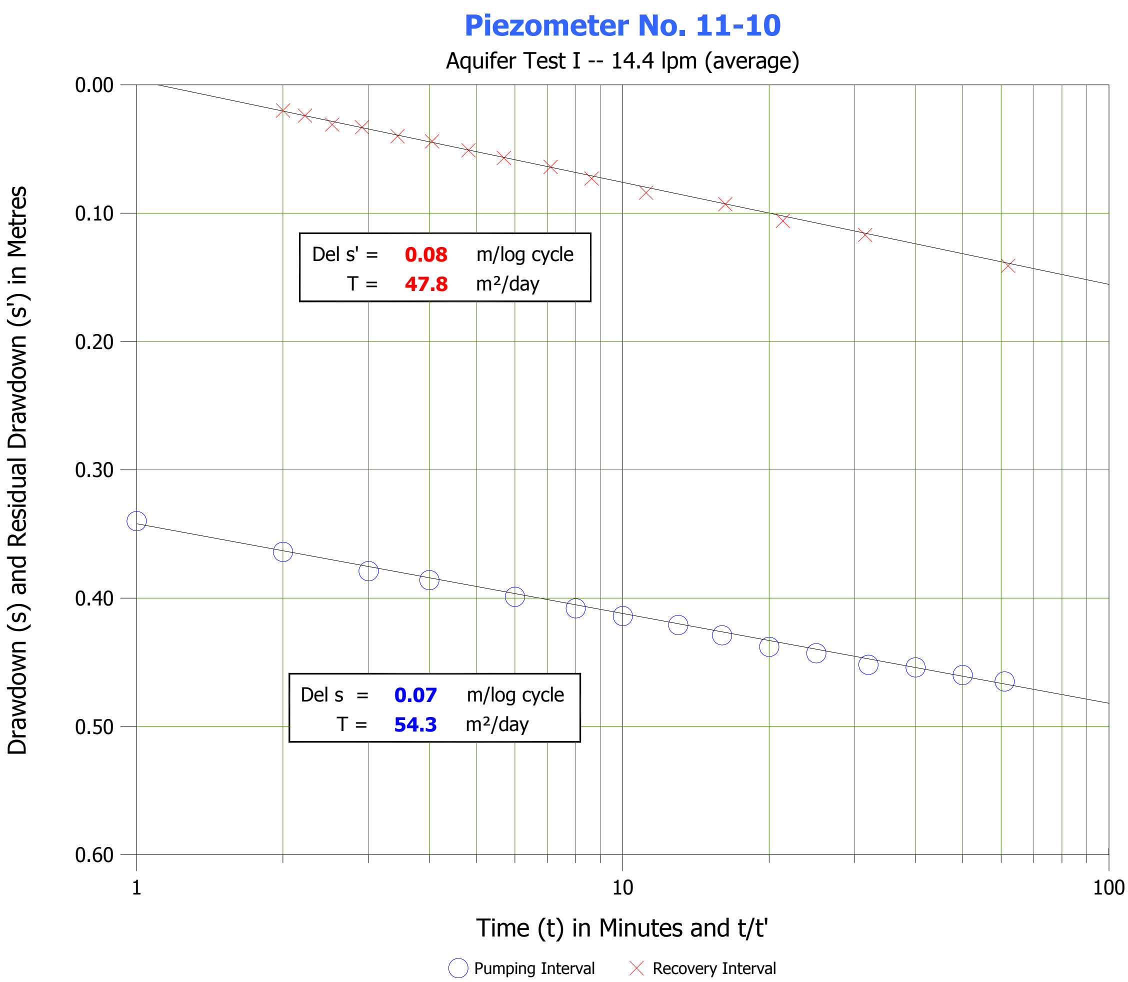
## *Piezometer No. 11-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 11-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 11-10**

*(formerly Piezometer No. 15)*

**04-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **14.4** | Pre-Test Water Level - NPWL (m): | **3.25** |
| Date Test Started: | **July 02, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **08:42** | Test Interval - Top (m): | **8.8** |
| Pumping Interval (minutes): | **61** | Test Interval - Bottom (m): | **14.9** |
| Recovery Interval (minutes): | **61** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40360.460504 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.34 | 14.4 |
| 2 | 0.36 | 14.4 |
| 3 | 0.38 | 14.4 |
| 4 | 0.39 | 14.4 |
| 6 | 0.40 | 14.4 |
| 8 | 0.41 | 14.4 |
| 10 | 0.41 | 14.4 |
| 13 | 0.42 | 14.4 |
| 16 | 0.43 | 14.4 |
| 20 | 0.44 | 14.4 |
| 25 | 0.44 | 14.4 |
| 32 | 0.45 | 14.4 |
| 40 | 0.45 | 14.4 |
| 50 | 0.46 | 14.4 |
| 61 | 0.47 | 14.4 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 62 | 0.14 |
| 2 | 32 | 0.12 |
| 3 | 21 | 0.11 |
| 4 | 16.3 | 0.09 |
| 6 | 11.2 | 0.08 |
| 8 | 8.6 | 0.07 |
| 10 | 7.1 | 0.06 |
| 13 | 5.7 | 0.06 |
| 16 | 4.8 | 0.05 |
| 20 | 4.1 | 0.04 |
| 25 | 3.4 | 0.04 |
| 32 | 2.9 | 0.03 |
| 40 | 2.5 | 0.03 |
| 50 | 2.2 | 0.02 |
| 61 | 2.0 | 0.02 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 12-10

*(Piezometer No. 18)*

**09-26-054-22 W4M**

*(M40360.468475)*

Well Spatial Location:

Easting: ***123,857***
Northing: ***5,948,754***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***633***
::*(elevation accuracy Ground Survey)*

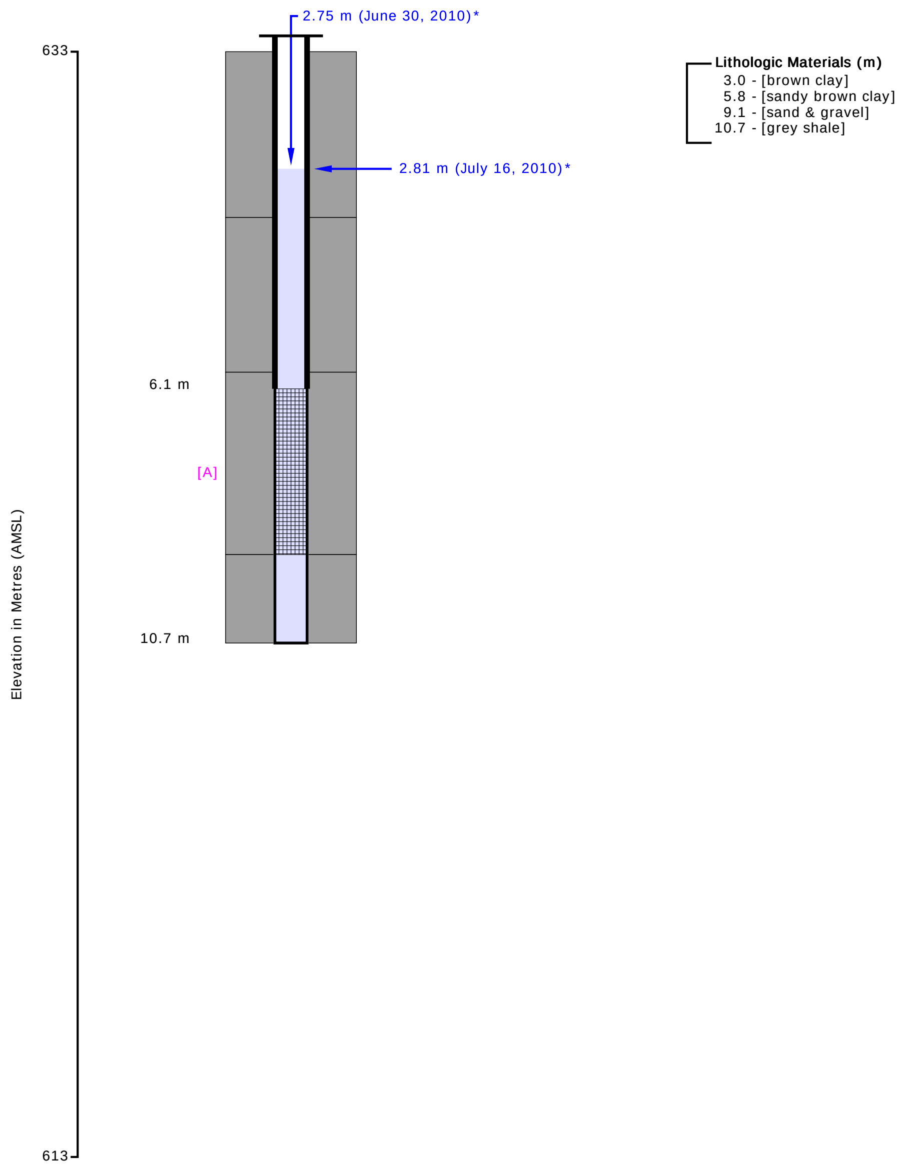
Date Completed: ***June 29, 2010***

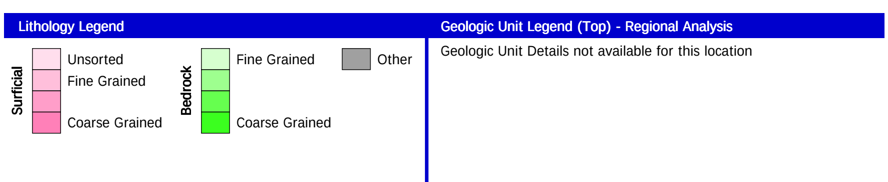
Depth Drilled (m): ***10.7***

Completion Interval (m): ***6.1* — *9.1 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***2.81* — *July 16, 2010***
Earliest Water Level (m): ***2.75* — *June 30, 2010***

## *Piezometer No. 12-10*
## *Well Diagram*




**Summary**

TGWC ID: M40360.468475
Well Name: Piezometer No. 12-10
Legal Location: 09-26-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.69 m (not drawn to scale)
Interval [A]: 6.1 to 9.1 m; Screened
*Water Level (recent): 2.81 m on July 16, 2010 @ 11:35 - Reference Point: Top of Casing
*Water Level (oldest): 2.75 m on June 30, 2010 @ 14:30 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*Drawn: November 30, 2012 16:27 --- http://www.tgwc.ca*

Owner: ***Joburg Aggregates Ltd.***
***1610 151 St NW, Edmonton, AB T5M 4E9***

Contractor: ***Lakeland Drilling Ltd.***
Well Name: ***Piezometer No. 12-10***

Field Survey: ***June 29, 2010 - Confirmed - Physically***

**METRIC REPORT**

Easting (m): ***123857.00*** ** 75/89
Northing (m): ***5948754.00*** **
Elevation (m): ***633*** ***
Google Earth

09-26-054-22 W4M

M40360.468475

189911-1

Work Type: ***Piezometer***
Drilling Method: ***Drilled***
Proposed Use: ***Monitoring***
Completion Type: ***Screen***

Date Started: ***June 29, 2010***
Date Completed: ***June 29, 2010***
Well Status: ***Observation***
Feature Class: ***Piezometer***

Elog Taken: ***No***
Gamma Taken: ***No***
Stick Up (m): ***0.7***
Flowing: ***No***

## General Details

Depth Completed (m): ***9.1***
Depth Drilled (m): ***10.7***

Top of Bedrock: ***Surficial Water Well ****
Completion Interval (m): ***6.1 — 9.1 ****

## Completion Details

Surface Casing: ***PVC — 50.8 mm (O.D.) x 6.10 m (bottom)***

Screen Material: ***PVC — (Attached To Casing)***
Fittings: ***Top: Threaded — Bottom: Plug***
Pack: ***[unknown]***

## Intervals

*Screen*: ***6.1*** *to* ***9.1 m - 20 slot***

*Bentonite*: ***0.0*** *to* ***5.5 m***
*Sand Pack*: ***5.5*** *to* ***10.7 m***

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 629.5 | 3.0 | [brown clay] |
| 626.7 | 5.8 | [sandy brown clay] |
| 623.4 | 9.1 | [sand & gravel] |
| 621.8 | 10.7 | [grey shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: ***June 30, 2010***
Analysis Details: ***July 08, 2010 - Exova Canada Inc. (750102-9)***

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 1170 | Nitrate as N: | 0.01 | Colour (TCU): | |
| TDS (Calculated): | 798 | Nitrite as N: | < 0.005 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 547 | pH (pH Unit): | 7.7 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 450 | Ion Balance (%): | 97 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 549 |
| Nitrate + Nitrite as N: | 0.01 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.7 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 149 | Mercury: | | < 0.0001 |
| Chloride: | | 2.4 | Molybdenum: | < 0.001 | < 0.001 |
| Iron: | | 0.41 | Magnesium: | | 42.4 |
| Manganese: | | 2.07 | Sodium: | | 68.6 |
| Aluminum: | 0.025 | 0.003 | Potassium: | | 5.3 |
| Arsenic: | 0.0022 | 0.0019 | Vanadium: | 0.0121 | 0.0057 |
| Barium: | 0.045 | 0.046 | Strontium: | 0.979 | 0.962 |
| Beryllium: | < 0.0001 | < 0.0001 | Nickel: | 0.0011 | 0.0008 |
| Cadmium: | 0.00001 | 0.00003 | Zinc: | 0.006 | 0.004 |
| Chromium: | 0.0043 | 0.0022 | Copper: | 0.001 | 0.001 |
| Cobalt: | 0.0014 | 0.0014 | Lead: | < 0.0001 | 0.0003 |
| Sulfate: | | 260 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: ***Sample collected by Mow-Tech Ltd.***

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

## General Comments / Observations

*Piezometer was developed following completion at a rate of approximately 65 lpm.*

Most Recent Water Level (m): ***2.81 m — July 16, 2010***

Oil Present: ***No***
Gas Present: ***No***

## Water Used For Drilling

## Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2010-06-30 14:33 | Pump | 6.10 to 9.10 | 63.0 | 67.0 | 13.9 | 2.75 | 0.23 | — | 171.8 | | 135.2 | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 --- | | | | | | | | | | | | | R C |
| | | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

** The Groundwater Centre (**TGWC**) calculated or determined value.*
*** 75 - MT GPS — 10TM NAD83*
**** 89 - Ground Survey — {Ground; AMSL}*

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339339 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-9 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 14:50 |
| **Sample Location** | |
| **Sample Description** | M40360.468475 (Piezometer No. 18) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 7.26 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 86.6 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | 0.003 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0005 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.0019 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.046 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.137 | 0.002 | | |
| Cadmium | Dissolved | mg/L | 0.00003 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0022 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0014 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.001 | 0.001 | | |
| Lead | Dissolved | mg/L | 0.0003 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.092 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.001 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0008 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0002 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 0.962 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0054 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0048 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0057 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.004 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.41 | 0.05 | | |
| Sulfur | Extractable | mg/L | 87.0 | 0.3 | | |
| Aluminum | Extractable | mg/L | 0.025 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0022 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.045 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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## Analytical Report

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| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339339 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-9 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 14:50 |
| **Sample Location** | |
| **Sample Description** | M40360.468475 (Piezometer No. 18) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.151 | 0.002 | | |
| Cadmium | Extractable | mg/L | 0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0043 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0014 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.001 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.101 | 0.001 | | |
| Molybdenum | Extractable | mg/L | <0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0011 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 0.979 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0063 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0054 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0121 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.006 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.70 | | | |
| Temperature of observed pH | | °C | 19.7 | | | |
| Electrical Conductivity | | µS/cm at 25 C | 1170 | 1 | | |
| Calcium | Dissolved | mg/L | 149 | 0.2 | | |
| Calcium | Extractable | mg/L | 150 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 42.4 | 0.2 | | |
| Magnesium | Extractable | mg/L | 43.3 | 0.2 | | |
| Sodium | Dissolved | mg/L | 68.6 | 0.4 | | |
| Sodium | Extractable | mg/L | 71.3 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.3 | 0.4 | | |
| Potassium | Extractable | mg/L | 5.6 | 0.4 | | |
| Iron | Dissolved | mg/L | 0.41 | 0.01 | | |
| Iron | Extractable | mg/L | 0.18 | 0.01 | | |
| Manganese | Dissolved | mg/L | 2.07 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.98 | 0.005 | | |

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339339 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-9 |
| **Sample Date** | June 30, 2010 |
| **Sample Time** | 14:50 |
| **Sample Location** | |
| **Sample Description** | M40360.468475 (Piezometer No. 18) / NE 26-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 2.4 | 0.4 | | |
| Nitrate - N | | mg/L | 0.01 | 0.01 | | |
| Nitrite - N | | mg/L | <0.005 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | 0.01 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 260 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 549 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 450 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 798 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 547 | | | |
| Ionic Balance | Dissolved | % | 97 | | | |

Approved by: RL Neumann

Randy Neumann, BSc
General Manager

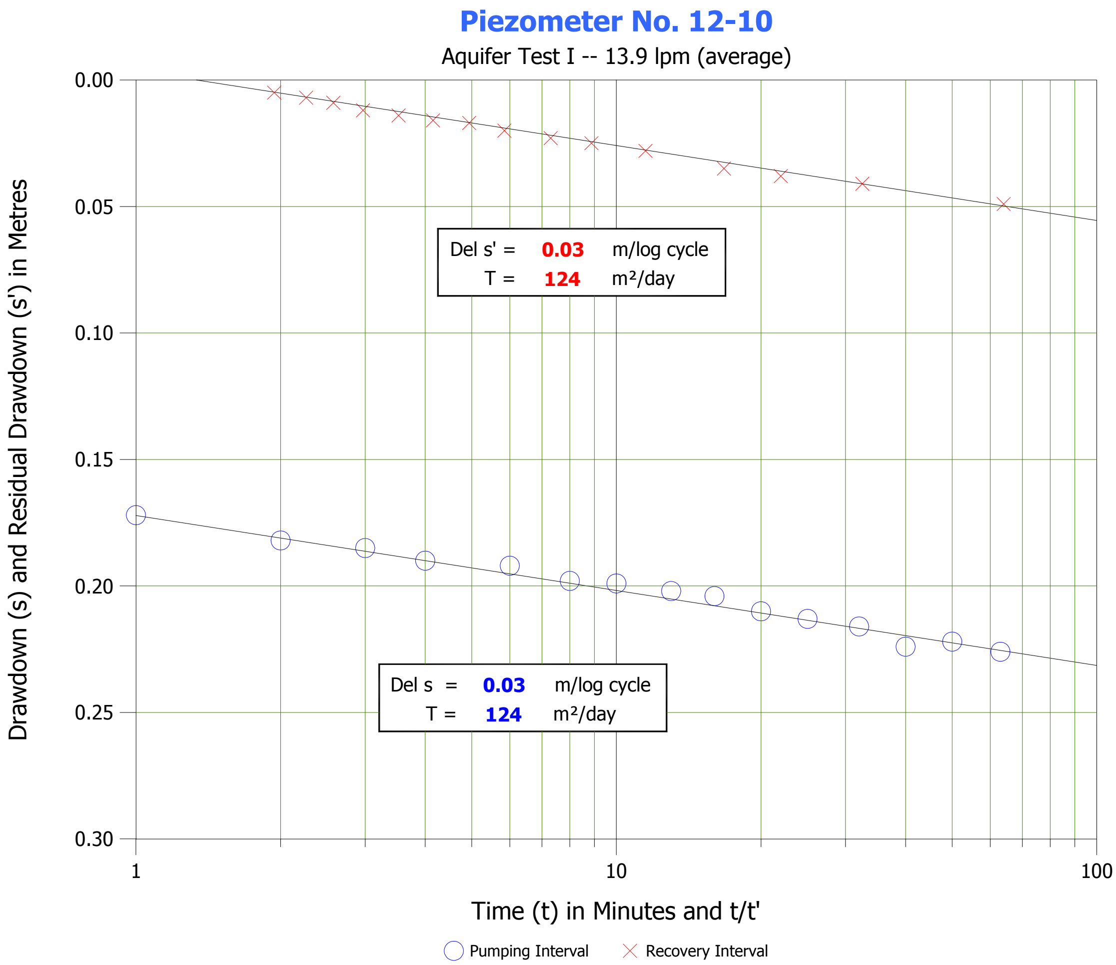
***Piezometer No. 12-10***
***Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations***

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (μS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Piezometer No. 12-10***
***Aquifer Test I***



# Aquifer Test I

**Piezometer No. 12-10**

*(formerly Piezometer No. 18)*

**09-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **13.9** | Pre-Test Water Level - NPWL (m): | **2.75** |
| Date Test Started: | **June 30, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **14:33** | Test Interval - Top (m): | **6.1** |
| Pumping Interval (minutes): | **63** | Test Interval - Bottom (m): | **9.1** |
| Recovery Interval (minutes): | **67** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40360.468475 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.17 | 13.9 |
| 2 | 0.18 | 13.9 |
| 3 | 0.19 | 13.9 |
| 4 | 0.19 | 13.9 |
| 6 | 0.19 | 13.9 |
| 8 | 0.20 | 13.9 |
| 10 | 0.20 | 13.9 |
| 13 | 0.20 | 13.9 |
| 16 | 0.20 | 13.9 |
| 20 | 0.21 | 13.9 |
| 25 | 0.21 | 13.9 |
| 32 | 0.22 | 13.9 |
| 40 | 0.22 | 13.9 |
| 50 | 0.22 | 13.9 |
| 63 | 0.23 | 13.9 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 64 | 0.05 |
| 2 | 33 | 0.04 |
| 3 | 22 | 0.04 |
| 4 | 16.8 | 0.04 |
| 6 | 11.5 | 0.03 |
| 8 | 8.9 | 0.03 |
| 10 | 7.3 | 0.02 |
| 13 | 5.8 | 0.02 |
| 16 | 4.9 | 0.02 |
| 20 | 4.2 | 0.02 |
| 25 | 3.5 | 0.01 |
| 32 | 3.0 | 0.01 |
| 40 | 2.6 | 0.01 |
| 50 | 2.3 | 0.01 |
| 67 | 1.94 | 0.01 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 13-10

*(Piezometer No. 17)*

**09-25-054-22 W4M**

*(M40366.446374)*

Well Spatial Location:

Easting: ***125,238***
Northing: ***5,948,783***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***642***
::*(elevation accuracy Ground Survey)*

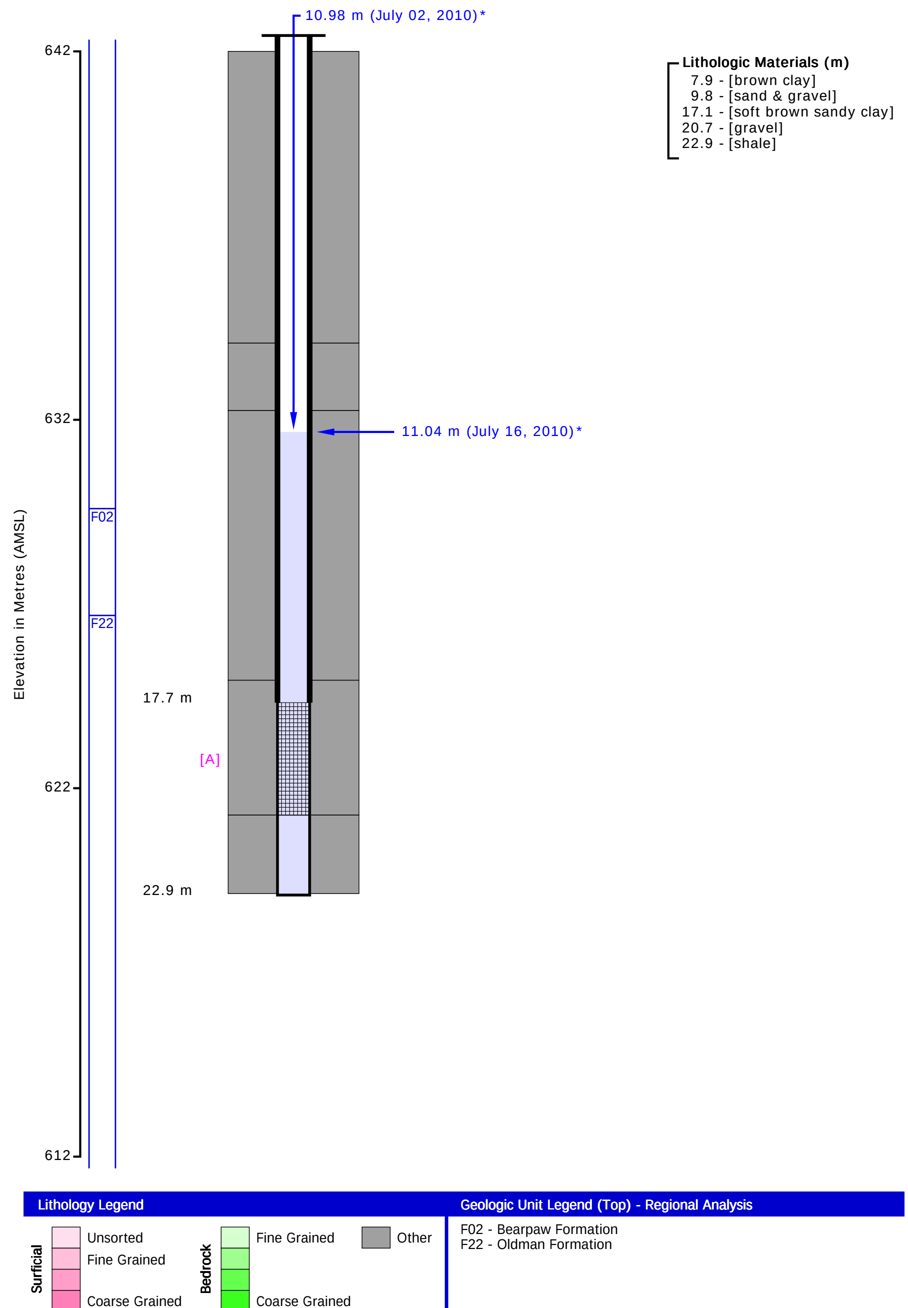
Date Completed: ***July 01, 2010***

Depth Drilled (m): ***22.9***

Completion Interval (m): ***17.7* — *20.7 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***11.04* — *July 16, 2010***
Earliest Water Level (m): ***10.98* — *July 02, 2010***

## *Piezometer No. 13-10*
## *Well Diagram*




**Summary**

TGWC ID: M40366.446374
Well Name: Piezometer No. 13-10
Legal Location: 09-25-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.71 m (not drawn to scale)
Interval [A]: 17.7 to 20.7 m; Screened
*Water Level (recent): 11.04 m on July 16, 2010 @ 08:31 - Reference Point: Top of Casing
*Water Level (oldest): 10.98 m on July 02, 2010 @ 13:15 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: August 27, 2010 08:10 --- http://www.tgwc.ca*

Owner: ***Joburg Aggregates Ltd.***
***1610 151 St NW, Edmonton, AB T5J 3G2***

Contractor: ***Lakeland Drilling Ltd.***
Well Name: ***Piezometer No. 13-10***

Field Survey: ***July 01, 2010 - Confirmed - Physically***

**METRIC REPORT**

Easting (m): ***125238.00*** ** 75/89
Northing (m): ***5948783.00*** **
Elevation (m): ***642*** ***
Google Earth

09-25-054-22 W4M

M40366.446374

Work Type: ***Piezometer***
Drilling Method: ***Drilled***
Proposed Use: ***Monitoring***
Completion Type: ***Screen***
Date Started: ***July 01, 2010***
Date Completed: ***July 01, 2010***
Well Status: ***Observation***
Feature Class: ***Piezometer***

Elog Taken: ***No***
Gamma Taken: ***No***
Stick Up (m): ***0.7***
Flowing: ***No***

## General Details

Depth Completed (m): ***20.7***
Depth Drilled (m): ***22.9***
Top of Bedrock: ***Surficial Water Well ****
Completion Interval (m): ***17.7 — 20.7 ****

## Completion Details

Surface Casing: ***PVC — 50.8 mm (O.D.) x 17.68 m (bottom)***

Screen Material: ***PVC — (Attached To Casing)***
Fittings: ***Top: Threaded — Bottom: Plug***
Pack: ***[unknown]***

## Intervals

*Screen*: ***17.7*** *to* ***20.7 m - 20 slot***

*Bentonite*: ***0.0*** *to* ***17.1 m***
*Sand Pack*: ***17.1*** *to* ***22.9 m***

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 634.1 | 7.9 | [brown clay] |
| 632.3 | 9.8 | [sand & gravel] |
| 625.0 | 17.1 | [soft brown sandy clay] |
| 621.3 | 20.7 | [gravel] |
| 619.2 | 22.9 | [shale] |

## General Comments / Observations

*Piezometer was developed for 30 minutes following completion at a rate of approximately 41.5 lpm.*

Most Recent Water Level (m): ***11.04 m — July 16, 2010***

Oil Present: ***No***
Gas Present: ***No***

### Water Used For Drilling

## Aquifer Tests

| Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *--- Used as Observation Water Well During Aquifer Test No. 2 with M40366.389930 ---* | | | | | | | | | | | | | R C |
| | *--- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 ---* | | | | | | | | | | | | | R C |

## Alias IDs

** The Groundwater Centre (**TGWC**) calculated or determined value.*
*** 75 - MT GPS — 10TM NAD83*
**** 89 - Ground Survey — {Ground; AMSL}*

# Piezometer No. 14-10

*(Piezometer No. 20)*

**09-25-054-22 W4M**

*(M40366.450631)*

Well Spatial Location:

Easting: ***125,292***
Northing: ***5,948,796***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***643***
::*(elevation accuracy Ground Survey)*

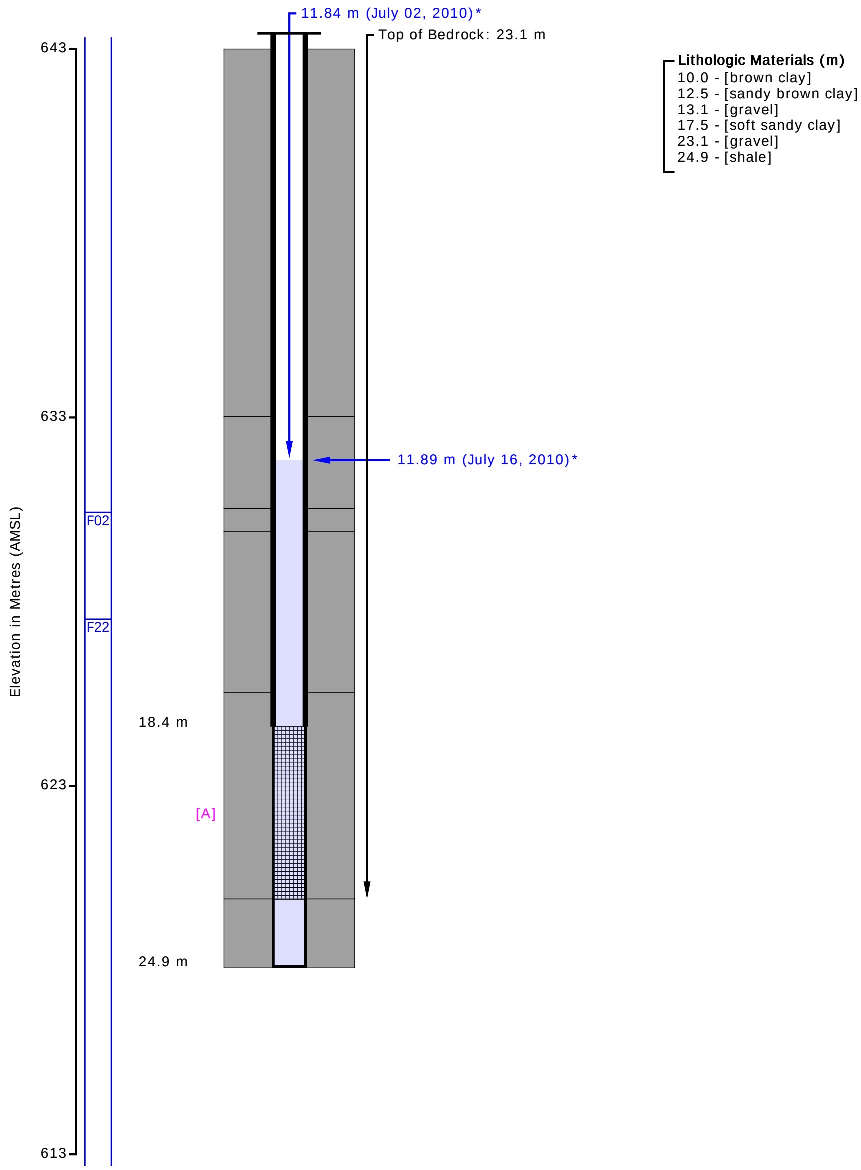
Date Completed: ***July 01, 2010***

Depth Drilled (m): ***24.9***

Completion Interval (m): ***18.4* — *23.1 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***11.89* — *July 16, 2010***
Earliest Water Level (m): ***11.84* — *July 02, 2010***

## *Piezometer No. 14-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

F02 - Bearpaw Formation
F22 - Oldman Formation

**Summary**

TGWC ID: M40366.450631
Well Name: Piezometer No. 14-10
Legal Location: 09-25-054-22 W4M
Casing (OD): 50.8 mm; PVC (2.0")
Casing Stick-Up: 0.73 m (not drawn to scale)
Interval [A]: 18.4 to 23.1 m; Screened
*Water Level (recent): 11.89 m on July 16, 2010 @ 08:33 - Reference Point: Top of Casing
*Water Level (oldest): 11.84 m on July 02, 2010 @ 13:24 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: August 27, 2010 08:11 --- http://www.tgwc.ca*

Owner: ***Joburg Aggregates Ltd.***
***1610 151 St NW, Edmonton, AB T5M 4E9***

Contractor: ***Lakeland Drilling Ltd.***
Well Name: ***Piezometer No. 14-10***

Field Survey: ***July 01, 2010 - Confirmed - Physically***

**METRIC REPORT**

| | | |
|---|---|---|
| Easting (m): | ***125292.00*** ** | 75/89 |
| Northing (m): | ***5948796.00*** ** | |
| Elevation (m): | ***643*** *** | |

Google Earth

09-25-054-22 W4M

M40366.450631

Work Type: ***Piezometer***
Drilling Method: ***Drilled***
Proposed Use: ***Monitoring***
Completion Type: ***Screen***

Date Started: ***July 01, 2010***
Date Completed: ***July 01, 2010***
Well Status: ***Observation***
Feature Class: ***Piezometer***

Elog Taken: ***No***
Gamma Taken: ***No***
Stick Up (m): ***0.7***
Flowing: ***No***

## General Details

Depth Completed (m): ***23.1***
Depth Drilled (m): ***24.9***
Top of Bedrock (m): ***23.1 ****
Completion Interval (m): ***18.4 — 23.1 ****

## Completion Details

Surface Casing: ***PVC — 50.8 mm (O.D.)*** **x** ***18.39 m (bottom)***

Screen Material: ***PVC — (Attached To Casing)***
Fittings: ***Top: Threaded — Bottom: Plug***
Pack: ***[unknown]***

## Intervals

*Screen*: ***18.4*** *to* ***23.1 m - 20 slot***

*Bentonite*: ***0.0*** *to* ***17.8 m***
*Sand Pack*: ***17.8*** *to* ***24.9 m***

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 632.9 | 10.0 | [brown clay] |
| 630.4 | 12.5 | [sandy brown clay] |
| 629.8 | 13.1 | [gravel] |
| 625.4 | 17.5 | [soft sandy clay] |
| 619.8 | 23.1 | [gravel] |
| 618.0 | 24.9 | [shale] |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

## General Comments / Observations

*Piezometer was developed for 30 minutes following completion at a rate of approximately 41.5 lpm.*

Most Recent Water Level (m): ***11.89 m — July 16, 2010***

Oil Present: ***No***
Gas Present: ***No***

## Water Used For Drilling

## Aquifer Tests

| Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Duration (minutes) Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Q20 (m³/day)* Effective | Transmissivity (m²/day)* Apparent | Transmissivity (m²/day)* Aquifer | Transmissivity (m²/day)* Effective |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | R C |

## Alias IDs

** The Groundwater Centre (**TGWC**) calculated or determined value.*
*** 75 - MT GPS — 10TM NAD83*
**** 89 - Ground Survey — {Ground; AMSL}*

# Water Test Hole No. 1-10

*(Water Test Hole 8-10)*

**09-25-054-22 W4M**

*(M40360.481948)*

Well Spatial Location:

Easting: ***125,229***
Northing: ***5,948,781***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***642***
::*(elevation accuracy Ground Survey)*

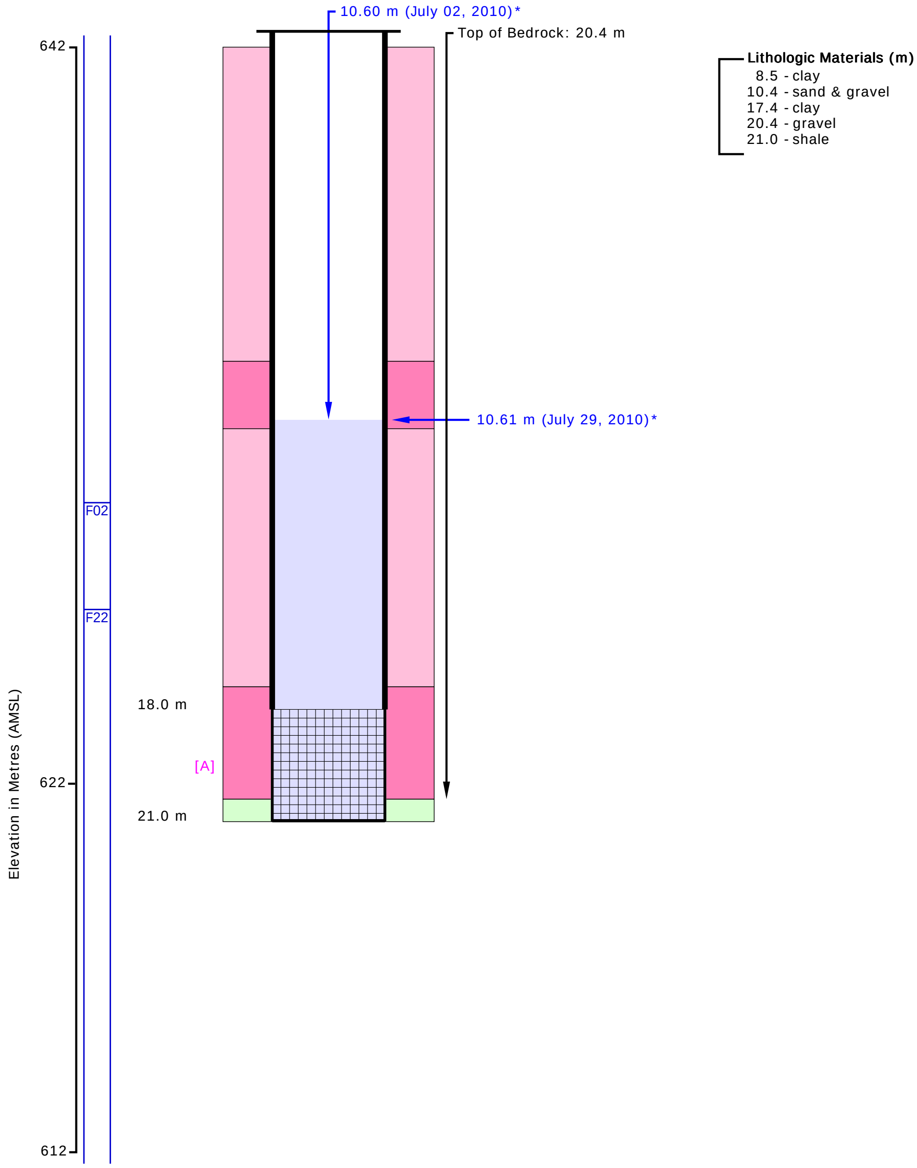
Date Completed: ***July 01, 2010***

Depth Drilled (m): ***21.0***

Completion Interval (m): ***18.0* — *21.0 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***10.61* — *July 29, 2010***
Earliest Water Level (m): ***10.60* — *July 02, 2010***

# *Water Test Hole No. 1-10*
# *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained
Bedrock: Fine Grained, Coarse Grained
Other

**Geologic Unit Legend (Top) - Regional Analysis**

F02 - Bearpaw Formation
F22 - Oldman Formation

**Summary**

TGWC ID: M40360.481948
Well Name: Water Test Hole No. 1-10
Legal Location: 09-25-054-22 W4M
Casing (OD): 177.8 mm; Steel (7.0")
Casing Stick-Up: 0.49 m (not drawn to scale)
Interval [A]: 18.0 to 21.0 m; Screened
*Water Level (recent): 10.61 m on July 29, 2010 @ 13:30 - Reference Point: Top of Casing
*Water Level (oldest): 10.60 m on July 02, 2010 @ 11:32 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: November 30, 2012 16:30 --- http://www.tgwc.ca*

Owner: *Joburg Aggregates Ltd.*
*1610 151 St NW, Edmonton, AB T5M 4E9*

Contractor: *Lakeland Drilling Ltd.*
Well Name: *Water Test Hole No. 1-10*

Field Survey: *July 01, 2010 - Confirmed - Physically*

**METRIC REPORT**

Easting (m): *125229.00* ** 75/89
Northing (m): *5948781.00* **
Elevation (m): *642* ***
Google Earth

09-25-054-22 W4M

M40360.481948

189912-2

Work Type: *Water Test Hole*
Drilling Method: *Drilled*
Proposed Use: *Monitoring*
Completion Type: *Screen*
Date Started: *June 30, 2010*
Date Completed: *July 01, 2010*
Well Status: *Producing*
Feature Class: *Water Well*

Elog Taken: *No*
Gamma Taken: *No*
Stick Up (m): *0.5*
Flowing: *No*

## General Details

Depth Completed (m): *21.0*
Depth Drilled (m): *21.0*
Completion Aquifer: *Surficial **
Sand & Gravel Thickness (m): *22.3 (total) — 20.4 (below 15 m) **
Top of Bedrock (m): *20.4 **
Completion Interval (m): *18.0 — 21.0 **

## Completion Details

Surface Casing: *Steel — 177.8 mm (O.D.) x 17.98 m (bottom)*

Screen Material: *Steel — (Attached To Casing)*
Fittings: *Top: Threaded — Bottom: Plug*
Pack: *[unknown]*

## Intervals

*Screen*: *18.0 to 21.0 m - 200 slot*

*Bentonite Chips*: *0.0 to 17.4 m*

## Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 633.3 | 8.5 | Brown Clay |
| 631.5 | 10.4 | Sand & Gravel |
| 624.5 | 17.4 | Sandy Brown Clay |
| 621.4 | 20.4 | Gravel |
| 620.8 | 21.0 | Grey Shale |

## Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: *July 02, 2010*
Analysis Details: *July 08, 2010 - Exova Canada Inc. (750102-10)*

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (µS/cm): | 2010 | Nitrate as N: | < 0.05 | Colour (TCU): | |
| TDS (Calculated): | 1580 | Nitrite as N: | < 0.02 | Turbidity (NTU): | |
| Hardness (as CaCO3): | 841 | pH (pH Unit): | 7.6 | Fluoride: | |
| T-Alkalinity (as CaCO3): | 575 | Ion Balance (%): | 105 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 701 |
| Nitrate + Nitrite as N: | < 0.07 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.8 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 238 | Mercury: | | < 0.0001 |
| Chloride: | | 2.3 | Molybdenum: | 0.001 | < 0.002 |
| Iron: | | 4.37 | Magnesium: | | 60.2 |
| Manganese: | | 1.34 | Sodium: | | 238 |
| Aluminum: | < 0.002 | < 0.004 | Potassium: | | 5.9 |
| Arsenic: | 0.0082 | 0.011 | Vanadium: | 0.0173 | 0.0042 |
| Barium: | 0.019 | 0.022 | Strontium: | 1.62 | 1.58 |
| Beryllium: | < 0.0001 | < 0.0002 | Nickel: | 0.0018 | 0.0021 |
| Cadmium: | < 0.00001 | < 0.00002 | Zinc: | 0.002 | 0.01 |
| Chromium: | 0.0065 | 0.0024 | Copper: | 0.002 | 0.004 |
| Cobalt: | 0.0004 | 0.0004 | Lead: | < 0.0001 | < 0.0002 |
| Sulfate: | | 695 | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: *Sample collected by Mow-Tech Ltd.*

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

## General Comments / Observations

Most Recent Water Level (m): *10.61 m — July 29, 2010*

Oil Present: *No*
Gas Present: *No*

## Water Used For Drilling

## Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Effective | Transmissivity (m²/day)* Apparent | Aquifer | Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2010-07-13 10:00 | Pump | 18.00 to 21.00 | 1480.0 | 2610.0 | 705.3 | 10.58 | 3.94 | — | 1207.8 | | 429.7 | | | R C |
| 1 | 2010-07-02 11:35 | Pump | 18.00 to 21.00 | 65.0 | 12.0 | 11.5 | 10.60 | 0.04 | — | 1932.0 | | 688.9 | | | R C |

## Alias IDs

TGWC: *M40366.453127*

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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W: www.exova.com

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339340 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-10 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 12:30 |
| **Sample Location** | |
| **Sample Description** | M40364.478499 (WTH No. 1-10) / NE 25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 8.22 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 232 | 0.3 | | |
| Mercury | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Aluminum | Dissolved | mg/L | <0.004 | 0.002 | | |
| Antimony | Dissolved | mg/L | 0.0005 | 0.0002 | | |
| Arsenic | Dissolved | mg/L | 0.011 | 0.0002 | | |
| Barium | Dissolved | mg/L | 0.022 | 0.001 | | |
| Beryllium | Dissolved | mg/L | <0.0002 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.001 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.18 | 0.002 | | |
| Cadmium | Dissolved | mg/L | <0.00002 | 0.00001 | | |
| Chromium | Dissolved | mg/L | 0.0024 | 0.0005 | | |
| Cobalt | Dissolved | mg/L | 0.0004 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.004 | 0.001 | | |
| Lead | Dissolved | mg/L | <0.0002 | 0.0001 | | |
| Lithium | Dissolved | mg/L | 0.15 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | <0.002 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0021 | 0.0005 | | |
| Selenium | Dissolved | mg/L | <0.0004 | 0.0002 | | |
| Silver | Dissolved | mg/L | <0.00002 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.58 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.0001 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.002 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.014 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.020 | 0.0005 | | |
| Vanadium | Dissolved | mg/L | 0.0042 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.01 | 0.001 | | |
| Subsample | Field Filtered | | Field Filtered | | | |
| **Metals Extractable** | | | | | | |
| Silicon | Extractable | mg/L | 7.54 | 0.05 | | |
| Sulfur | Extractable | mg/L | 214 | 0.3 | | |
| Aluminum | Extractable | mg/L | <0.002 | 0.002 | | |
| Antimony | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Arsenic | Extractable | mg/L | 0.0082 | 0.0002 | | |
| Barium | Extractable | mg/L | 0.019 | 0.001 | | |
| Beryllium | Extractable | mg/L | <0.0001 | 0.0001 | | |

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W: www.exova.com

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339340 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-10 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 12:30 |
| **Sample Location** | |
| **Sample Description** | M40364.478499 (WTH No. 1-10) / NE 25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Extractable - Continued** | | | | | | |
| Bismuth | Extractable | mg/L | <0.0005 | 0.0005 | | |
| Boron | Extractable | mg/L | 0.209 | 0.002 | | |
| Cadmium | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Chromium | Extractable | mg/L | 0.0065 | 0.0005 | | |
| Cobalt | Extractable | mg/L | 0.0004 | 0.0001 | | |
| Copper | Extractable | mg/L | 0.002 | 0.001 | | |
| Lead | Extractable | mg/L | <0.0001 | 0.0001 | | |
| Lithium | Extractable | mg/L | 0.174 | 0.001 | | |
| Molybdenum | Extractable | mg/L | 0.001 | 0.001 | | |
| Nickel | Extractable | mg/L | 0.0018 | 0.0005 | | |
| Selenium | Extractable | mg/L | <0.0002 | 0.0002 | | |
| Silver | Extractable | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Extractable | mg/L | 1.62 | 0.001 | | |
| Thallium | Extractable | mg/L | <0.00005 | 0.00005 | | |
| Tin | Extractable | mg/L | <0.001 | 0.001 | | |
| Titanium | Extractable | mg/L | 0.0132 | 0.0005 | | |
| Uranium | Extractable | mg/L | 0.0208 | 0.0005 | | |
| Vanadium | Extractable | mg/L | 0.0173 | 0.0001 | | |
| Zinc | Extractable | mg/L | 0.002 | 0.001 | | |
| **Routine Water** | | | | | | |
| pH | | | 7.60 | | | |
| Temperature of observed pH | | °C | 19.8 | | | |
| Electrical Conductivity | | μS/cm at 25 C | 2010 | 1 | | |
| Calcium | Dissolved | mg/L | 238 | 0.2 | | |
| Calcium | Extractable | mg/L | 219 | 0.2 | | |
| Magnesium | Dissolved | mg/L | 60.2 | 0.2 | | |
| Magnesium | Extractable | mg/L | 56.6 | 0.2 | | |
| Sodium | Dissolved | mg/L | 238 | 0.4 | | |
| Sodium | Extractable | mg/L | 230 | 0.4 | | |
| Potassium | Dissolved | mg/L | 5.9 | 0.4 | | |
| Potassium | Extractable | mg/L | 5.8 | 0.4 | | |
| Iron | Dissolved | mg/L | 4.37 | 0.01 | | |
| Iron | Extractable | mg/L | 0.30 | 0.01 | | |
| Manganese | Dissolved | mg/L | 1.34 | 0.005 | | |
| Manganese | Extractable | mg/L | 1.16 | 0.005 | | |

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750102** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-383640 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 5, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 054 and 055, R 21 and 22 | Date Reported: | Jul 8, 2010 |
| | T5S 2W3 | LSD: | | Report Number: | 1339340 |
| Attn: | Tara Parker | P.O.: | 13868 | | |
| Sampled By: | | Acct code: | | | |
| Company: | MOW-Tech Ltd. | | | | |

| | |
|---|---|
| **Reference Number** | 750102-10 |
| **Sample Date** | July 02, 2010 |
| **Sample Time** | 12:30 |
| **Sample Location** | |
| **Sample Description** | M40364.478499 (WTH No. 1-10) / NE 25-054 |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Chloride | Dissolved | mg/L | 2.3 | 0.4 | | |
| Nitrate - N | | mg/L | <0.05 | 0.01 | | |
| Nitrite - N | | mg/L | <0.02 | 0.005 | | |
| Nitrate and Nitrite - N | | mg/L | <0.07 | 0.01 | | |
| Sulfate (SO4) | Dissolved | mg/L | 695 | 0.9 | | |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 701 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 575 | 5 | | |
| Total Dissolved Solids | Calculated | mg/L | 1580 | 1 | | |
| Hardness | Dissolved as CaCO3 | mg/L | 841 | | | |
| Ionic Balance | Dissolved | % | 105 | | | |

Approved by: RLNeumann

Randy Neumann, BSc
General Manager

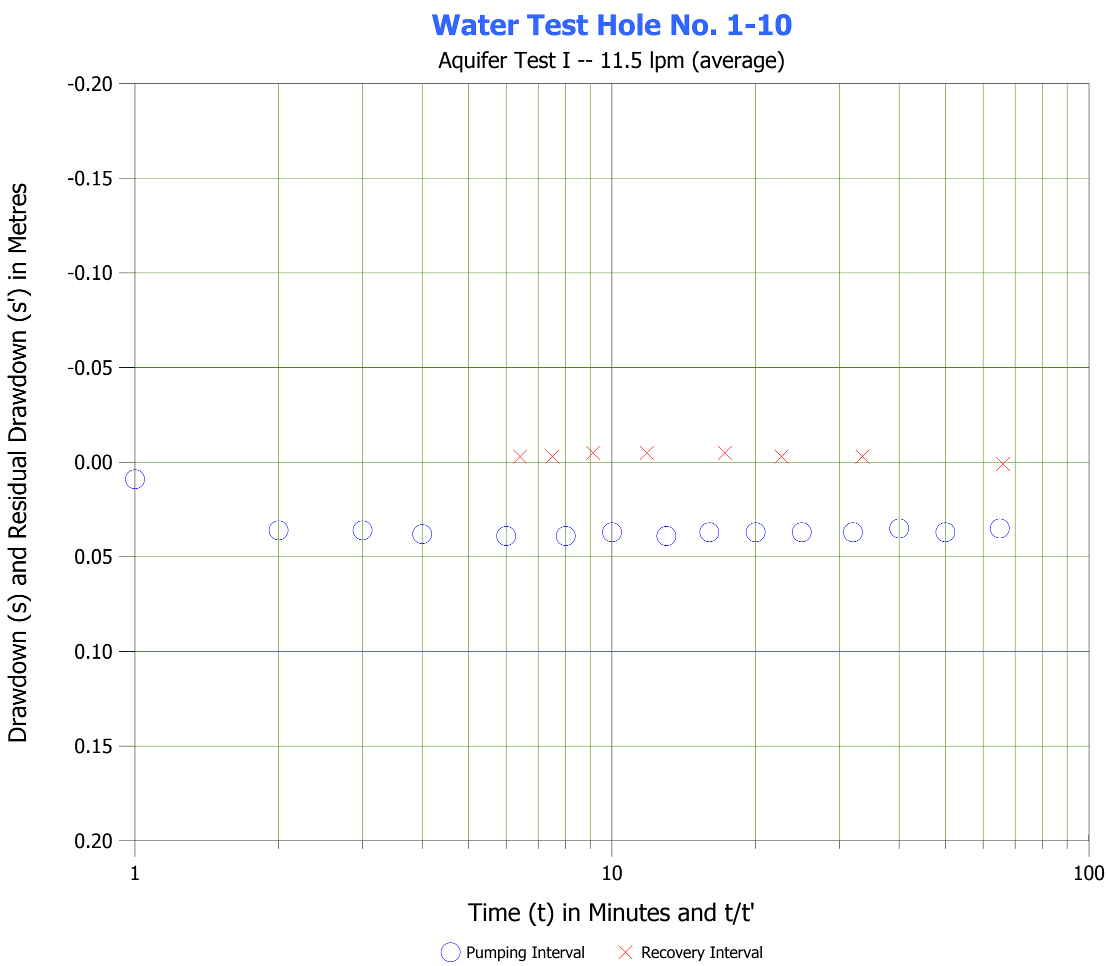
## *Water Test Hole No. 1-10*
## *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Water Test Hole No. 1-10***
***Aquifer Test I***



# Aquifer Test I

**Water Test Hole No. 1-10**

*(formerly Water Test Hole 8-10)*

**09-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **11.5** | Pre-Test Water Level - NPWL (m): | **10.60** |
| Date Test Started: | **July 02, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **11:35** | Test Interval - Top (m): | **18.0** |
| Pumping Interval (minutes): | **65** | Test Interval - Bottom (m): | **21.0** |
| Recovery Interval (minutes): | **12** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40360.481948 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 0.01 | 11.5 |
| 2 | 0.04 | 11.5 |
| 3 | 0.04 | 11.5 |
| 4 | 0.04 | 11.5 |
| 6 | 0.04 | 11.5 |
| 8 | 0.04 | 11.5 |
| 10 | 0.04 | 11.5 |
| 13 | 0.04 | 11.5 |
| 16 | 0.04 | 11.5 |
| 20 | 0.04 | 11.5 |
| 25 | 0.04 | 11.5 |
| 32 | 0.04 | 11.5 |
| 40 | 0.04 | 11.5 |
| 50 | 0.04 | 11.5 |
| 65 | 0.04 | 11.5 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 1 | 66 | 0.00 |
| 2 | 34 | 0.00 |
| 3 | 23 | 0.00 |
| 4 | 17.3 | -0.01 |
| 6 | 11.8 | -0.01 |
| 8 | 9.1 | -0.01 |
| 10 | 7.5 | 0.00 |
| 12 | 6.4 | 0.00 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Water Test Hole No. 2-10

**05-36-054-22 W4M**

*(M40366.389930)*

Well Spatial Location:

Easting: ***123,852***
Northing: ***5,950,027***
::*(spatial accuracy MT GPS — 10TM NAD83)*

Ground Elevation AMSL (m): ***633***
::*(elevation accuracy Ground Survey)*

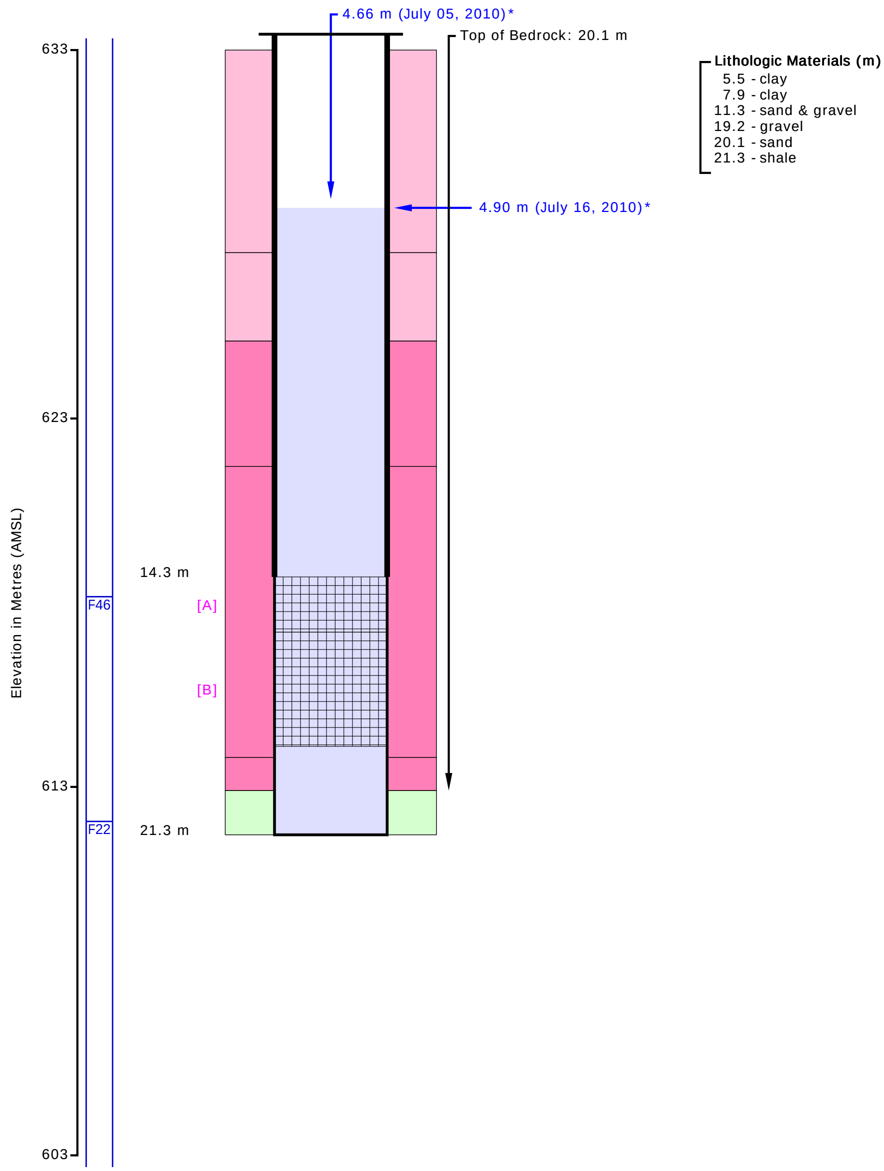
Date Completed: ***July 03, 2010***

Depth Drilled (m): ***21.3***

Completion Interval (m): ***14.3* — *18.9 ****
::*(* TGWC determined value)*

Most Recent Water Level (m): ***4.90* — *July 16, 2010***
Earliest Water Level (m): ***4.66* — *July 05, 2010***

## *Water Test Hole No. 2-10*
## *Well Diagram*




**Lithology Legend**

Surficial: Unsorted, Fine Grained, Coarse Grained

Bedrock: Fine Grained, Coarse Grained

Other

**Geologic Unit Legend (Top) - Regional Analysis**

F46 - Lower Surficial Deposits
F22 - Oldman Formation

**Summary**

TGWC ID: M40366.389930
Well Name: Water Test Hole No. 2-10
Legal Location: 05-36-054-22 W4M
Casing (OD): 177.8 mm; Steel (7.0")
Casing Stick-Up: 0.62 m (not drawn to scale)
Interval [A]: 14.3 to 15.8 m; Screened
Interval [B]: 15.8 to 18.9 m; Screened
*Water Level (recent): 4.90 m on July 16, 2010 @ 10:00 - Reference Point: Top of Casing
*Water Level (oldest): 4.66 m on July 05, 2010 @ 15:20 - Reference Point: Top of Casing

** Water-Level Measurements are measured from reference point listed.*
*NOTE: Geologic Unit is a guide based on a regional groundwater assessment completed by hydrogeological consultants ltd. (HCL) (http://www.hcl.ca) on behalf of Strathcona County in conjunction with Prairie Farm Rehabilitation Administration (P.F.R.A.).*
*Drawn: August 12, 2010 09:23 --- http://www.tgwc.ca*

Owner: *Joburg Aggregates Ltd.*
*1610 151 St NW, Edmonton, AB T5M 4E9*

Contractor: *Lakeland Drilling Ltd.*
Well Name: *Water Test Hole No. 2-10*

Field Survey: *July 03, 2010 - Confirmed - Physically*

## METRIC REPORT

Easting (m): *123852.00* ** 75/89
Northing (m): *5950027.00* **
Elevation (m): *633* ***
Google Earth

05-36-054-22 W4M

M40366.389930

189916-2

Work Type: *Water Test Hole*
Drilling Method: *Drilled*
Proposed Use: *Monitoring*
Completion Type: *Screen*

Date Started: *July 01, 2010*
Date Completed: *July 03, 2010*
Well Status: *Producing*
Feature Class: *Water Well*

Elog Taken: *No*
Gamma Taken: *No*
Stick Up (m): *0.6*
Flowing: *No*

### General Details

Depth Completed (m): *18.9*
Depth Drilled (m): *21.3*
Completion Aquifer: *Surficial **
Sand & Gravel Thickness (m): *12.2 (total) — 5.1 (below 15 m) **
Top of Bedrock (m): *20.1 **
Completion Interval (m): *14.3 — 18.9 **

### Completion Details

Surface Casing: *Steel — 177.8 mm (O.D.) x 14.33 m (bottom)*

Screen Material: *Steel — (Attached To Casing)*
Fittings: *Top: Threaded — Bottom: Plug*
Pack: *[unknown]*

### Intervals

*Screen: 14.3 to 15.9 m - 40 slot*
*Screen: 15.9 to 18.9 m - 200 slot*

*Bentonite Chips: 0.0 to 7.9 m*

### Lithology Details

| Elevation (AMSL) | Depth (BGL) | Lithology Descriptions (rate lpm) |
|---|---|---|
| 627.7 | 5.5 | Brown Clay |
| 625.2 | 7.9 | Grey Clay |
| 621.9 | 11.3 | Sand & Gravel |
| 614.0 | 19.2 | Gravel |
| 613.0 | 20.1 | Sand |
| 611.8 | 21.3 | Shale |

### Chemistry Summary Details (mg/L, except as noted) (most recent first)

Sampling Details: *July 07, 2010*
Analysis Details: *July 12, 2010 - Exova Canada Inc. (750775-1)*

| Constituent | Result | Constituent | Result | Constituent | Result |
|---|---|---|---|---|---|
| Conductivity (μS/cm): | 1650 | Nitrate as N: | < 0.01 | Colour (TCU): | > 60 |
| TDS (Calculated): | 1210 | Nitrite as N: | 0.053 | Turbidity (NTU): | 32 |
| Hardness (as CaCO3): | 651 | pH (pH Unit): | 7.51 | Fluoride: | 0.11 |
| T-Alkalinity (as CaCO3): | 559 | Ion Balance (%): | 102 | Carbonate: | < 6 |
| P-Alkalinity (as CaCO3): | < 5 | Total Coliforms**: | | Bicarbonate: | 681 |
| Nitrate + Nitrite as N: | 0.05 | Fecal Coliforms**: | | Hydroxide: | < 5 |
| Total Suspended Solids: | | Escherichia coli**: | | Total Iron: | |
| Sulfate Reducing Bacteria*: | | | | Total Mn: | |
| Iron Related Bacteria*: | | | | Temperature (°C): | 19.5 |

| Constituent | Extractable | Dissolved | Constituent | Extractable | Dissolved |
|---|---|---|---|---|---|
| Calcium: | | 181 | Mercury: | | |
| Chloride: | | 1.6 | Molybdenum: | | 0.004 |
| Iron: | | 3.63 | Magnesium: | | 50.5 |
| Manganese: | | 1.07 | Sodium: | | 185 |
| Aluminum: | | < 0.002 | Potassium: | | 5.8 |
| Arsenic: | | 0.0042 | Vanadium: | | 0.0062 |
| Barium: | | 0.024 | Strontium: | | 1.36 |
| Beryllium: | | < 0.0001 | Nickel: | | 0.0017 |
| Cadmium: | | < 0.00001 | Zinc: | | 0.004 |
| Chromium: | | 0.0023 | Copper: | | 0.001 |
| Cobalt: | | < 0.0001 | Lead: | | 0.0006 |
| Sulfate: | 455 | | | | |

Extractable - unfiltered
Dissolved - filtered

(1 / 1)

Comments: *Sample collected by Mow-Tech Ltd.*

*note: constituents have been compared to the maximum acceptable concentration,Health Canada. 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

### General Comments / Observations

*The water test hole was developed following completion at a rate of approximately 1,200 lpm.*

Most Recent Water Level (m): *4.90 m — July 16, 2010*

Oil Present: *No*
Gas Present: *No*

### Water Used For Drilling

### Aquifer Tests

| | Date & Time | Testing Method | Depth of Test Interval (metre) | Duration (minutes) Pumping | Duration (minutes) Recovery | Avg. Rate (lpm) | NPWL (metre) | Drawdown (metre) | Pump (metre) | Q20 (m³/day)* Apparent | Q20 (m³/day)* Effective | Transmissivity (m²/day)* Apparent | Transmissivity (m²/day)* Aquifer | Transmissivity (m²/day)* Effective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2010-07-06 14:10 | Pump | 14.30 to 18.90 | 4470.0 | 5350.0 | 1109.4 | 4.64 | 7.36 | — | 1386.1 | | 378.8 | | | R C |
| 1 | 2010-07-05 16:10 | Pump | [unknown] | 30.0 | 1290.0 | 1137.0 | 4.66 | 2.08 | — | 4132.0 | | 1128.5 | | | R C |
| | --- Used as Observation Water Well During Aquifer Test No. 2 with M40360.481948 --- | | | | | | | | | | | | | | R C |

### Alias IDs

* The Groundwater Centre (**TGWC**) calculated or determined value.
** 75 - MT GPS — 10TM NAD83
*** 89 - Ground Survey — {Ground; AMSL}

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## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750775** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-953847 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 8, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 54 and 55, R 21 and 22, W4M | Date Reported: | Jul 12, 2010 |
| | T5S 2W3 | LSD: | SW 36-054-22W4M | Report Number: | 1340189 |
| Attn: | Tara Parker | P.O.: | 13883 | | |
| Sampled By: | Mow- Tech Ltd. | Acct code: | | | |
| Company: | | | | | |

| | |
|---|---|
| **Reference Number** | 750775-1 |
| **Sample Date** | July 07, 2010 |
| **Sample Time** | 09:45 |
| **Sample Location** | |
| **Sample Description** | SW 36-54-2 / M40366.389930 (WTH No. 2-10) |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Metals Dissolved** | | | | | | |
| Silicon | Dissolved | mg/L | 8.05 | 0.05 | | |
| Sulfur | Dissolved | mg/L | 160 | 0.3 | | |
| Aluminum | Dissolved | mg/L | <0.002 | 0.002 | 0.1 | Below OG |
| Antimony | Dissolved | mg/L | 0.0004 | 0.0002 | 0.006 | Below MAC |
| Arsenic | Dissolved | mg/L | 0.0042 | 0.0002 | 0.01 | Below MAC |
| Barium | Dissolved | mg/L | 0.024 | 0.001 | 1 | Below MAC |
| Beryllium | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Bismuth | Dissolved | mg/L | <0.0005 | 0.0005 | | |
| Boron | Dissolved | mg/L | 0.118 | 0.002 | 5 | Below MAC |
| Cadmium | Dissolved | mg/L | <0.00001 | 0.00001 | 0.005 | Below MAC |
| Chromium | Dissolved | mg/L | 0.0023 | 0.0005 | 0.05 | Below MAC |
| Cobalt | Dissolved | mg/L | <0.0001 | 0.0001 | | |
| Copper | Dissolved | mg/L | 0.001 | 0.001 | 1 | Below AO |
| Lead | Dissolved | mg/L | 0.0006 | 0.0001 | 0.01 | Below MAC |
| Lithium | Dissolved | mg/L | 0.087 | 0.001 | | |
| Molybdenum | Dissolved | mg/L | 0.004 | 0.001 | | |
| Nickel | Dissolved | mg/L | 0.0017 | 0.0005 | | |
| Selenium | Dissolved | mg/L | 0.0003 | 0.0002 | 0.01 | Below MAC |
| Silver | Dissolved | mg/L | <0.00001 | 0.00001 | | |
| Strontium | Dissolved | mg/L | 1.36 | 0.001 | | |
| Thallium | Dissolved | mg/L | <0.00005 | 0.00005 | | |
| Tin | Dissolved | mg/L | <0.001 | 0.001 | | |
| Titanium | Dissolved | mg/L | 0.0041 | 0.0005 | | |
| Uranium | Dissolved | mg/L | 0.0032 | 0.0005 | 0.02 | Below MAC |
| Vanadium | Dissolved | mg/L | 0.0062 | 0.0001 | | |
| Zinc | Dissolved | mg/L | 0.004 | 0.001 | 5 | Below AO |
| **Physical and Aggregate Properties** | | | | | | |
| Colour | Apparent, Potable | Colour units | >60 | 5 | 15 | Above AO |
| Turbidity | | NTU | 32.0 | 0.1 | 0.1 | Above OG |
| **Routine Water** | | | | | | |
| pH | | | 7.51 | | 6.5 - 8.5 | Within AO |
| Temperature of observed pH | | °C | 19.5 | | | |
| Electrical Conductivity | | µS/cm at 25 C | 1650 | 1 | | |
| Calcium | Dissolved | mg/L | 181 | 0.2 | | |
| Calcium | Extractable | mg/L | 179 | 0.2 | | |

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Exova

## Analytical Report

| | | | | | |
|---|---|---|---|---|---|
| Bill To: | Hydrogeological Consultants | Project: | | Lot ID: | **750775** |
| Report To: | Hydrogeological Consultants | ID: | 10-351 | Control Number: | Z-953847 |
| | 17740 - 118 Avenue | Name: | Gravel Development for Heartland | Date Received: | Jul 8, 2010 |
| | Edmonton, AB, Canada | Location: | Tp 54 and 55, R 21 and 22, W4M | Date Reported: | Jul 12, 2010 |
| | T5S 2W3 | LSD: | SW 36-054-22W4M | Report Number: | 1340189 |
| Attn: | Tara Parker | P.O.: | 13883 | | |
| Sampled By: | Mow- Tech Ltd. | Acct code: | | | |
| Company: | | | | | |

| | |
|---|---|
| **Reference Number** | 750775-1 |
| **Sample Date** | July 07, 2010 |
| **Sample Time** | 09:45 |
| **Sample Location** | |
| **Sample Description** | SW 36-54-2 / M40366.389930 (WTH No. 2-10) |
| **Sample Matrix** | Water |

| Analyte | | Units | Result | Nominal Detection Limit | Guideline Limit | Guideline Comments |
|---|---|---|---|---|---|---|
| **Routine Water - Continued** | | | | | | |
| Magnesium | Dissolved | mg/L | 50.5 | 0.2 | | |
| Magnesium | Extractable | mg/L | 49.7 | 0.2 | | |
| Sodium | Dissolved | mg/L | 185 | 0.4 | 200 | Below AO |
| Sodium | Extractable | mg/L | 183 | 0.4 | 200 | Below AO |
| Potassium | Dissolved | mg/L | 5.8 | 0.4 | | |
| Potassium | Extractable | mg/L | 6.0 | 0.4 | | |
| Iron | Dissolved | mg/L | 3.63 | 0.01 | 0.3 | Above AO |
| Iron | Extractable | mg/L | 3.42 | 0.01 | 0.3 | Above AO |
| Manganese | Dissolved | mg/L | 1.07 | 0.005 | 0.05 | Above AO |
| Manganese | Extractable | mg/L | 1.06 | 0.005 | 0.05 | Above AO |
| Chloride | Dissolved | mg/L | 1.6 | 0.4 | 250 | Below AO |
| Fluoride | | mg/L | 0.11 | 0.05 | 1.5 | Below MAC |
| Nitrate - N | | mg/L | <0.01 | 0.01 | 10 | Below MAC |
| Nitrite - N | | mg/L | 0.053 | 0.005 | 1 | Below MAC |
| Nitrate and Nitrite - N | | mg/L | 0.05 | 0.01 | 10 | Below MAC |
| Sulfate (SO4) | | mg/L | 455 | 0.9 | 500 | Below AO |
| Hydroxide | | mg/L | <5 | 5 | | |
| Carbonate | | mg/L | <6 | 6 | | |
| Bicarbonate | | mg/L | 681 | 5 | | |
| P-Alkalinity | as CaCO3 | mg/L | <5 | 5 | | |
| T-Alkalinity | as CaCO3 | mg/L | 559 | 5 | | |
| Total Dissolved Solids | | mg/L | 1210 | 1 | | |
| Hardness | as CaCO3 | mg/L | 651 | | | |
| Ionic Balance | | % | 102 | | | |

Approved by: Anthony Neumann

Anthony Neumann, MSc
Laboratory Operations Manager

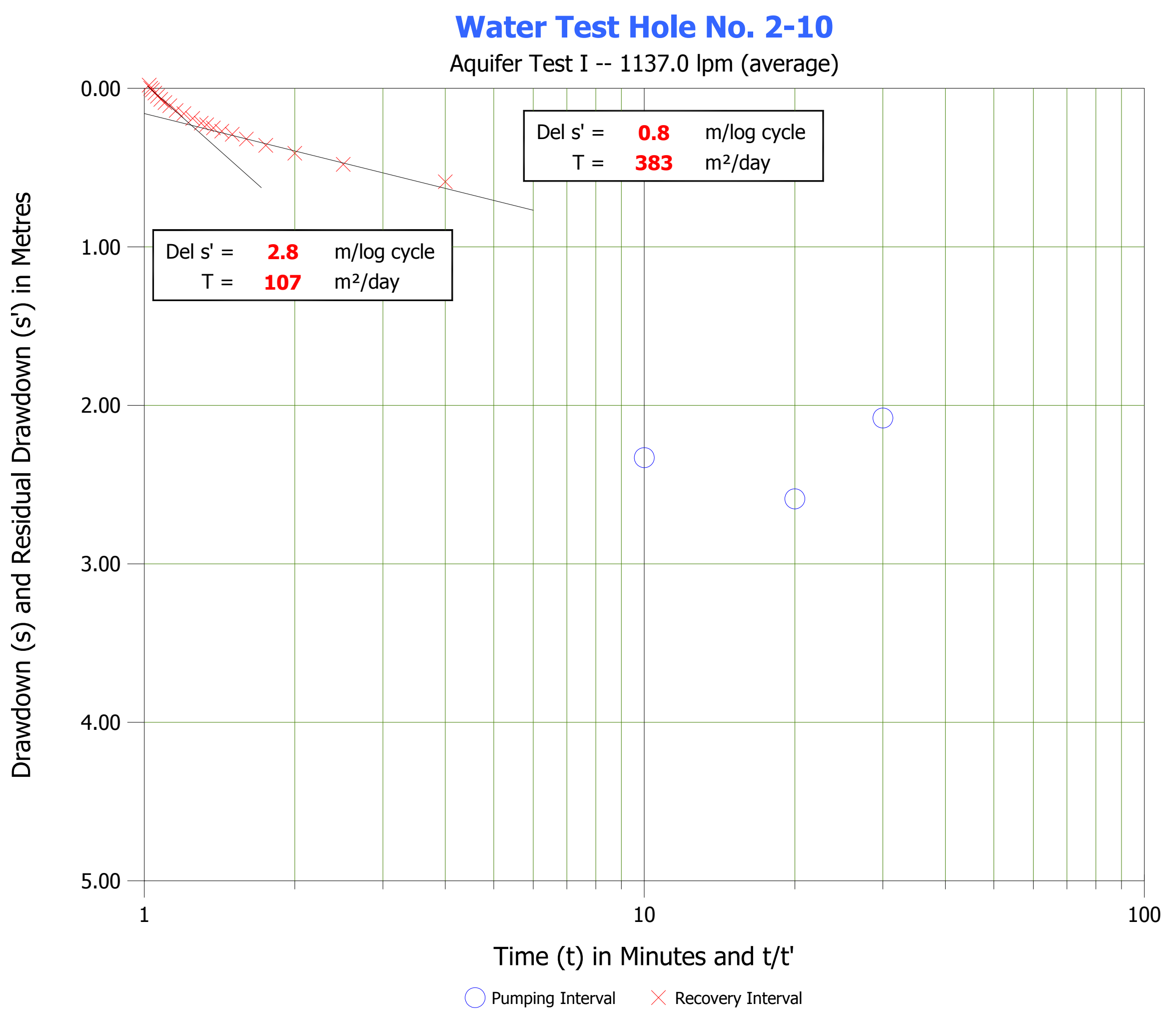
### *Water Test Hole No. 2-10*
### *Summary of Guidelines for Canadian Drinking Water Quality – Maximum Concentrations*

| Constituent | AO | MAC |
|---|---|---|
| pH (pH units) | 6.5 - 8.5 | --- |
| Conductivity (µS/cm) | --- | --- |
| Total Dissolved Solids | 500 | --- |
| Sodium | 200 | --- |
| Potassium | --- | --- |
| Calcium | --- | --- |
| Magnesium | --- | --- |
| Total Hardness | --- | --- |
| Manganese | 0.05 | --- |
| Carbonate | --- | --- |
| Bicarbonate | --- | --- |
| Total Alkalinity | --- | --- |
| Sulfate | 500 | --- |
| Chloride | 250 | --- |
| Fluoride | --- | 1.5 |
| Iron | 0.3 | --- |
| Nitrate (as N) | --- | 10 |
| Nitrate | --- | 45 |
| Nitrite (as N) | --- | 1 |
| Nitrite | --- | 3.2 |
| Nitrate + Nitrite (as N) | --- | 10 |
| Total Coliforms (CFU/100 mL) | --- | 0* |
| Fecal Coliforms (CFU/100 mL) | --- | 0 |
| Escherichia coli (CFU/100 mL) | --- | 0 |
| Ionic Balance (%) | --- | --- |

**Note:** Constituents marked with --- do not have a recommended maximum concentration associated with them.
Concentrations are in milligrams per litre unless otherwise stated.
**CFU/100 mL** - Colony Forming Units per 100 millilitres
**AO** - Aesthetic Objective
**MAC** - Maximum Acceptable Concentration
SGCDWQ - Summary of Guidelines for Canadian Drinking Water Quality, Federal–Provincial–Territorial Committee on Drinking Water, May 2008

*No sample should contain total coliform bacteria. The presence of total coliform bacteria, in the absence of Escherichia coli, may indicate the water well is prone to surface water infiltration and therefore faecal contamination. Total coliform detection may also indicate the presence of biofilm in the water well or plumbing system.

***Water Test Hole No. 2-10***
***Aggregate Test I***



# Aquifer Test I

**Water Test Hole No. 2-10**

**05-36-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **1137.0** | Pre-Test Water Level - NPWL (m): | **4.66** |
| Date Test Started: | **July 05, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **16:10** | Completion Interval - Top (m): | **14.3** |
| Pumping Interval (minutes): | **30** | Completion Interval - Bottom (m): | **18.9** |
| Recovery Interval (minutes): | **1,290** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Reference: M40366.389930 (AT 1)*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 10 | 2.33 | 1137.0 |
| 20 | 2.59 | 1137.0 |
| 30 | 2.08 | 1137.0 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 10 | 4.0 | 0.59 |
| 20 | 2.5 | 0.48 |
| 30 | 2.0 | 0.41 |
| 40 | 1.75 | 0.36 |
| 50 | 1.60 | 0.32 |
| 60 | 1.50 | 0.29 |
| 70 | 1.43 | 0.27 |
| 80 | 1.38 | 0.25 |
| 90 | 1.33 | 0.23 |
| 100 | 1.30 | 0.22 |
| 120 | 1.25 | 0.19 |
| 150 | 1.20 | 0.16 |
| 190 | 1.16 | 0.14 |
| 240 | 1.13 | 0.11 |
| 300 | 1.10 | 0.09 |
| 380 | 1.08 | 0.07 |
| 480 | 1.06 | 0.05 |
| 600 | 1.05 | 0.03 |
| 800 | 1.04 | 0.01 |
| 1,000 | 1.03 | 0.00 |
| 1,290 | 1.02 | -0.02 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

## Appendix C – Extended Aquifer Test Details

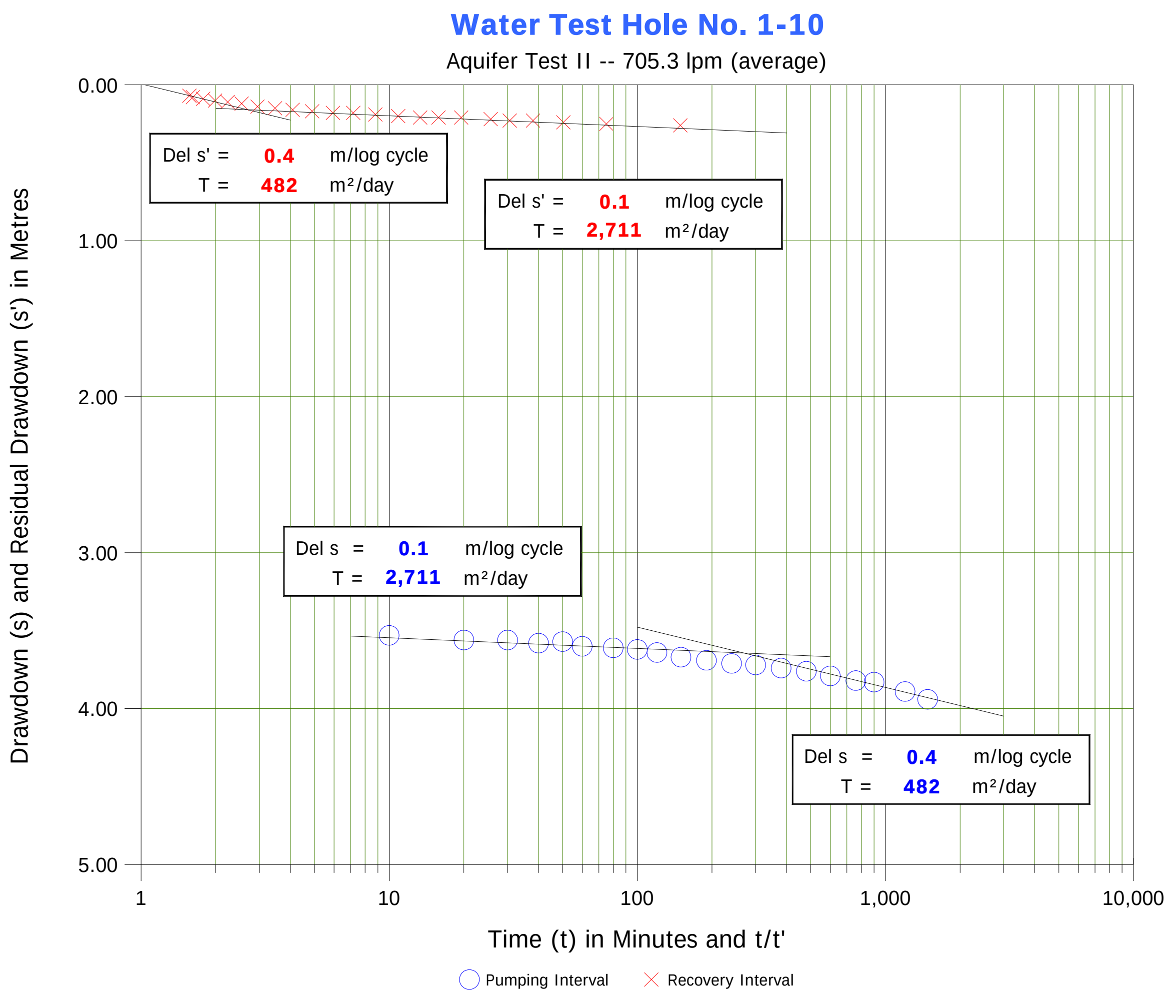
### TABLE OF CONTENTS

## Aquifer Test II with Water Test Hole No. 1-10

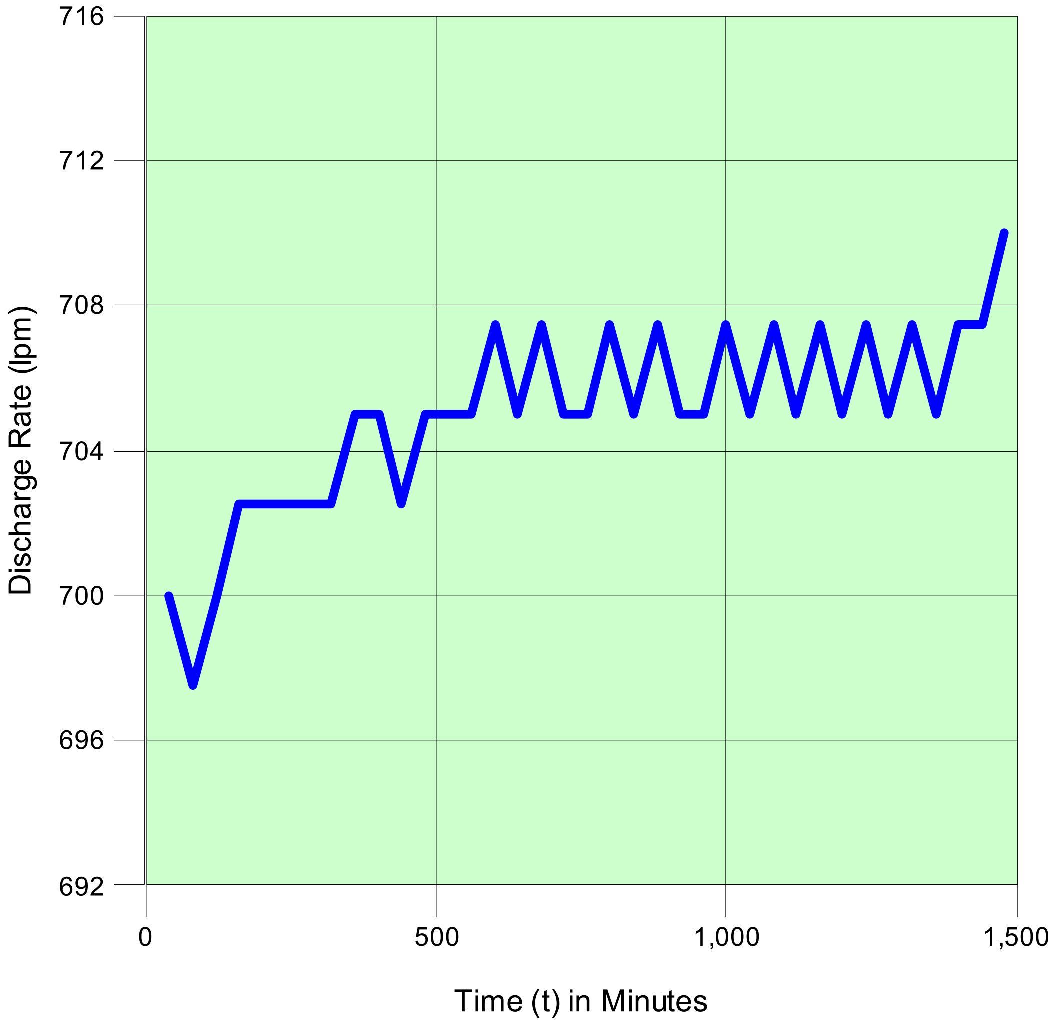
Test Started: July 13, 2010 @ 10:00 Hrs
Discharge (lpm): 705.3

| | NPWL (m BTOC) | Distance from Pumped Water Well (m) |
|---|---|---|
| **Pumped Water Well:** | | |
| Water Test Hole No. 1-10 | 10.58 | |
| | | |
| **Observation Water Wells:** | | |
| Piezometer No. 13-10 | 10.95 | 9 |
| Piezometer No. 14-10 | 11.83 | 65 |
| Piezometer No. 9-10 | 5.95 | 423 |

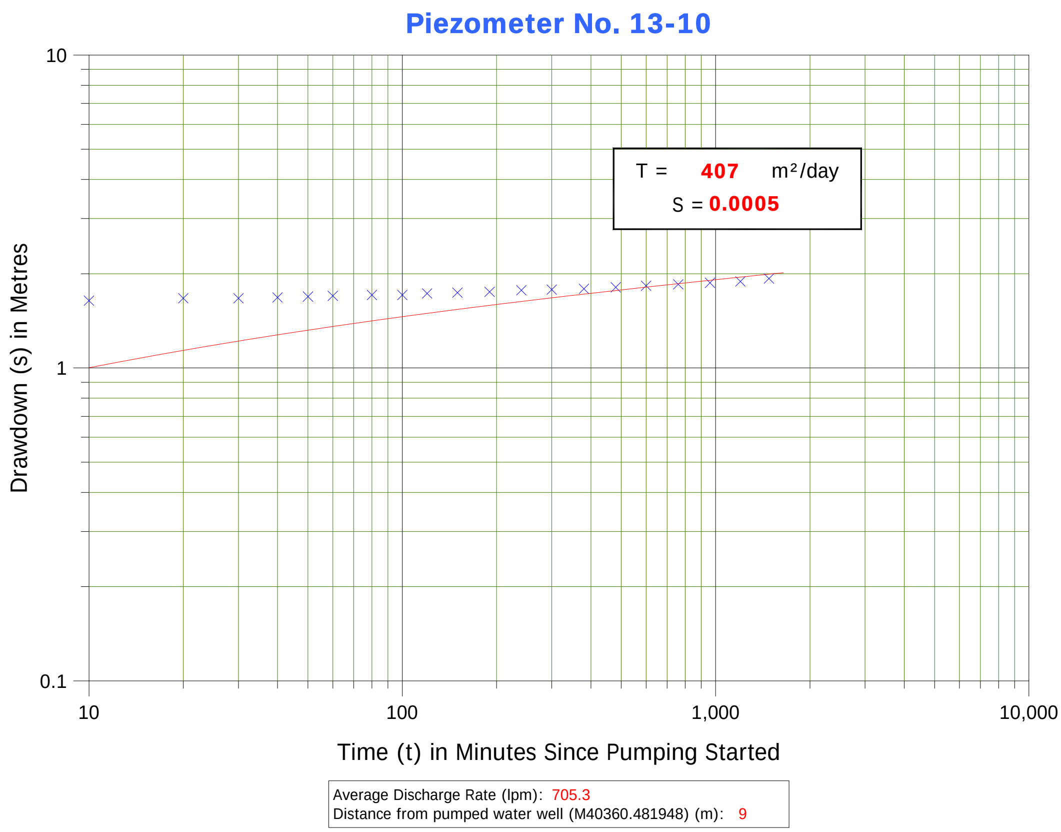
***Aquifer Test II***
***Pumped Water Well (Water Test Hole No. 1-10)***



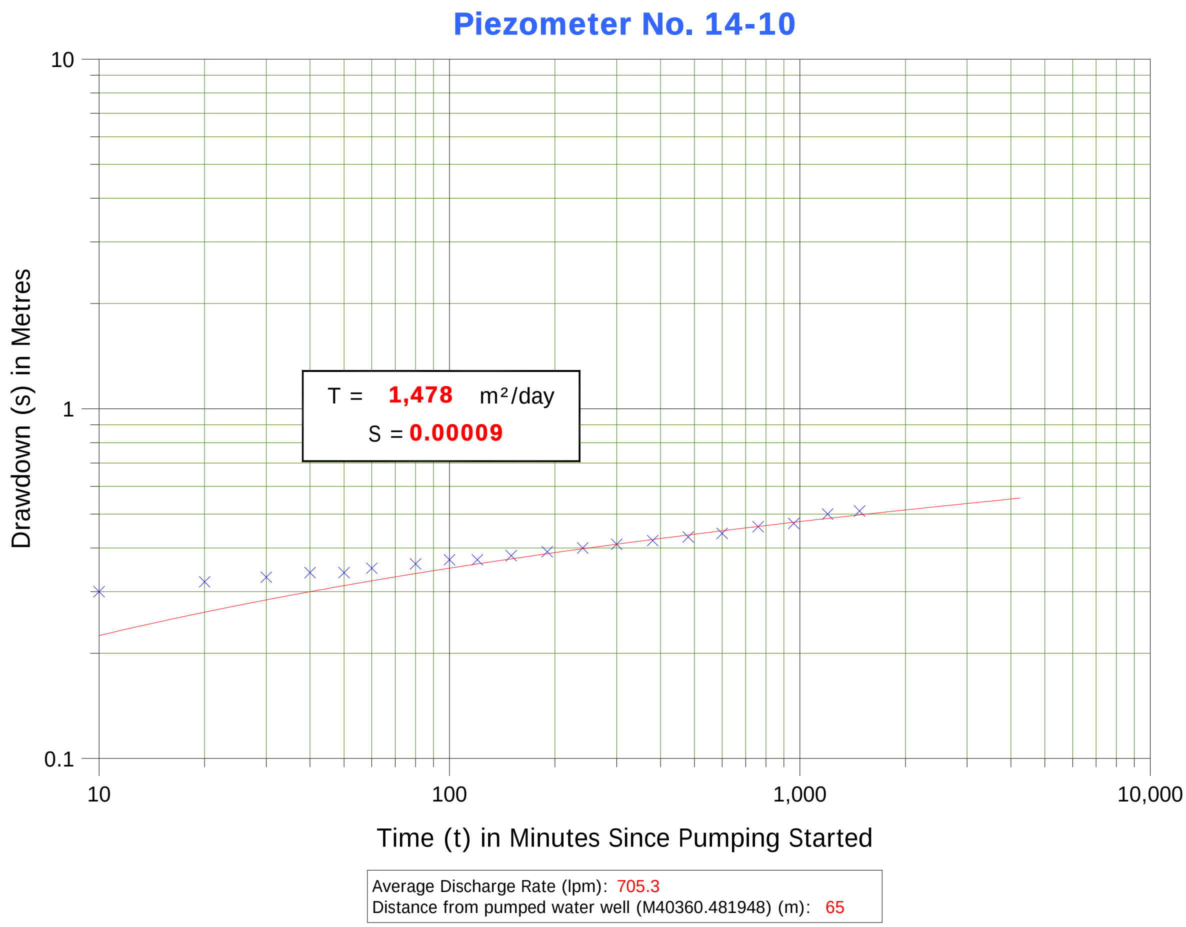
***Pumping Rate during Aquifer Test II***



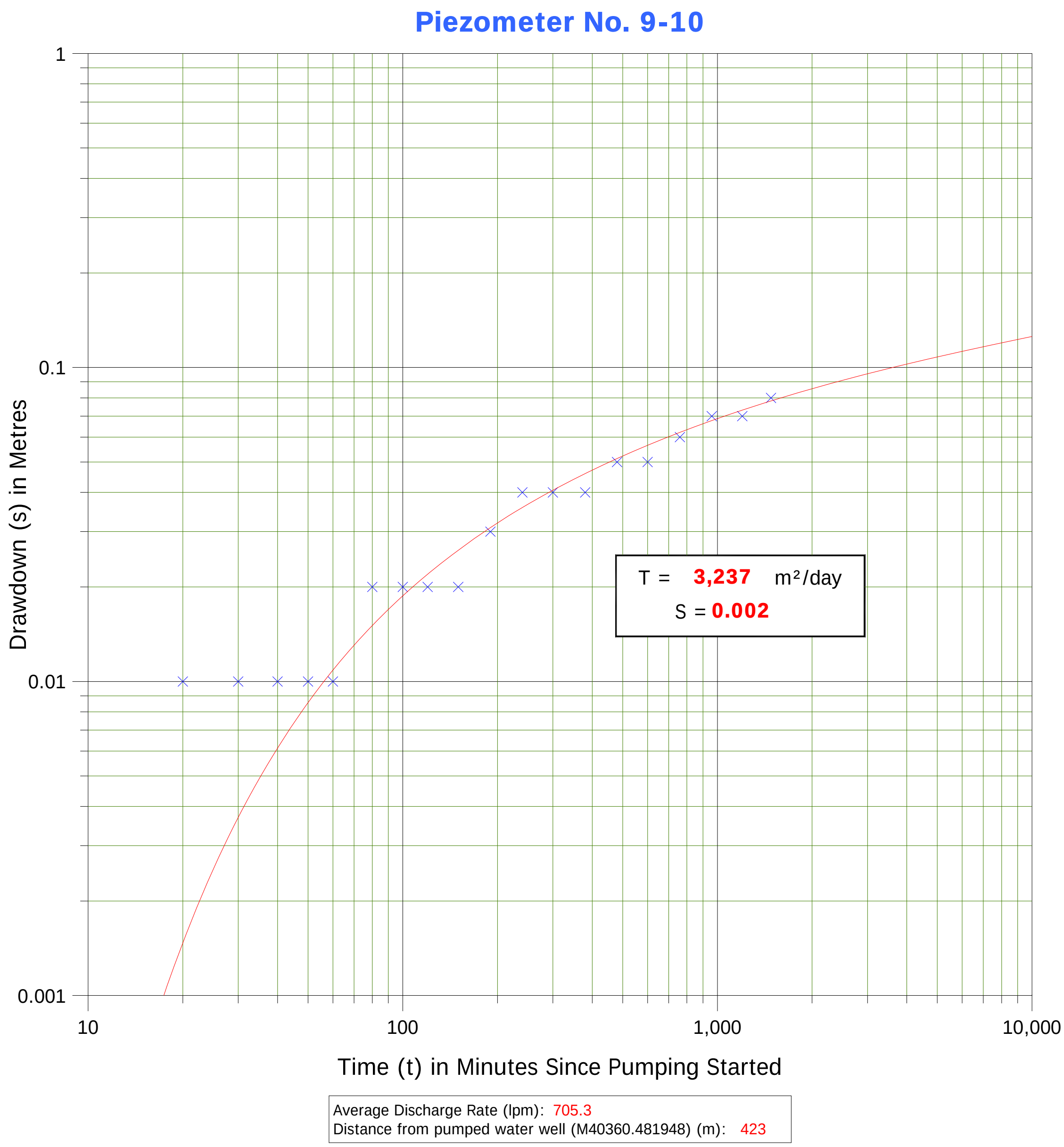
***Piezometer No. 13-10 Used as Observation WW during Aquifer Test II with WTH No. 1-10***



***Piezometer No. 14-10 Used as Observation WW during Aquifer Test II with WTH No. 1-10***



***Piezometer No. 9-10 Used as Observation WW during Aquifer Test II with WTH No. 1-10***



## *Aquifer Test II Data*

*Pumped Water Well:*

Water Test Hole No. 1-10

*Observation Water Well(s):*

Piezometer No. 13-10

Piezometer No. 14-10

Piezometer No. 9-10

# Aquifer Test II

**Water Test Hole No. 1-10**

**09-25-054-22 W4M**

Average Discharge (lpm): **705.3**
Date Test Started: **July 13, 2010**
Time Test Started (hours): **10:00**
Pumping Interval (minutes): **1,480**
Recovery Interval (minutes): **2,610**

Pre-Test Water Level - NPWL (m): **10.58**
Depth to Pump Intake (m): **N/A**
Test Interval - Top (m): **18.0**
Test Interval - Bottom (m): **21.0**
Top of Main Aquifer (m):* **N/A**

***N/A** - Information Not Available*
*Reference: M40360.481948 (AT 2)*
** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 10 | 3.53 | 700.0 |
| 20 | 3.56 | 700.0 |
| 30 | 3.56 | 700.0 |
| 40 | 3.58 | 700.0 |
| 50 | 3.57 | 700.0 |
| 60 | 3.60 | 690.0 |
| 80 | 3.61 | 700.0 |
| 100 | 3.62 | 700.0 |
| 120 | 3.64 | 700.0 |
| 150 | 3.67 | 710.0 |
| 190 | 3.69 | 710.0 |
| 240 | 3.71 | 700.0 |
| 300 | 3.72 | 700.0 |
| 380 | 3.74 | 710.0 |
| 480 | 3.76 | 710.0 |
| 600 | 3.79 | 710.0 |
| 760 | 3.82 | 700.0 |
| 900 | 3.83 | 710.0 |
| 1,200 | 3.89 | 700.0 |
| 1,480 | 3.94 | 710.0 |

## Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 10 | 149 | 0.26 |
| 20 | 75 | 0.25 |
| 30 | 50 | 0.24 |
| 40 | 38 | 0.23 |
| 50 | 31 | 0.23 |
| 60 | 26 | 0.22 |
| 80 | 19.5 | 0.21 |
| 100 | 15.8 | 0.21 |
| 120 | 13.3 | 0.21 |
| 150 | 10.9 | 0.20 |
| 190 | 8.8 | 0.19 |
| 240 | 7.2 | 0.18 |
| 300 | 5.9 | 0.18 |
| 380 | 4.9 | 0.17 |
| 480 | 4.1 | 0.16 |
| 600 | 3.5 | 0.15 |
| 760 | 2.9 | 0.14 |
| 960 | 2.5 | 0.12 |
| 1,200 | 2.2 | 0.11 |
| 1,500 | 2.0 | 0.10 |
| 1,900 | 1.78 | 0.09 |
| 2,400 | 1.62 | 0.08 |
| 2,610 | 1.57 | 0.07 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 13-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 1-10

**09-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **705.3** | Pre-Test Water Level - NPWL (m): | **10.95** |
| Pumped Well: Date Test Started: | **July 13, 2010** | Distance From Pumped Well (m): | **9** |
| Pumped Well: Time Test Started (hours): | **10:00** | Test Interval - Top (m): | **17.7** |
| Pumped Well: Pumping Interval (minutes): | **1,480** | Test Interval - Bottom (m): | **20.7** |
| Pumped Well: Recovery Interval (minutes): | **2,610** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40366.446374; 1.1 — Pumped: M40360.481948; 2*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 1.64 |
| 20 | 1.67 |
| 30 | 1.67 |
| 40 | 1.68 |
| 50 | 1.69 |
| 60 | 1.70 |
| 80 | 1.71 |
| 100 | 1.71 |
| 120 | 1.73 |
| 150 | 1.74 |
| 190 | 1.75 |
| 240 | 1.77 |
| 300 | 1.78 |
| 380 | 1.79 |
| 480 | 1.81 |
| 600 | 1.83 |
| 760 | 1.85 |
| 960 | 1.87 |
| 1,200 | 1.89 |
| 1,480 | 1.93 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 14-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 1-10

**09-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **705.3** | Pre-Test Water Level - NPWL (m): | **11.83** |
| Pumped Well: Date Test Started: | **July 13, 2010** | Distance From Pumped Well (m): | **65** |
| Pumped Well: Time Test Started (hours): | **10:00** | Test Interval - Top (m): | **18.4** |
| Pumped Well: Pumping Interval (minutes): | **1,480** | Test Interval - Bottom (m): | **23.1** |
| Pumped Well: Recovery Interval (minutes): | **2,610** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40366.450631; 1.1 — Pumped: M40360.481948; 2*

** **TGWC** calculated or determined value.*

*This report was generated on: July 29, 2010 — Data "AS IS"; no warranty either expressed or implied. © TGWC — Page 1 of 1*

## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.30 |
| 20 | 0.32 |
| 30 | 0.33 |
| 40 | 0.34 |
| 50 | 0.34 |
| 60 | 0.35 |
| 80 | 0.36 |
| 100 | 0.37 |
| 120 | 0.37 |
| 150 | 0.38 |
| 190 | 0.39 |
| 240 | 0.40 |
| 300 | 0.41 |
| 380 | 0.42 |
| 480 | 0.43 |
| 600 | 0.44 |
| 760 | 0.46 |
| 960 | 0.47 |
| 1,200 | 0.50 |
| 1,480 | 0.51 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 9-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 1-10

**09-25-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **705.3** | Pre-Test Water Level - NPWL (m): | **5.95** |
| Pumped Well: Date Test Started: | **July 13, 2010** | Distance From Pumped Well (m): | **423** |
| Pumped Well: Time Test Started (hours): | **10:00** | Test Interval - Top (m): | **11.0** |
| Pumped Well: Pumping Interval (minutes): | **1,480** | Test Interval - Bottom (m): | **15.5** |
| Pumped Well: Recovery Interval (minutes): | **2,610** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40357.441154; 1.1 — Pumped: M40360.481948; 2*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.00 |
| 20 | 0.01 |
| 30 | 0.01 |
| 40 | 0.01 |
| 50 | 0.01 |
| 60 | 0.01 |
| 80 | 0.02 |
| 100 | 0.02 |
| 120 | 0.02 |
| 150 | 0.02 |
| 190 | 0.03 |
| 240 | 0.04 |
| 300 | 0.04 |
| 380 | 0.04 |
| 480 | 0.05 |
| 600 | 0.05 |
| 760 | 0.06 |
| 960 | 0.07 |
| 1,200 | 0.07 |
| 1,480 | 0.08 |

*Test Comments:*

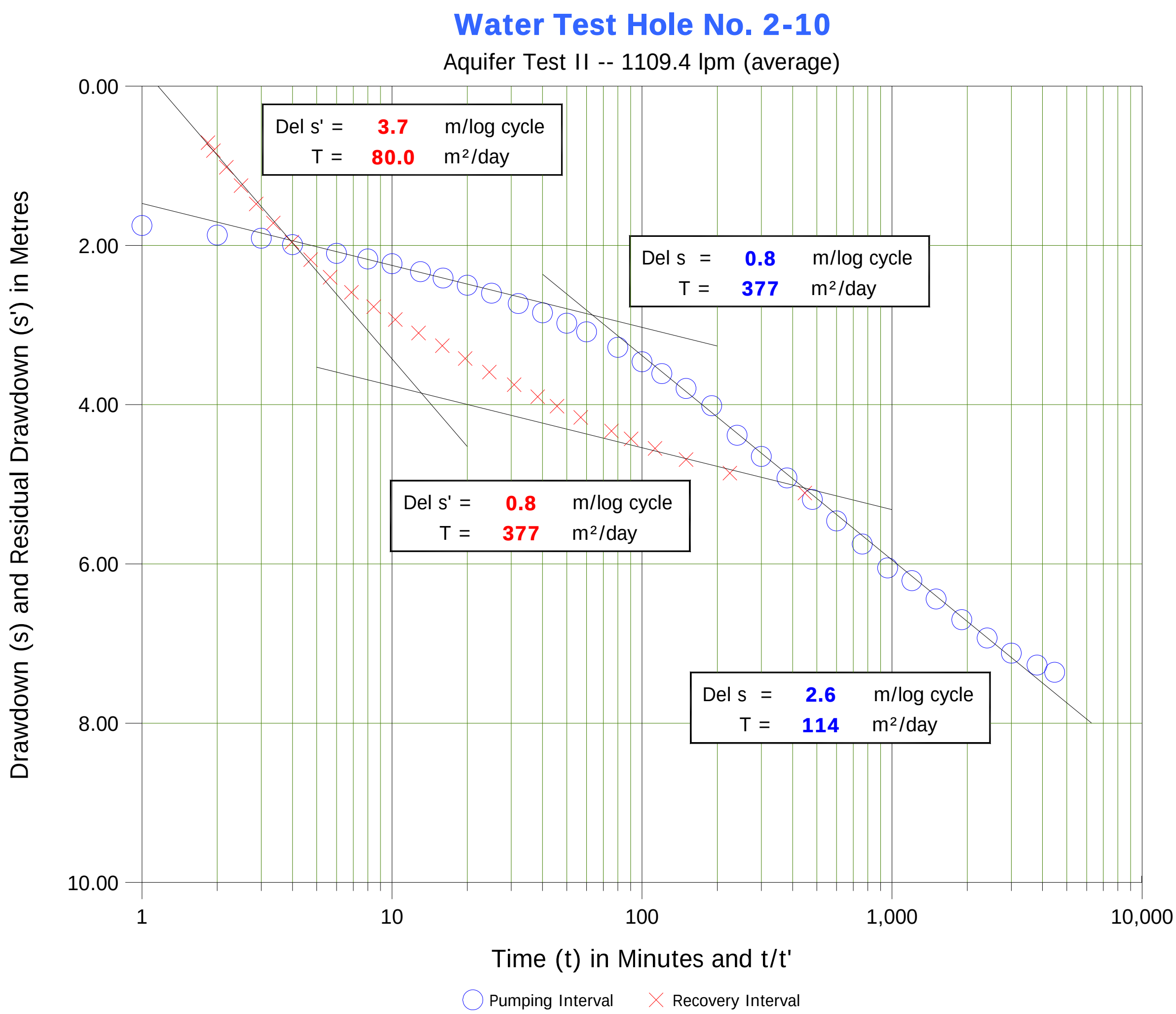
Aquifer test conducted by Mow-Tech Ltd.

## Aquifer Test II with Water Test Hole No. 2-10

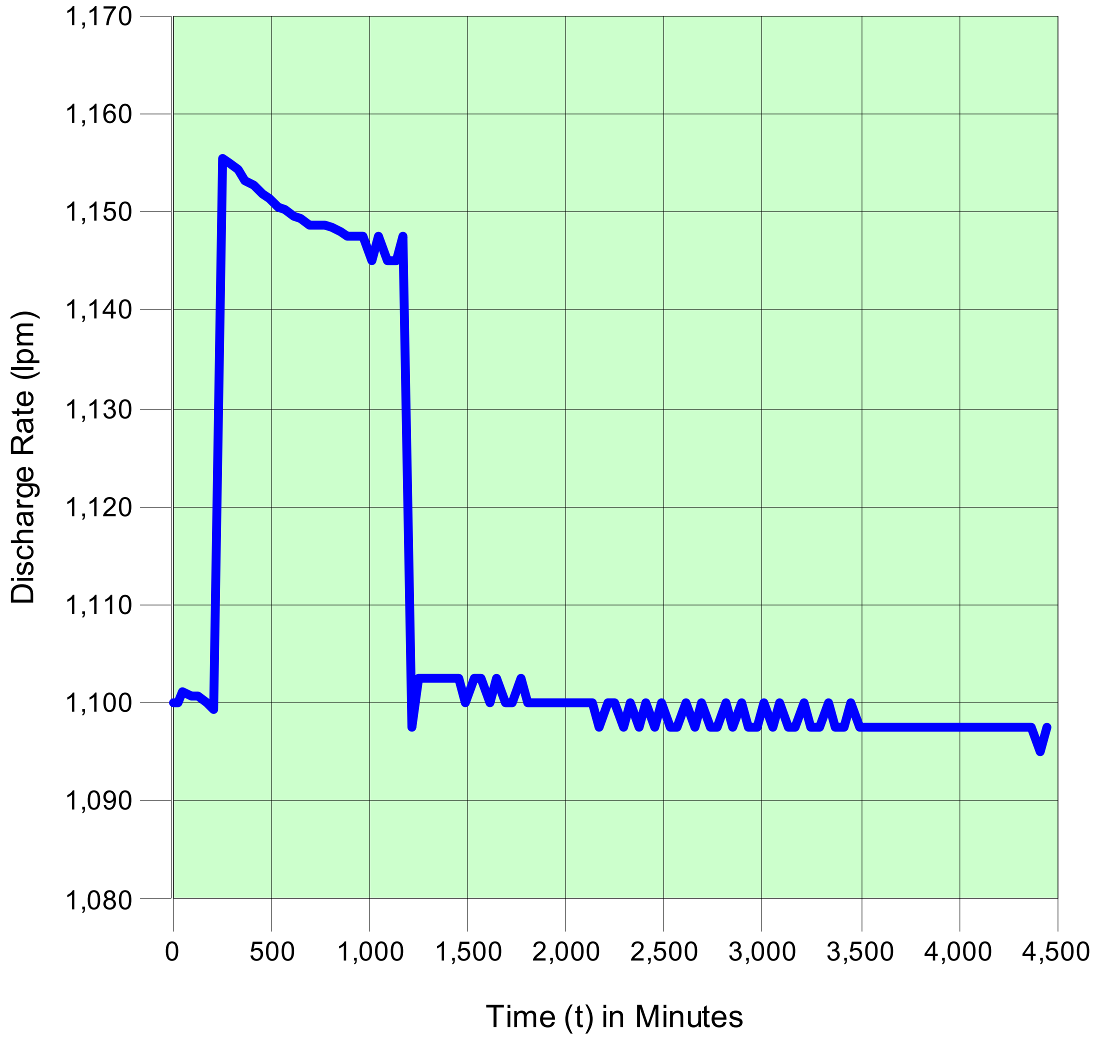
Test Started: July 06, 2010 @ 14:10 Hrs
Discharge (lpm): 1109.4

| | NPWL (m BTOC) | Distance from Pumped Water Well (m) |
|---|---|---|
| **Pumped Water Well:** | | |
| Water Test Hole No. 2-10 | 4.64 | |
| | | |
| **Observation Water Wells:** | | |
| Piezometer No. 7-10 | 2.64 | 318 |
| Piezometer No. 4-10 | 3.74 | 491 |
| Piezometer No. 2-10 | 4.42 | 724 |
| Piezometer No. 6-10 | 5.55 | 966 |
| Piezometer No. 12-10 | 2.80 | 1,273 |
| Piezometer No. 1-10 | 5.14 | 1,564 |

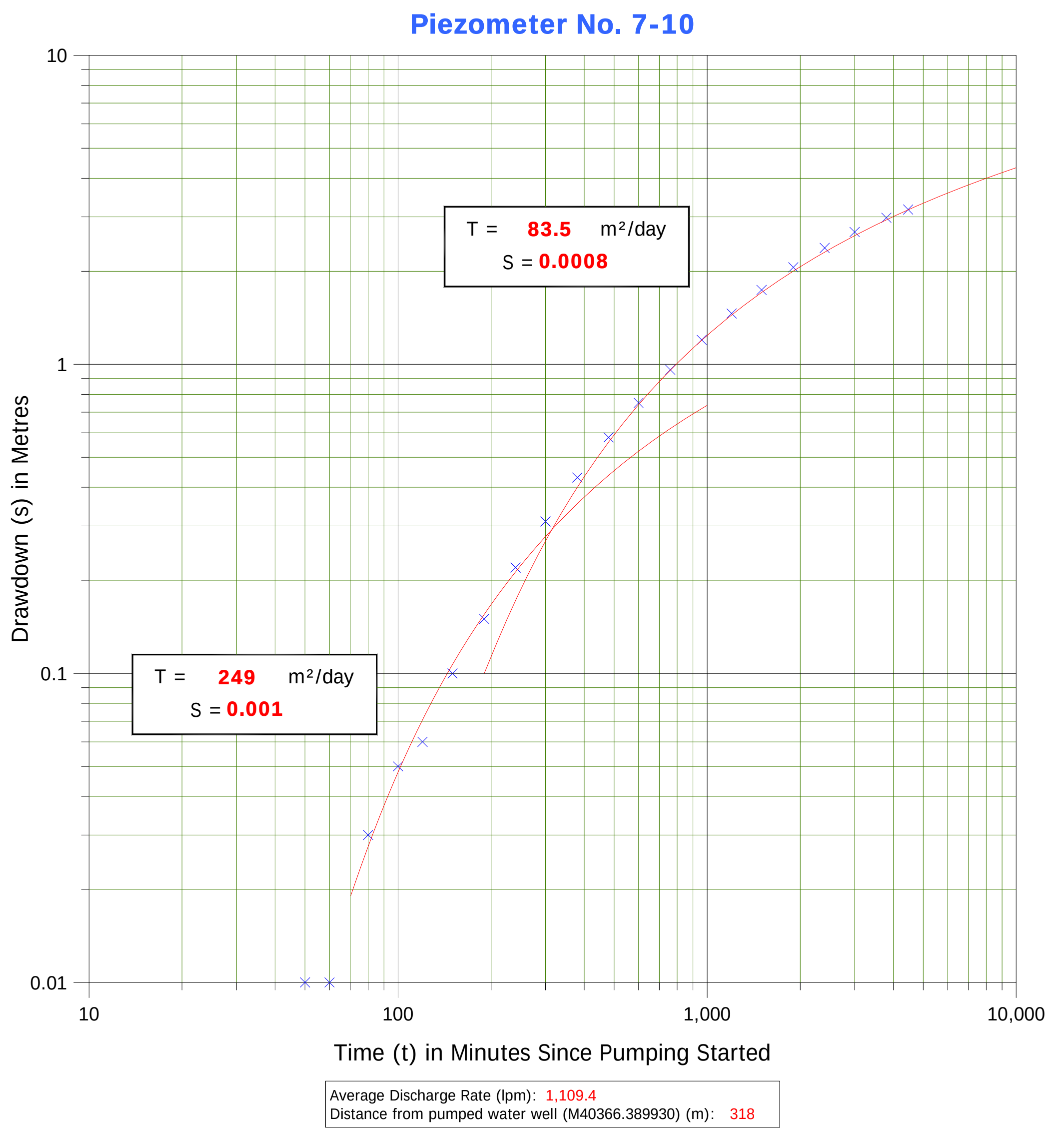
***Aquifer Test II***
***Pumped Water Well (Water Test Hole No. 2-10)***



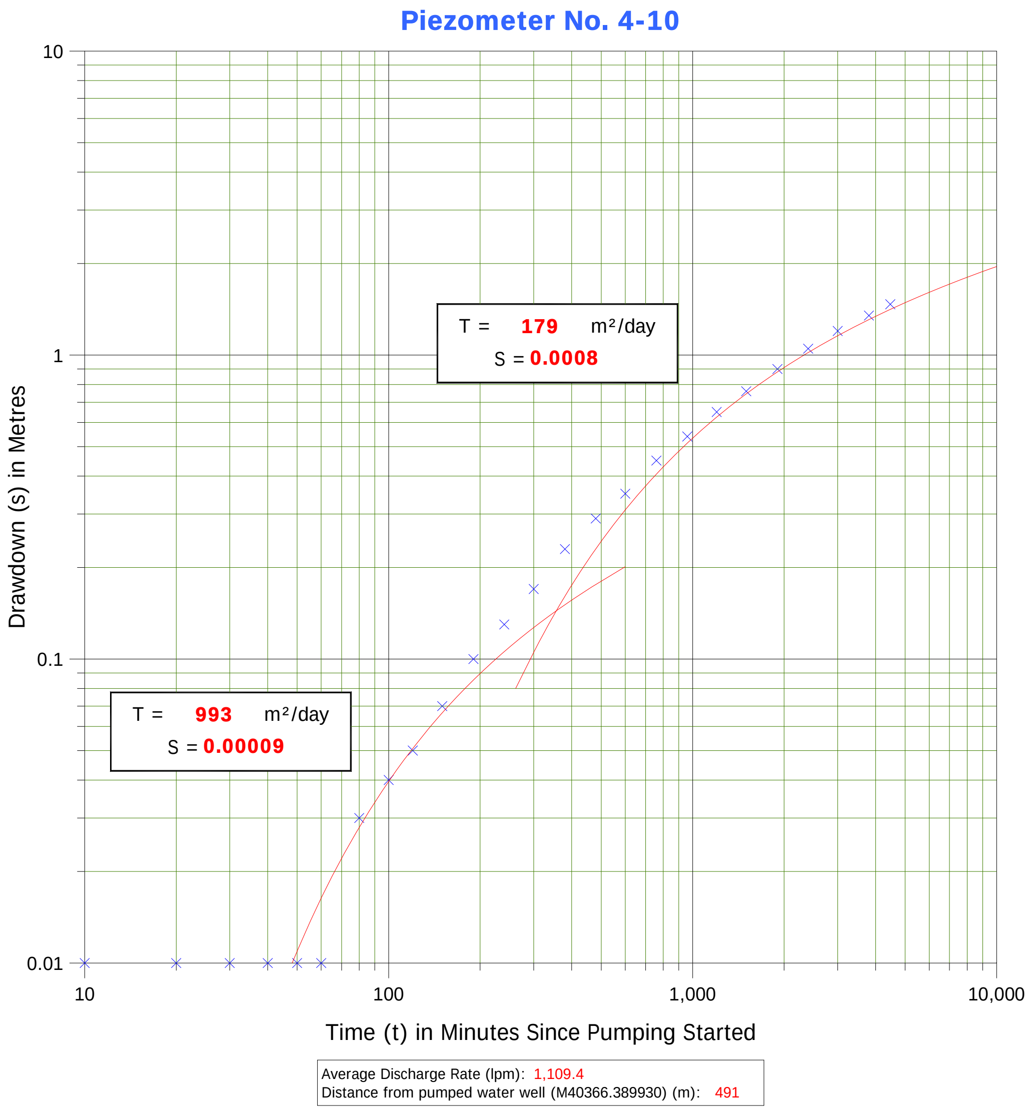
***Pumping Rate during Aquifer Test II***



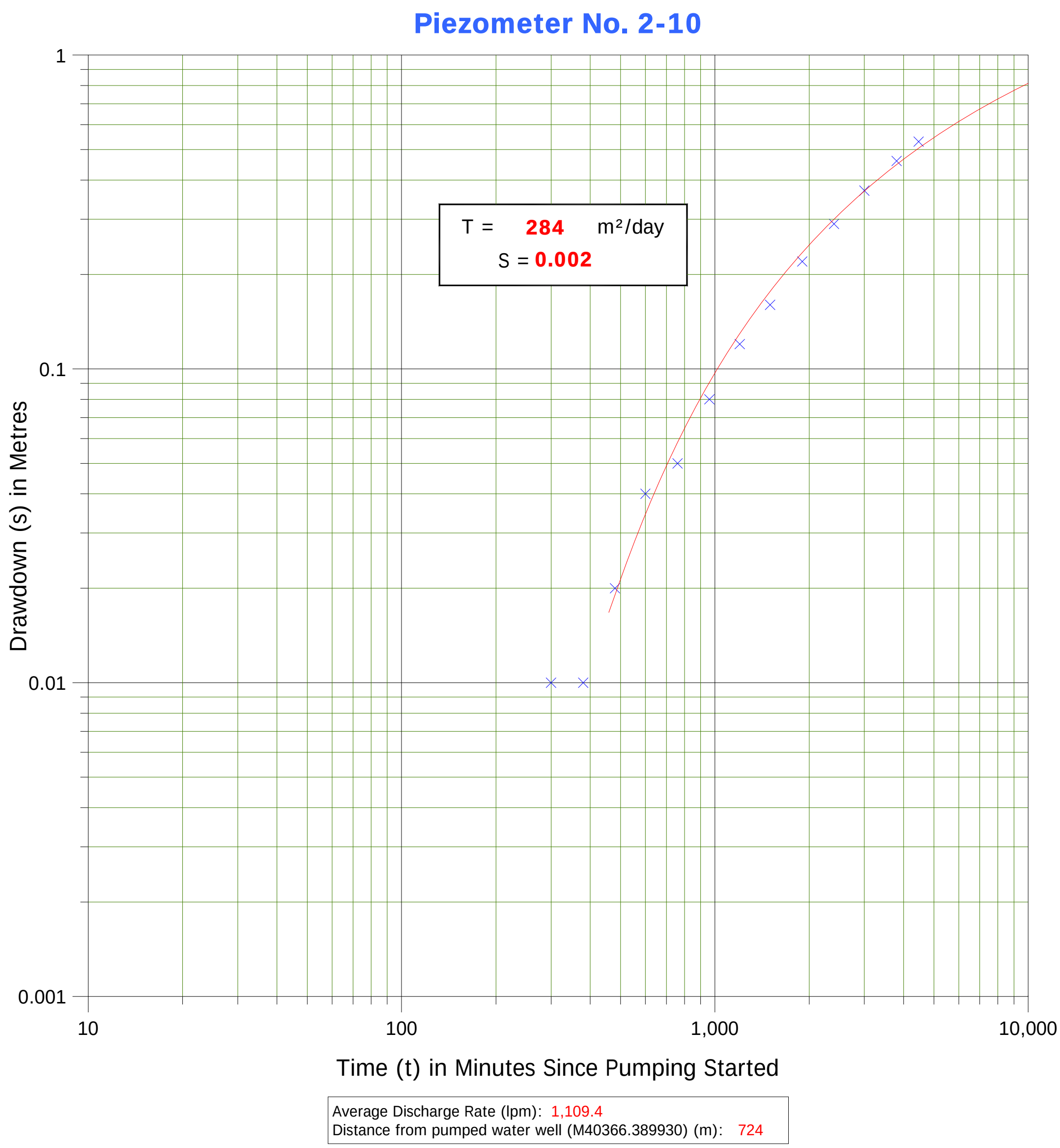
***Piezometer No. 7-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***



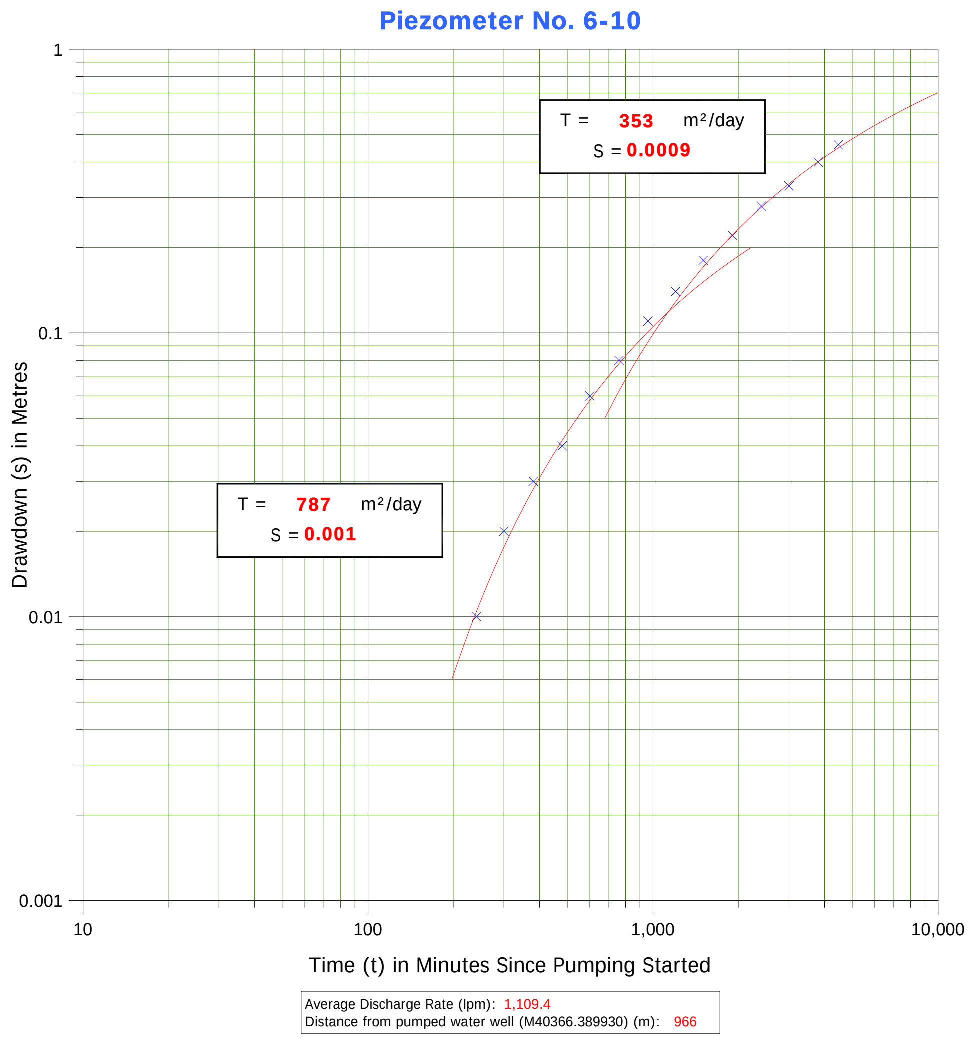
***Piezometer No. 4-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***



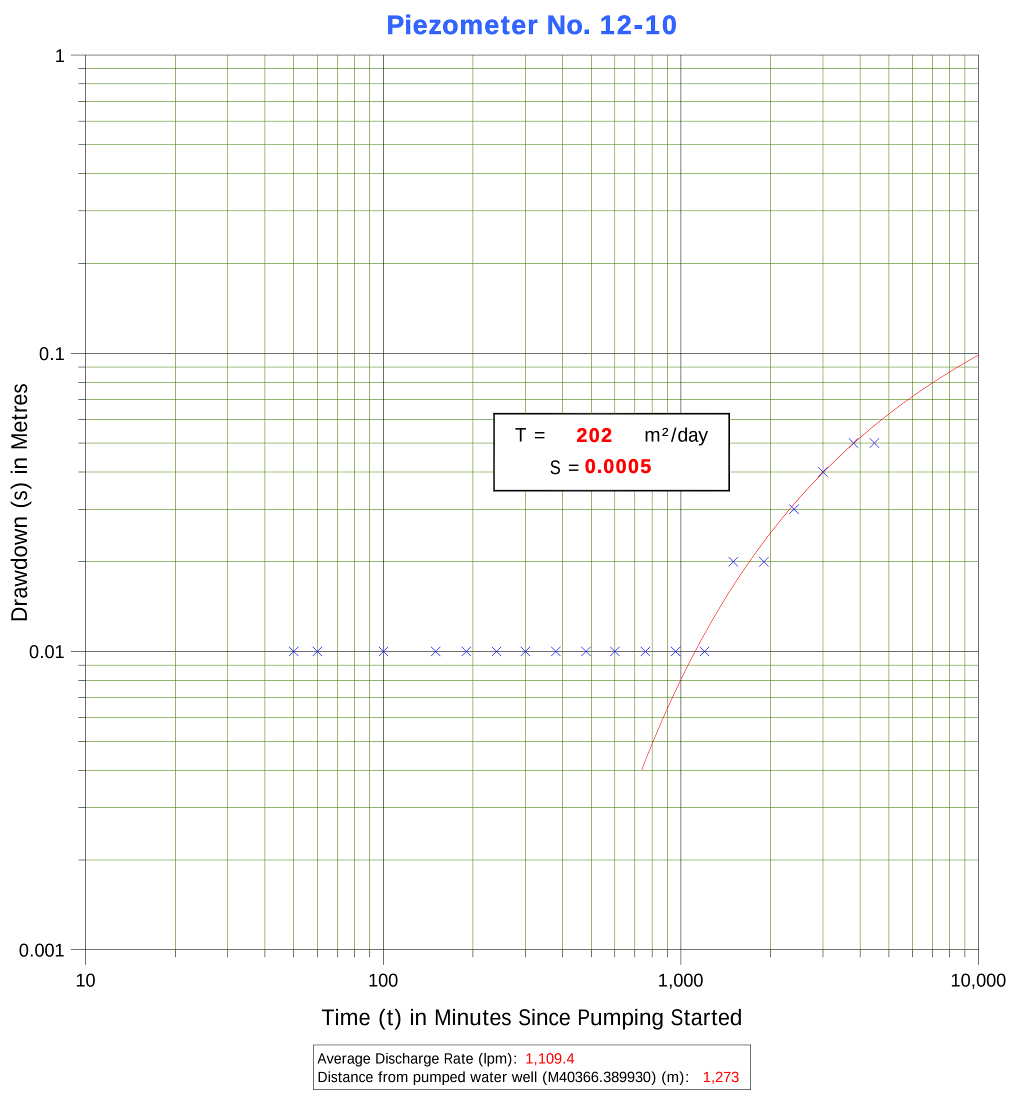
***Piezometer No. 2-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***



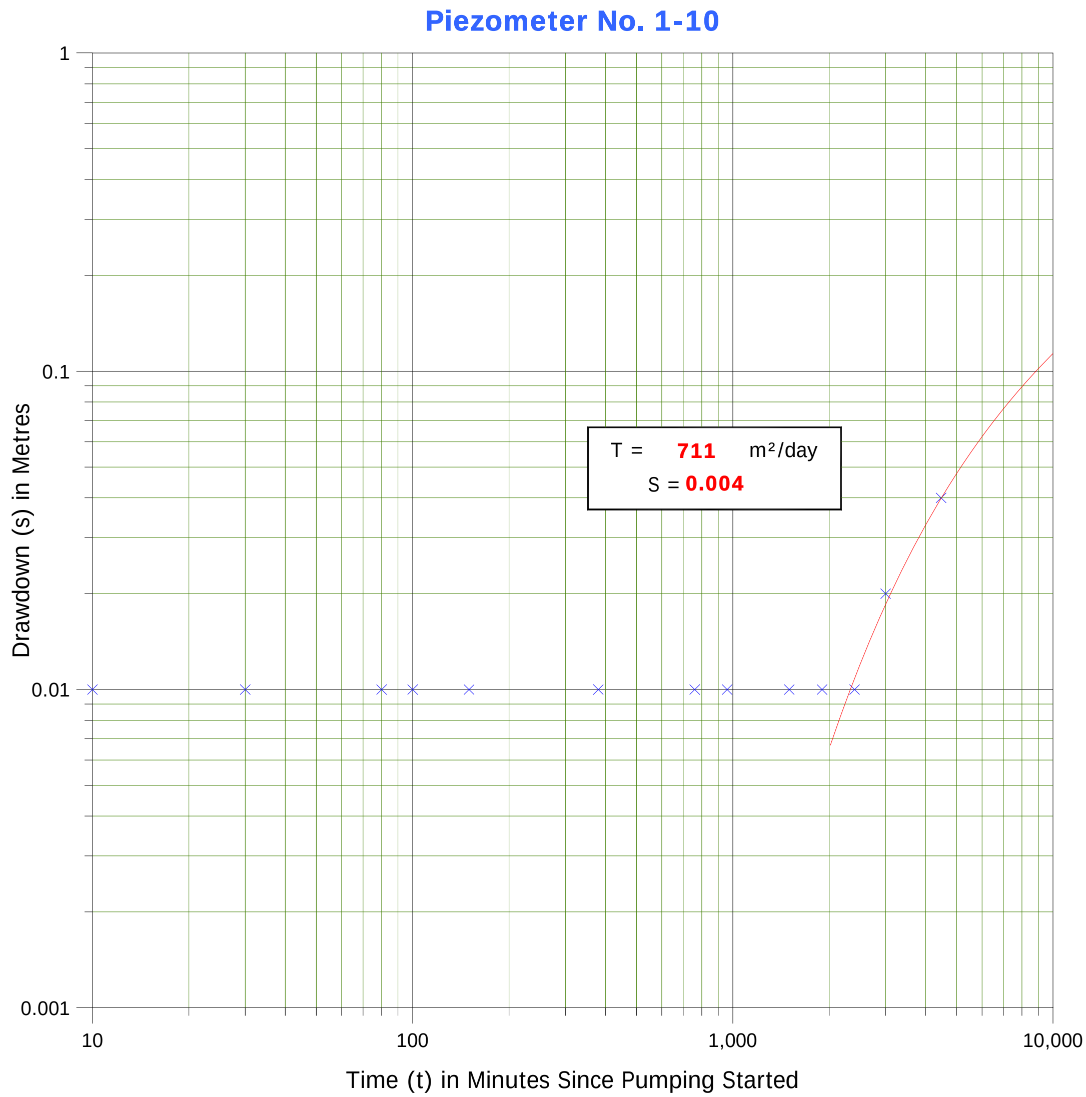
***Piezometer No. 6-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***



***Piezometer No. 12-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***



***Piezometer No. 1-10 Used as Observation WW during Aquifer Test II with WTH No. 2-10***




Average Discharge Rate (lpm): 1,109.4
Distance from pumped water well (M40366.389930) (m): 1,564

## *Aquifer Test II Data*

*Pumped Water Well:*

Water Test Hole No. 2-10

*Observation Water Well(s):*

Piezometer No. 7-10
Piezometer No. 4-10
Piezometer No. 2-10
Piezometer No. 6-10
Piezometer No. 12-10
Piezometer No. 1-10

# Aquifer Test II

## Water Test Hole No. 2-10

**05-36-054-22 W4M**

| | | | |
|---|---|---|---|
| Average Discharge (lpm): | **1109.4** | Pre-Test Water Level - NPWL (m): | **4.64** |
| Date Test Started: | **July 06, 2010** | Depth to Pump Intake (m): | **N/A** |
| Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **14.3** |
| Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **18.9** |
| Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*
*Reference: M40366.389930 (AT 2)*
** **TGWC** calculated or determined value.*


### Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) | Discharge (Lpm) |
|---|---|---|
| 1 | 1.75 | 1100.0 |
| 2 | 1.87 | 1100.0 |
| 3 | 1.91 | 1100.0 |
| 4 | 1.99 | 1100.0 |
| 6 | 2.10 | 1100.0 |
| 8 | 2.17 | 1100.0 |
| 10 | 2.23 | 1100.0 |
| 13 | 2.33 | 1100.0 |
| 16 | 2.41 | 1100.0 |
| 20 | 2.50 | 1100.2 |
| 25 | 2.60 | 1100.0 |
| 32 | 2.73 | 1101.0 |
| 40 | 2.85 | 1101.7 |
| 50 | 2.98 | 1102.1 |
| 60 | 3.09 | 1101.4 |
| 80 | 3.28 | 1101.0 |
| 100 | 3.46 | 1100.0 |
| 120 | 3.61 | 1101.0 |
| 150 | 3.80 | 1100.0 |
| 190 | 4.01 | 1100.0 |
| 240 | 4.38 | 1156.0 |
| 300 | 4.65 | 1155.0 |
| 380 | 4.92 | 1153.0 |
| 480 | 5.19 | 1151.0 |
| 600 | 5.46 | 1150.0 |
| 760 | 5.75 | 1148.0 |
| 960 | 6.05 | 1150.0 |
| 1,200 | 6.21 | 1100.0 |
| 1,500 | 6.44 | 1110.0 |
| 1,900 | 6.70 | 1100.0 |
| 2,400 | 6.93 | 1100.0 |
| 3,000 | 7.12 | 1100.0 |
| 3,800 | 7.27 | 1100.0 |
| 4,470 | 7.36 | 1100.0 |

### Recovery Interval

Measurement Point: Top of Casing

| Time (t') Since Pumping Stopped (minutes) | (t/t') | Residual Drawdown (s') (metre) |
|---|---|---|
| 10 | 448 | 5.11 |
| 20 | 225 | 4.86 |
| 30 | 150 | 4.69 |
| 40 | 113 | 4.55 |
| 50 | 90 | 4.43 |
| 60 | 76 | 4.33 |
| 80 | 57 | 4.16 |
| 100 | 46 | 4.02 |
| 120 | 38 | 3.90 |
| 150 | 31 | 3.75 |
| 190 | 25 | 3.59 |
| 240 | 19.6 | 3.42 |
| 300 | 15.9 | 3.26 |
| 380 | 12.8 | 3.10 |
| 480 | 10.3 | 2.93 |
| 600 | 8.5 | 2.77 |
| 760 | 6.9 | 2.59 |
| 960 | 5.7 | 2.40 |
| 1,200 | 4.7 | 2.18 |
| 1,500 | 4.0 | 1.96 |
| 1,900 | 3.4 | 1.72 |
| 2,400 | 2.9 | 1.48 |
| 3,000 | 2.5 | 1.25 |
| 3,800 | 2.2 | 1.02 |
| 4,800 | 1.93 | 0.81 |
| 5,350 | 1.84 | 0.71 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 7-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**05-36-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** | Pre-Test Water Level - NPWL (m): | **2.64** |
| Pumped Well: Date Test Started: | **July 06, 2010** | Distance From Pumped Well (m): | **318** |
| Pumped Well: Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **7.6** |
| Pumped Well: Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **9.1** |
| Pumped Well: Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*
*Obs: M40357.429458; 2.1 — Pumped: M40366.389930; 2*
** **TGWC** calculated or determined value.*
*This report was generated on: July 29, 2010 — Data "AS IS"; no warranty either expressed or implied. © TGWC — Page 1 of 1*

## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.00 |
| 20 | 0.00 |
| 30 | 0.00 |
| 40 | 0.00 |
| 50 | 0.01 |
| 60 | 0.01 |
| 80 | 0.03 |
| 100 | 0.05 |
| 120 | 0.06 |
| 150 | 0.10 |
| 190 | 0.15 |
| 240 | 0.22 |
| 300 | 0.31 |
| 380 | 0.43 |
| 480 | 0.58 |
| 600 | 0.75 |
| 760 | 0.96 |
| 960 | 1.20 |
| 1,200 | 1.46 |
| 1,500 | 1.74 |
| 1,900 | 2.06 |
| 2,400 | 2.38 |
| 3,000 | 2.68 |
| 3,800 | 2.98 |
| 4,470 | 3.17 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

## Piezometer No. 4-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**16-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** | Pre-Test Water Level - NPWL (m): | **3.74** |
| Pumped Well: Date Test Started: | **July 06, 2010** | Distance From Pumped Well (m): | **491** |
| Pumped Well: Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **6.1** |
| Pumped Well: Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **9.1** |
| Pumped Well: Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40354.390392; 1.1 — Pumped: M40366.389930; 2*

** **TGWC** calculated or determined value.*



### Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.01 |
| 20 | 0.01 |
| 30 | 0.01 |
| 40 | 0.01 |
| 50 | 0.01 |
| 60 | 0.01 |
| 80 | 0.03 |
| 100 | 0.04 |
| 120 | 0.05 |
| 150 | 0.07 |
| 190 | 0.10 |
| 240 | 0.13 |
| 300 | 0.17 |
| 380 | 0.23 |
| 480 | 0.29 |
| 600 | 0.35 |
| 760 | 0.45 |
| 960 | 0.54 |
| 1,200 | 0.65 |
| 1,500 | 0.76 |
| 1,900 | 0.90 |
| 2,400 | 1.05 |
| 3,000 | 1.20 |
| 3,800 | 1.35 |
| 4,470 | 1.47 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

## Piezometer No. 2-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**16-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** | Pre-Test Water Level - NPWL (m): | **4.42** |
| Pumped Well: Date Test Started: | **July 06, 2010** | Distance From Pumped Well (m): | **724** |
| Pumped Well: Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **3.0** |
| Pumped Well: Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **7.6** |
| Pumped Well: Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40346.477063; 2.1 — Pumped: M40366.389930; 2*

** **TGWC** calculated or determined value.*



### Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.00 |
| 20 | -0.01 |
| 30 | 0.00 |
| 40 | -0.01 |
| 50 | 0.00 |
| 60 | 0.00 |
| 80 | 0.00 |
| 100 | 0.00 |
| 120 | 0.00 |
| 150 | 0.00 |
| 190 | 0.00 |
| 240 | 0.00 |
| 300 | 0.01 |
| 380 | 0.01 |
| 480 | 0.02 |
| 600 | 0.04 |
| 760 | 0.05 |
| 960 | 0.08 |
| 1,200 | 0.12 |
| 1,500 | 0.16 |
| 1,900 | 0.22 |
| 2,400 | 0.29 |
| 3,000 | 0.37 |
| 3,800 | 0.46 |
| 4,470 | 0.53 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 6-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**15-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** | Pre-Test Water Level - NPWL (m): | **5.55** |
| Pumped Well: Date Test Started: | **July 06, 2010** | Distance From Pumped Well (m): | **966** |
| Pumped Well: Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **7.6** |
| Pumped Well: Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **10.7** |
| Pumped Well: Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*
*Obs: M40357.413171; 2.1 — Pumped: M40366.389930; 2*
** **TGWC** calculated or determined value.*


## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.00 |
| 20 | 0.00 |
| 30 | 0.00 |
| 40 | 0.00 |
| 50 | 0.00 |
| 60 | 0.00 |
| 80 | -0.01 |
| 100 | -0.01 |
| 120 | 0.00 |
| 150 | 0.00 |
| 190 | 0.00 |
| 240 | 0.01 |
| 300 | 0.02 |
| 380 | 0.03 |
| 480 | 0.04 |
| 600 | 0.06 |
| 760 | 0.08 |
| 960 | 0.11 |
| 1,200 | 0.14 |
| 1,500 | 0.18 |
| 1,900 | 0.22 |
| 2,400 | 0.28 |
| 3,000 | 0.33 |
| 3,800 | 0.40 |
| 4,470 | 0.46 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 12-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**09-26-054-22 W4M**

| | | | |
|---|---|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** | Pre-Test Water Level - NPWL (m): | **2.80** |
| Pumped Well: Date Test Started: | **July 06, 2010** | Distance From Pumped Well (m): | **1,273** |
| Pumped Well: Time Test Started (hours): | **14:10** | Test Interval - Top (m): | **6.1** |
| Pumped Well: Pumping Interval (minutes): | **4,470** | Test Interval - Bottom (m): | **9.1** |
| Pumped Well: Recovery Interval (minutes): | **5,350** | Top of Main Aquifer (m):* | **N/A** |

***N/A** - Information Not Available*

*Obs: M40360.468475; 2.1 — Pumped: M40366.389930; 2*

** **TGWC** calculated or determined value.*



## Pumping Interval

Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.00 |
| 20 | 0.00 |
| 30 | 0.00 |
| 40 | 0.00 |
| 50 | 0.01 |
| 60 | 0.01 |
| 80 | 0.00 |
| 100 | 0.01 |
| 120 | 0.00 |
| 150 | 0.01 |
| 190 | 0.01 |
| 240 | 0.01 |
| 300 | 0.01 |
| 380 | 0.01 |
| 480 | 0.01 |
| 600 | 0.01 |
| 760 | 0.01 |
| 960 | 0.01 |
| 1,200 | 0.01 |
| 1,500 | 0.02 |
| 1,900 | 0.02 |
| 2,400 | 0.03 |
| 3,000 | 0.04 |
| 3,800 | 0.05 |
| 4,470 | 0.05 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

# Piezometer No. 1-10

Used as Observation Water Well During
Aquifer Test II with Water Test Hole No. 2-10

**05-25-054-22 W4M**

| | |
|---|---|
| Pumped Well: Average Discharge (lpm): | **1,109.4** |
| Pumped Well: Date Test Started: | **July 06, 2010** |
| Pumped Well: Time Test Started (hours): | **14:10** |
| Pumped Well: Pumping Interval (minutes): | **4,470** |
| Pumped Well: Recovery Interval (minutes): | **5,350** |
| Pre-Test Water Level - NPWL (m): | **5.14** |
| Distance From Pumped Well (m): | **1,565** |
| Test Interval - Top (m): | **5.3** |
| Test Interval - Bottom (m): | **9.9** |
| Top of Main Aquifer (m):* | **N/A** |

***N/A*** *- Information Not Available*

*Obs: M40346.437175; 2.1 — Pumped: M40366.389930; 2*

** **TGWC** calculated or determined value.*



## Pumping Interval

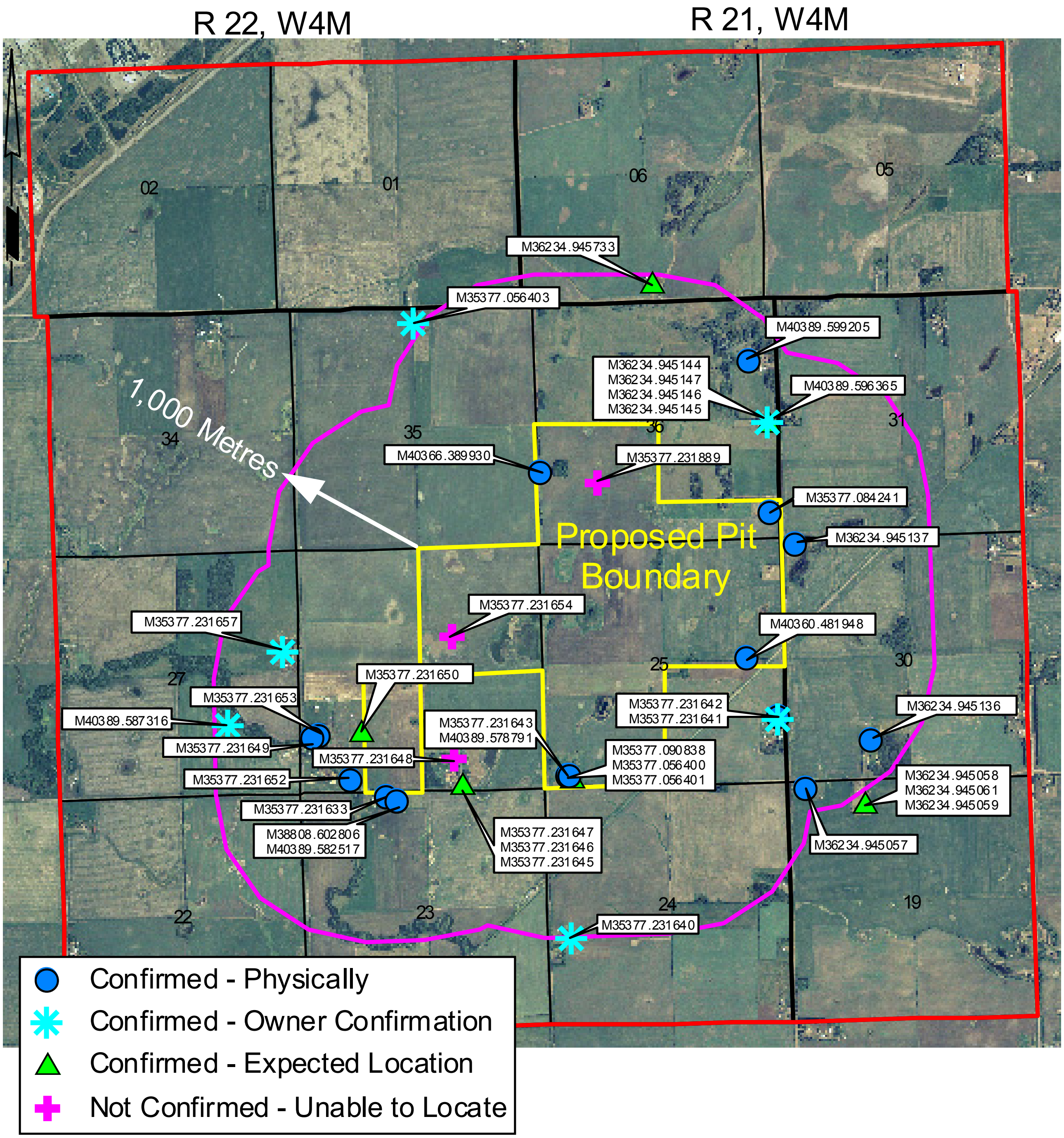
Measurement Point: Top of Casing

| Time (t) Since Pumping Started (minutes) | Drawdown (s) (metre) |
|---|---|
| 10 | 0.01 |
| 20 | 0.00 |
| 30 | 0.01 |
| 40 | 0.00 |
| 50 | 0.00 |
| 60 | 0.00 |
| 80 | 0.01 |
| 100 | 0.01 |
| 120 | 0.00 |
| 150 | 0.01 |
| 190 | 0.00 |
| 240 | 0.00 |
| 300 | 0.00 |
| 380 | 0.01 |
| 480 | 0.00 |
| 600 | 0.00 |
| 760 | 0.01 |
| 960 | 0.01 |
| 1,200 | 0.00 |
| 1,500 | 0.01 |
| 1,900 | 0.01 |
| 2,400 | 0.01 |
| 3,000 | 0.02 |
| 4,470 | 0.04 |

*Test Comments:*

Aquifer test conducted by Mow-Tech Ltd.

## Appendix D – Water Well Survey



## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 1 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | - | Joburg Aggregates Ltd. | Joburg Aggregates Ltd. | Mohr, Reg | Bethiel, A. | Martin, Evan |
| Legal Location | **SW 36-054-22 W4M** | **05-36-054-22 W4M** | **09-25-054-22 W4M** | **SE 36-054-22 W4M** | **10-26-054-22 W4M** | **NW 30-054-21 W4M** |
| Ground Elevation | 631.8 m | 633.2 m | 641.8 m | 636.4 m | 631.6 m | 637.1 m |
| Well Type | Water Test Hole | Water Test Hole | Water Test Hole | New Well | New Well | New Well |
| Water Status | Observation | Producing | Producing | Producing | Producing | Producing |
| Well Depth Drilled | 13.7 m | 21.3 m | 21.0 m | 36.6 m | 30.2 m | 20.4 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | - | 9.4 m | 7.4 m | - | - | - |
| Max. Pumping Rate | - | 1,137.0 Lpm | 705.3 Lpm | 50.0 Lpm | - | 45.5 Lpm |
| Completion Details | 11.0 - 13.7 m | 14.3 - 18.9 m | 18.0 - 21.0 m | 24.4 - 36.6 m | | 18.0 - 20.4 m |
| Distance | 704 m | 928 m | 976 m | 1,122 m | 1,177 m | 1,217 m |
| Earliest Water Level | April 07, 1988 | July 05, 2010 | July 02, 2010 | June 27, 1990 | - | October 02, 1974 |
| | 0.3 m | 4.7 m | 10.6 m | 6.1 m | - | 6.1 m |
| Latest Water Level | 1988-04-07 | 2010-07-16 | 2010-07-29 | 2010-05-31 | - | 2010-07-29 |
| | 0.3 m | 4.9 m | 10.6 m | 4.6 m | - | 7.2 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | - | 1 | 1 | - | - | - |
| (latest analysis) | | July 12, 2010 | July 08, 2010 | | | |
| Comments | | The water test hole was developed following completion at a rate of approximately 1,200 lpm. | | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well is located in wishing well ornament approx. 15 metres southwest of house. Water well is no longer in use. House is supplied by city water.] | | Orginal owner: Frey, Robert. [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well is used for watering the garden, Evan hauls water for house. Water well is located 15 metres southeast of house.] |
| AENV Well ID(s) | 0260458; 260458 | | | 0151872; 151872 | 0260224; 260224 | 0082770 |
| Licensed/Registered Diversion | - | - | - | 1.0 m³/day | - | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M35377.231889 | M40366.389930 | M40360.481948 | M35377.084241 | M35377.231654 | M36234.945137 |
| Date Verified | May 31, 2010 | July 03, 2010 | July 01, 2010 | May 31, 2010 | May 31, 2010 | June 11, 2010 |
| Verification Status | (04) Not Confirmed - Unable to Locate | (01) Confirmed - Physically | (01) Confirmed - Physically | (01) Confirmed - Physically | (04) Not Confirmed - Unable to Locate | (01) Confirmed - Physically |
| Well Name | [unknown] | Water Test Hole No. 2-10 | Water Test Hole No. 1-10 | 1990 Mohr Water Well | [unknown] | 1974 Martin Water Well |

*Data "AS IS"; no warranty either expressed or implied.*

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 2 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | McEachern, Chris | McEachern, Chris | Whitson, Art | Whitson, A. B. | Grier, Don | Smith, Ralph |
| Legal Location | **SW 25-054-22 W4M** | **SW 25-065-22 W4M** | **SW 25-054-22 W4M** | **04-25-054-22 W4M** | **SW 25-054-22 W4M** | **SE 25-054-22 W4M** |
| Ground Elevation | 635.5 m | 635.6 m | 635.6 m | 635.6 m | 635.6 m | 656.4 m |
| Well Type | New Well | Well Inventory | Chemistry | New Well | New Well | New Well |
| Water Status | Producing | Not In Use | Producing | Producing | Producing | Producing |
| Well Depth Drilled | 55.2 m | - | 48.8 m | 9.1 m | 63.1 m | 61.0 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | 20.2 m | - | - | - | 44.8 m | 26.9 m |
| Max. Pumping Rate | 15.9 Lpm | - | - | - | 9.1 Lpm | 22.7 Lpm |
| Completion Details | 34.1 - 55.2 m | | | | 59.4 - 63.1 m | 54.9 - 61.0 m |
| Distance | 1,313 m | 1,314 m | 1,318 m | 1,318 m | 1,318 m | 1,384 m |
| Earliest Water Level | November 21, 1979 | - | - | January 01, 1911 | June 01, 1973 | October 31, 1981 |
| | 9.1 m | - | - | 4.6 m | 14.6 m | 27.4 m |
| Latest Water Level | 2010-06-11 | - | - | 1911-01-01 | 1973-06-01 | 2010-05-31 |
| | 14.0 m | - | - | 4.6 m | 14.6 m | 28.0 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | 1 | - | - | 1 | 2 | 1 |
| (latest analysis) | December 27, 1979 | | | February 01, 1967 | March 25, 1988 | March 19, 1982 |
| Comments | Original owner: Whitson, Art. [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), water well is located in shed and is used to supply stock. Water well is located 40 metres west of trailer. Trailer is supplied by cistern.] | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well not in use, 7 inch steel cased water well with piece of wood inserted into casing. No access to WL. Was told by renter that water well is deep? Trailer is supplied by cistern.] | | | Seal type listed as 'Driven' but no interval defined. | [Hydrogeological Consultants Ltd. (HCL) field survey (May 2010), water well is located in backyard approx. 10 metres north of house. Water well supplies approx. 3/4 gallon per minute. New submersible pump last year.] |
| AENV Well ID(s) | 0260213; 260213 | | 0158534 | 0264944; 264944 | 0264946; 264946 | 0260212; 260212 |
| Licensed/Registered Diversion | - | - | - | - | - | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M35377.231643 | M40389.578791 | M35377.090838 | M35377.056400 | M35377.056401 | M35377.231642 |
| Date Verified | June 11, 2010 | June 11, 2010 | May 31, 2010 | May 31, 2010 | May 31, 2010 | May 31, 2010 |
| Verification Status | (01) Confirmed - Physically | (01) Confirmed - Physically | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (01) Confirmed - Physically |
| Well Name | 1979 McEachern Water Well | McEachern Water Well | [unknown] | [unknown] | [unknown] | 1981 Smith Water Well |

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 3 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | Smith, Ralph | Mohr, Jim | Smith, Gloria | Bethel Luth Chrch | Ritchie, F.E. | Smith, F. |
| Legal Location | **SE 25-054-22 W4M** | **SE 36-054-22 W4M** | **WH 31-054-21 W4M** | **NW 31-054-21 W4M** | **12-31-054-21 W4M** | **12-31-054-21 W4M** |
| Ground Elevation | 656.4 m | 631.7 m | 631.8 m | 631.8 m | 631.8 m | 631.8 m |
| Well Type | Well Inventory | Well Inventory | Chemistry | New Well | Federal Well Survey | Federal Well Survey |
| Water Status | Not In Use | Producing | Producing | Producing | Producing | Producing |
| Well Depth Drilled | 67.1 m | - | 8.5 m | 76.2 m | 95.1 m | 8.5 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | - | - | - | - | - | - |
| Max. Pumping Rate | - | - | - | 54.6 Lpm | - | - |
| Completion Details | | | | 65.2 - 73.2 m | | |
| Distance | 1,385 m | 1,488 m | 1,490 m | 1,490 m | 1,490 m | 1,490 m |
| Earliest Water Level | - | - | June 16, 1977 | October 24, 1968 | January 01, 1921 | January 01, 1920 |
| | - | - | 4.6 m | 21.3 m | 57.9 m | 3.1 m |
| Latest Water Level | - | - | 1977-06-16 | 1968-10-24 | 1921-01-01 | 1920-01-01 |
| | - | - | 4.6 m | 21.3 m | 57.9 m | 3.1 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | 2 | - | 1 | - | - | - |
| (latest analysis) | December 11, 1972 | | June 29, 1977 | | | |
| Comments | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well is no longer in use, water well is located in basement of house North side of house. House was built in 1904. Working head. Water well drilled in the late 60s by Peter Hansen.] | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), House is supplied by city water, Water well on-site, borded water well that has metal plate then a concret cover and is approx. 1 ft bgl, casing covered.] | | | | |
| AENV Well ID(s) | 0260211; 260211 | | 0082777 | 0082778 | 0082779 | 0082780 |
| Licensed/Registered Diversion | 3.6 m³/day | - | - | - | - | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M35377.231641 | M40389.596365 | M36234.945144 | M36234.945145 | M36234.945146 | M36234.945147 |
| Date Verified | May 31, 2010 | May 31, 2010 | June 01, 2010 | May 31, 2010 | May 31, 2010 | May 31, 2010 |
| Verification Status | (02) Confirmed - Owner Confirmation | (02) Confirmed - Owner Confirmation | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location |
| Well Name | Smith Water Well | Mohr Bored Water Well | [unknown] | [unknown] | [unknown] | [unknown] |

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 4 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | Mid Western Industrial Gas Ltd | Slater, Buck | Simmons, F. | Slater, Grace | Mohr, Martin | Dehaan, Henry & Mary |
| Legal Location | 02-26-054-22 W4M | SE 26-054-22 W4M | SE 26-054-22 W4M | 02-26-054-22 W4M | NE 36-054-22 W4M | 13-19-054-21 W4M |
| Ground Elevation | 634.1 m | 633.1 m | 633.1 m | 633.1 m | 629.6 m | 659.3 m |
| Well Type | New Well | New Well | New Well | New Well | Well Inventory | Federal Well Survey |
| Water Status | Producing | Producing | Producing | Producing | Not In Use | Not In Use |
| Well Depth Drilled | 22.9 m | 61.0 m | 33.5 m | 70.1 m | - | 91.4 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | 7.6 m | 39.9 m | - | 41.5 m | - | - |
| Max. Pumping Rate | 34.1 Lpm | 22.7 Lpm | - | 45.5 Lpm | - | - |
| Completion Details | 12.2 - 13.4 m | 55.2 - 61.0 m | | 50.3 - 61.3 m | | |
| Distance | 1,599 m | 1,689 m | 1,689 m | 1,689 m | 1,737 m | 1,839 m |
| Earliest Water Level | September 18, 1964 | September 01, 1973 | - | December 12, 1966 | - | January 01, 1919 |
| | 4.6 m | 15.2 m | - | 8.8 m | - | 61.0 m |
| Latest Water Level | 1964-09-18 | 1973-09-01 | - | 1966-12-12 | - | 1919-01-01 |
| | 4.6 m | 15.2 m | - | 8.8 m | - | 61.0 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | - | 1 | - | 1 | - | - |
| (latest analysis) | | August 24, 1982 | | | | |
| Comments | Hardness 540 ppm. | Seal type listed as 'Driven' but no interval defined. | | | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), Stock water well that has caved in, wood cribbing, water well is no longer in use. Landowners haul water for the house.] | Original owner: Krebs, A. [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), water well is located in a water well pit 4 metres south of house. Water well is not in use, house is supplied by city water.] |
| AENV Well ID(s) | 0260218; 260218 | 0260215; 260215 | 0260216; 260216 | 0260217; 260217 | | 0082690; 0082693; 82690; 82693 |
| Licensed/Registered Diversion | - | 1.2 m³/day | - | - | - | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M35377.231648 | M35377.231645 | M35377.231646 | M35377.231647 | M40389.599205 | M36234.945057 |
| Date Verified | June 01, 2010 | June 01, 2010 | June 01, 2010 | June 01, 2010 | May 31, 2010 | June 01, 2010 |
| Verification Status | (04) Not Confirmed - Unable to Locate | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (01) Confirmed - Physically | (01) Confirmed - Physically |
| Well Name | [unknown] | [unknown] | [unknown] | [unknown] | Mohr Water Well | 1919 Dehaan Water Well |

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 5 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | Davies, Keith | Ireland, Ken | Brick, A.W. | McEachern, Matilda | McEachern, Matilda | McEachern, Matilda |
| Legal Location | **SW 30-054-21 W4M** | **SW 26-054-22 W4M** | **02-06-055-21 W4M** | **NW 23-054-22 W4M** | **NW 23-054-22 W4M** | **NW 23-054-22 W4M** |
| Ground Elevation | 659.2 m | 634.5 m | 627.1 m | 632.9 m | 632.9 m | 631.9 m |
| Well Type | New Well | Chemistry | Federal Well Survey | New Well | Well Inventory | New Well |
| Water Status | Producing | Producing | Producing | Producing | Not In Use | Producing |
| Well Depth Drilled | 73.1 m | 61.0 m | 16.5 m | 42.7 m | - | 46.9 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | 18.9 m | - | - | 17.5 m | - | 16.6 m |
| Max. Pumping Rate | 4.6 Lpm | - | - | 22.7 Lpm | - | 34.1 Lpm |
| Completion Details | 60.4 - 67.1 m | | | 25.0 - 42.7 m | | 22.6 - 46.0 m |
| Distance | 1,973 m | 1,978 m | 2,039 m | 2,067 m | 2,074 m | 2,104 m |
| Earliest Water Level | March 31, 1981 | - | - | February 24, 2005 | - | April 17, 1984 |
| | 35.1 m | - | - | 7.5 m | - | 4.6 m |
| Latest Water Level | 2010-06-01 | - | - | 2005-02-24 | - | 2010-06-07 |
| | 41.5 m | - | - | 7.5 m | - | 5.9 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | - | 1 | - | - | - | 1 |
| (latest analysis) | | April 12, 1978 | | | | November 28, 1984 |
| Comments | Original owner: Eccleston, Wayne. [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), Water well located 15 metres north of house, Water well is only used to supply water to his horses, the two houses on property are both supplied by city water.] | | | Original owner: McEachern, Mel. [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), stock water well is located 150 metres east of house.] | [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), old not in use bored water well is located in shed. Lots of debrey in pit, no access to water well.] | Original owner: McEachern, Mel. [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well is located in livestock area 30 metres north of blue shop.] |
| AENV Well ID(s) | 0082769 | 0260220; 260220 | 0083366 | 10800226; 1300079 | | 0260203; 260203 |
| Licensed/Registered Diversion | - | - | - | - | - | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M36234.945136 | M35377.231650 | M36234.945733 | M38808.602806 | M40389.582517 | M35377.231633 |
| Date Verified | June 01, 2010 | June 01, 2010 | June 01, 2010 | June 07, 2010 | June 07, 2010 | June 07, 2010 |
| Verification Status | (01) Confirmed - Physically | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (01) Confirmed - Physically | (01) Confirmed - Physically | (01) Confirmed - Physically |
| Well Name | 1981 Davies Water Well | [unknown] | [unknown] | 2005 McEachern Stock Water Well | McEachern Bored Stock WW | 1984 McEachern House Water Well |

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 6 of 7: Printed on December 13, 2012*

| Parameter | | | | | | |
|---|---|---|---|---|---|---|
| Owner / Lessee | Gabert, Doug | Gaubert, Doug | Gabert, Doug | Galloway, Ed & Pat | Fischer, Gerald | Galloway, Ed & Pat |
| Legal Location | **NW 19-054-21 W4M** | **13-19-054-21 W4M** | **NW 19-054-21 W4M** | **SW 26-054-22 W4M** | **NE 35-054-22 W4M** | **SW 26-054-22 W4M** |
| Ground Elevation | 664.3 m | 664.3 m | 664.3 m | 629.8 m | 627.6 m | 629.8 m |
| Well Type | Chemistry | New Well | Chemistry | New Well | New Well | New Well |
| Water Status | Producing | Producing | Producing | Producing | Producing | Producing |
| Well Depth Drilled | 85.3 m | 70.1 m | 54.9 m | 54.9 m | 51.8 m | 61.0 m |
| Top of Aquifer | - | - | - | - | - | - |
| Total Available Head | - | - | - | 40.5 m | | 33.1 m |
| Max. Pumping Rate | - | 18.2 Lpm | - | 27.3 Lpm | 22.7 Lpm | 45.5 Lpm |
| Completion Details | | 67.1 - 70.1 m | | 52.7 - 54.9 m | | 47.9 - 61.0 m |
| Distance | 2,193 m | 2,193 m | 2,193 m | 2,218 m | 2,235 m | 2,244 m |
| Earliest Water Level | - | January 03, 1980 | - | June 08, 1978 | September 01, 1973 | October 02, 1984 |
| | - | 33.5 m | - | 12.2 m | 7.3 m | 18.3 m |
| Latest Water Level | - | 1980-01-03 | - | 1978-06-08 | 1973-09-01 | 2010-06-07 |
| | - | 33.5 m | - | 12.2 m | 7.3 m | 14.8 m |
| Daily Use | - | - | - | - | - | - |
| Number of Chemistries | 1 | - | - | - | 1 | - |
| (latest analysis) | March 03, 1982 | | | | April 11, 1984 | |
| Comments | | | | Seal type listed as 'Puddled Clay' but no interval defined. [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), water well is located at Ed Galloway's daughters house. Water well is located west of trailer. New house currently being constructed on-site.] | Seal type listed as 'Driven' but no interval defined. Original owner: Simmons, Hector. [Water well is located in a water well pit next to grey building]. WELLID changed from 0264947 by GIC on 2005-02-15 /// Seal type listed as "Driven" no interval was provided. | [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), water well is located east of barn. |
| AENV Well ID(s) | 0082691 | 0082692 | 0082694 | 0260222; 260222 | 0264947; 10798539; 1325000; 264947 | 0260223; 260223 |
| Licensed/Registered Diversion | - | - | - | - | 0.8 m³/day | - |

| Consultant Details | | | | | | |
|---|---|---|---|---|---|---|
| TGWC ID | M36234.945058 | M36234.945059 | M36234.945061 | M35377.231652 | M35377.056403 | M35377.231653 |
| Date Verified | June 01, 2010 | June 01, 2010 | June 01, 2010 | July 20, 2010 | June 01, 2010 | June 07, 2010 |
| Verification Status | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (03) Confirmed - Expected Location | (01) Confirmed - Physically | (02) Confirmed - Owner Confirmation | (01) Confirmed - Physically |
| Well Name | [unknown] | [unknown] | [unknown] | 1978 Kirby Water Well | 1973 Fischer Water Well | 1984 Galloway Stock Water Well |

## Field-Verified Survey
## Groundwater Records in Area of Interest (duplicates removed)

Survey Centred on: Centre of Proposed Development Boundary

*Page: 7 of 7: Printed on December 13, 2012*

| Parameter | | | | |
|---|---|---|---|---|
| Owner / Lessee | Galloway, Ed & Pat | Simmons, Jim & Patty | Smith, Jim | Gunthers, Gordon |
| Legal Location | **04-26-054-22 W4M** | **NE 27-054-22 W4M** | **05-24-054-22 W4M** | **SE 27-054-22 W4M** |
| Ground Elevation | 629.7 m | 632.4 m | 649.9 m | 625.7 m |
| Well Type | New Well | New Well | New Well | Well Inventory |
| Water Status | Producing | Producing | Producing | Producing |
| Well Depth Drilled | 59.4 m | 61.9 m | 57.6 m | - |
| Top of Aquifer | - | - | - | - |
| Total Available Head | - | - | 38.0 m | - |
| Max. Pumping Rate | 22.7 Lpm | 13.6 Lpm | 9.1 Lpm | - |
| Completion Details | 49.1 - 55.2 m | 24.4 - 61.0 m | 53.3 - 57.6 m | |
| Distance | 2,291 m | 2,294 m | 2,375 m | 2,781 m |
| Earliest Water Level | March 24, 1969 | April 11, 1967 | June 01, 1973 | - |
| | 9.8 m | 7.6 m | 21.9 m | - |
| Latest Water Level | 1969-03-24 | 1967-04-11 | 1998-07-01 | - |
| | 9.8 m | 7.6 m | 15.3 m | - |
| Daily Use | - | - | - | - |
| Number of Chemistries | 1 | 1 | 1 | - |
| (latest analysis) | May 09, 1972 | September 24, 1970 | July 04, 1998 | |
| Comments | Original owner: Klautt, A.R. [ Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), water well is located in older garage next to house. Working head mounted on wellhead. No access to fluid level.] | Original Owner: Simmons, Hector. [Hydrogeological Consultants Ltd. (HCL) field survey (June 2010), water well is located in water well pit 70 metres west of house. Water we;; supplies house and stock.] | Seal type listed as 'Driven' but no interval defined. | [Hydrogeological Consultants Ltd. (HCL) field survey (July 2010), two rental property on-site spoke with Bard (renter), Barb reported that there is a water well in a pit in the old barn that supplies house and trailer. Left letter with renter and also a letter at shop.] |
| AENV Well ID(s) | 0260219; 0260221; 260219 | 0260227; 260227 | 0260210; 260210 | |
| Licensed/Registered Diversion | - | - | - | - |

| Consultant Details | | | | |
|---|---|---|---|---|
| TGWC ID | M35377.231649 | M35377.231657 | M35377.231640 | M40389.587316 |
| Date Verified | June 07, 2010 | June 01, 2010 | July 01, 1998 | June 01, 2010 |
| Verification Status | (01) Confirmed - Physically | (02) Confirmed - Owner Confirmation | (02) Confirmed - Owner Confirmation | (02) Confirmed - Owner Confirmation |
| Well Name | 1969 Galloway House Water Well | 1967 Simmons Water Well | Smith Domestic Water Well | Gunthers Water Well |

# Appendix H

Alberta Conservation Information Management System (ACIMS) &
Fish and Wildlife Internet Mapping Tool (FWIMT) Reports

**Date**: 25/8/2022
**Requestor**: Consultant
**Reason for Request**: Environmental Reporting
**SEC:** 36 **TWP:** 054 **RGE:** 22 **MER:** 4

Alberta Parks

## Non-sensitive EOs (updated: October 2017)

| M_RR_TTT_SS | EO_ID | ECODE | S_RANK | SNAME | SCOMNAME | LAST_OBS_D |
|---|---|---|---|---|---|---|

**No Non-sensitive EOs Found: Next Steps - See FAQ (https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/faqs.aspx#2 - Process)**

## Sensitive EOs (updated: October 2017)

| M-RR-TTT | EO_ID | ECODE | S_RANK | SNAME | SCOMNAME | LAST_OBS_D |
|---|---|---|---|---|---|---|

**No Sensitive EOs Found: Next Steps - See FAQ (https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/faqs.aspx#2 - Process)**

Updated: Feb 17, 2022

**Date**: 25/8/2022
**Requestor**: Consultant
**Reason for Request**: Environmental Reporting
**SEC:** 25 **TWP:** 054 **RGE:** 22 **MER:** 4

## Non-sensitive EOs (updated: October 2017)

| M_RR_TTT_SS | EO_ID | ECODE | S_RANK | SNAME | SCOMNAME | LAST_OBS_D |
|---|---|---|---|---|---|---|

**No Non-sensitive EOs Found: Next Steps - See FAQ (https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/faqs.aspx#2 - Process)**

## Sensitive EOs (updated: October 2017)

| M-RR-TTT | EO_ID | ECODE | S_RANK | SNAME | SCOMNAME | LAST_OBS_D |
|---|---|---|---|---|---|---|

**No Sensitive EOs Found: Next Steps - See FAQ (https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/faqs.aspx#2 - Process)**

Updated: Feb 17, 2022

# Fish and Wildlife Internet Mapping Tool (FWIMT)

(source database: Fish and Wildlife Management Information System (FWMIS))

## Species Summary Report

**Report Date:** 25-Aug-2022 09:49

### Species present within the current extent

| Fish Inventory | Wildlife Inventory | Stocked Inventory |
|---|---|---|
| No Species Found in Search Extent | AMERICAN KESTREL<br>BLACK TERN | No Species Found in Search Extent |

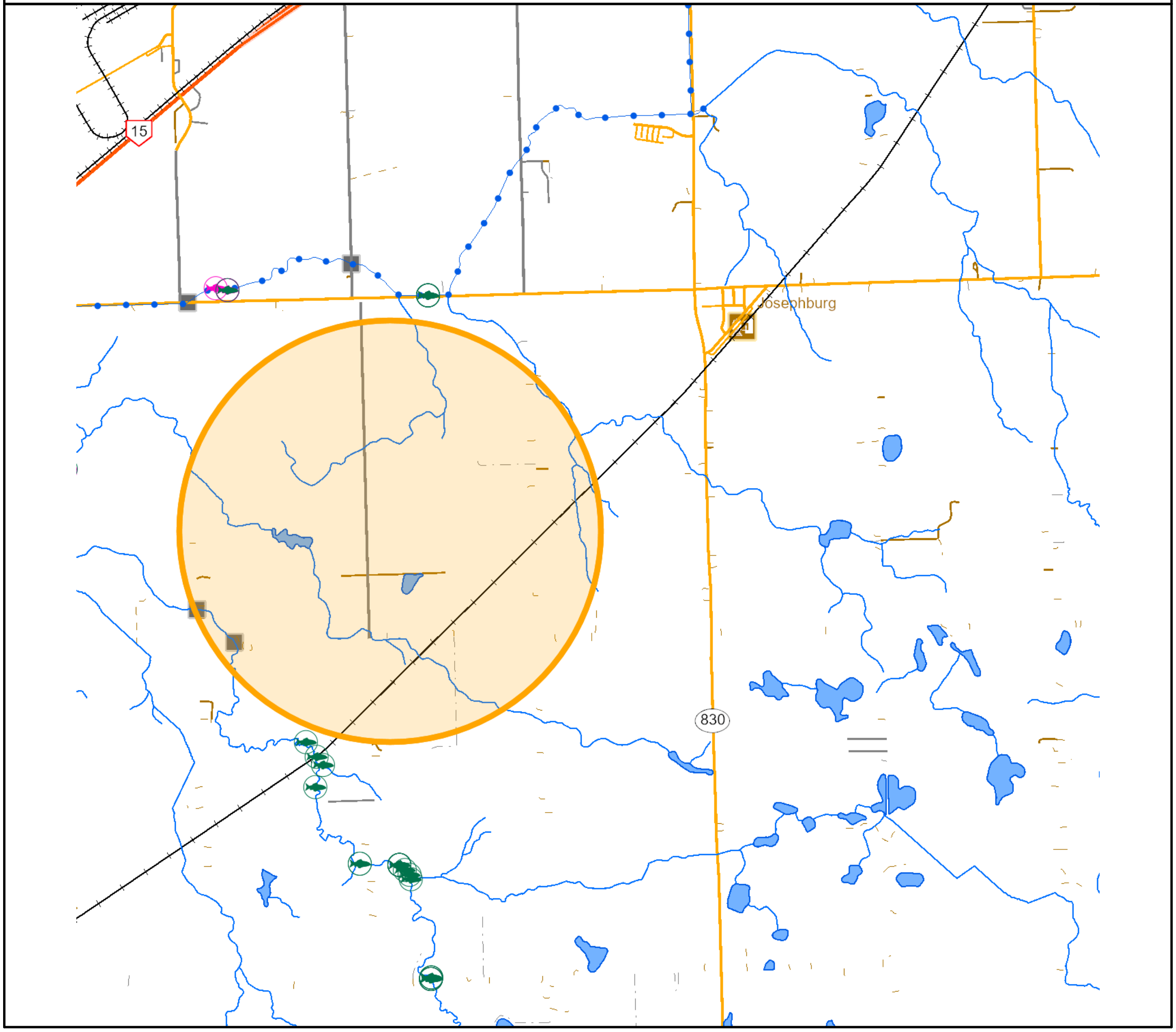
### Buffer Extent

| Centroid (X,Y) | Projection | Centroid (Qtr Sec Twp Rng Mer) | Radius or Dimensions |
|---|---|---|---|
| 624090, 5948948 | 10-TM AEP Forest | NW 25 54 22 4 | 2 kilometers |

### Contact Information

For contact information, please visit:
https://www.alberta.ca/fisheries-and-wildlife-management-contacts.aspx

25-Aug-2022 09:49 **Map Results**




Display may contain: Base Map Data provided by the Government of Alberta under the Alberta Open Government Licence. Cadastral and Dispositions Data provided by Alberta Data Partnerships. (c)GeoEye, all rights reserved. Information as depicted is subject to change, therefore the Government of Alberta assumes no responsibility for discrepancies at time of use

# Appendix I

Spencer Environmental Management Services Ltd. Biophysical & Wetland Assessment

# Biophysical & Wetland Assessment in Support of Proposed Gravel Extraction near Josephburg, Strathcona County

**Final Report**

*Prepared for:*

**Sameng Inc.**
Edmonton, Alberta

*Prepared by:*

**Spencer Environmental Management Services Ltd.**
Edmonton, Alberta

Project Number EP 461

January 2011

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

Suite 801, Capital Place
9707-110 Street, Edmonton, Alberta, T5K 2L9
Phone (780) 429-2108  Fax (780) 429-2127

David Yue, P.Eng.
Principal
Sameng Inc.
1500 Baker Centre
10025 - 106 Street
Edmonton, Alberta
T5J 1G3

13 January 2011
Our file: EP 461

Dear Mr. Yue,

**Re: Biophysical & Wetland Assessment in Support of Proposed Gravel Extraction near Josephburg, Strathcona County - Final Report**

Please accept this PDF copy of our final report for the above-mentioned project. This report acknowledges all of the comments received from your office and as communicated to you in previous email correspondence. It is our understanding that, at this time, you do not require any hard copies of this report. Please let us know if this requirement changes and we can have hard copies prepared for you.

We trust that this report will satisfy your needs at this time and we look forward to our continued involvement with this project.

Sincerely,

**Spencer Environmental Management Services Ltd.**

ALBERTA SOCIETY of Professional Biologists
Andrew S.M. Forrest
1271
PROFESSIONAL BIOLOGIST

Andrew Forrest, M.Sc., P.Biol.
Environmental Scientist

ALBERTA SOCIETY of Professional Biologists
Lynn A. Maslen
545
PROFESSIONAL BIOLOGIST

Lynn Maslen, M.Sc., P.Biol.
Vice-President, Science Practice

## Table of Contents

## List of Figures



## List of Tables

## List of Plates

# 1.0 INTRODUCTION

## 1.1 Background

Reperio Resources Corp. (Reperio) proposes to develop a gravel extraction operation on approximately 5 ½ quarter sections of land situated in the north half of Strathcona County, east of the City of Fort Saskatchewan (Figure 1.1). The proposed operation would include gravel extraction, processing, washing and pit dewatering. Reperio retained Sameng Inc. (Sameng) as the primary engineering consultant to develop facility and operation plans and to facilitate the acquisition of the all necessary gravel extraction related approvals. Sameng, in turn, retained Spencer Environmental Management Services Ltd. (Spencer Environmental) to prepare a biophysical and wetland assessment report in compliance with municipal and provincial environmental legislation and permitting requirements.

This document was prepared as an information document that would simultaneously meet the requirements of Strathcona County's Wetland Conservation and Biophysical Assessment policies (SER-009-036 and SER-009-032, respectively) and the information requirements of Alberta Environment in support of applications for wetland removal pursuant to Alberta's *Water Act* and related Interim Wetland Policy (1993).

## 1.2 MDP Compliance

According to the current Municipal Development Plan, Bylaw 1-2007, the proposed project is located in the Agricultural Large Holdings Policy Area of Strathcona County. Although the proposed gravel extraction project could be seen to be counter to the County's agricultural objective to minimize non-agricultural development within areas where the focus is on promoting agricultural development, the proposed gravel extraction would be temporary (approximate project lifespan of 22 years) and includes plans to ultimately return the land to agriculture. In addition, the planning of the proposed project considered the environmental management principles set out in the MDP, including having regard for conservation of significant features.

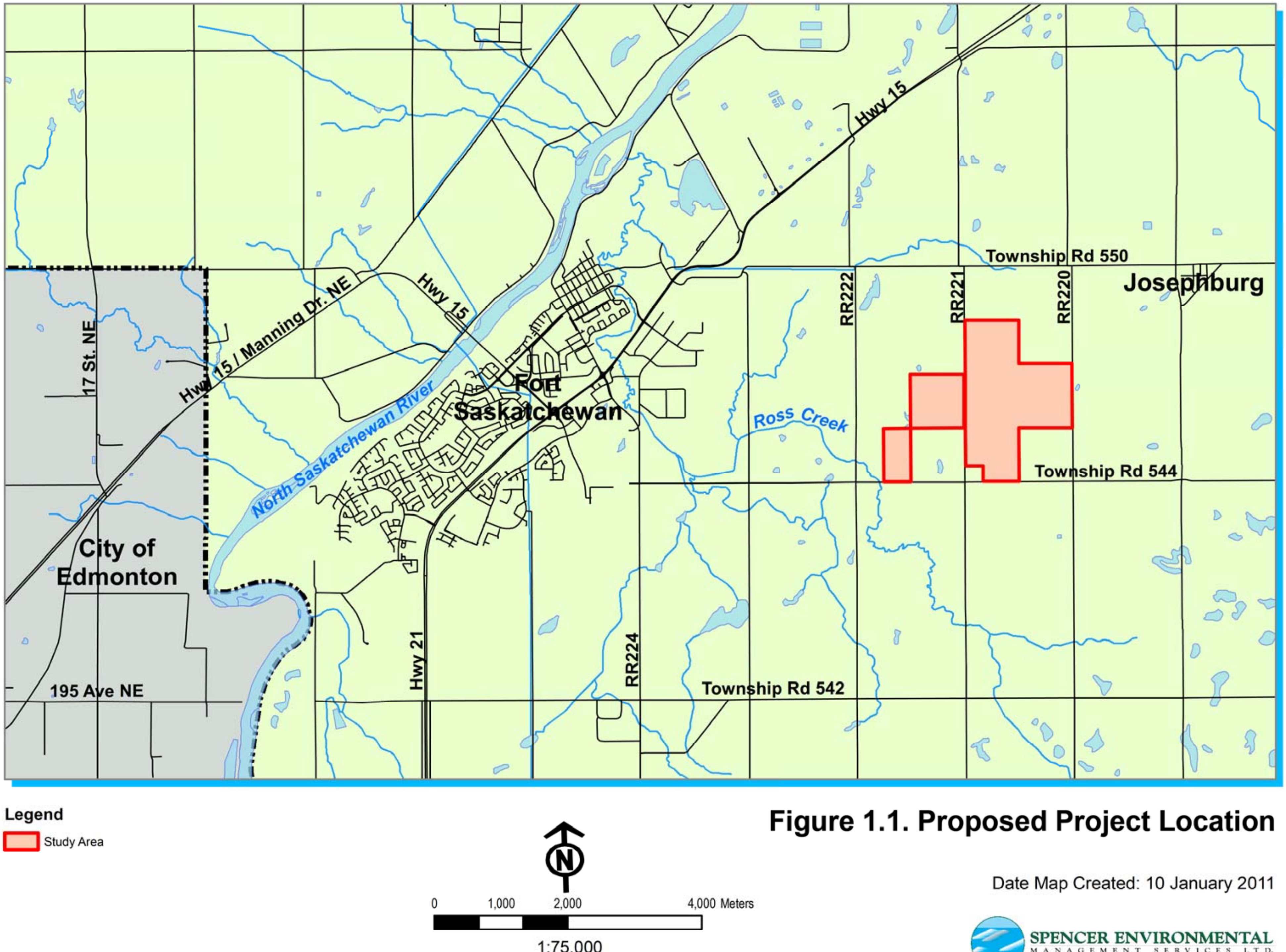



**Figure 1.1. Proposed Project Location**

Date Map Created: 10 January 2011

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

## 1.3 Project Description

### 1.3.1 Project Location

The proposed project is situated in Strathcona County, east of Fort Saskatchewan and approximately 2 km southwest of the hamlet of Josephburg (Figure 1.1). Reperio has already purchased and/or leased lands to be mined for gravel. Specifically, those lands are:

- Owned:

  NE 25-54-22-W4M
  NW 25-54-22-W4M
  NE 26-54-22-W4M
  SE 36-54-22-W4M (Lot D, 40 ac)

- Leased:

  SW 25-54-22-W4M
  SW 36-54-22-W4M
  E ½ of SW 26-54-22-W4M

### 1.3.2 Project Activities

Considering the relatively large project area, development will occur in two phases. Phase 1 will involve the three central quarter sections of land (SW 25-54-22-W4M, NW 25-54-22-W4M and SW 36-54-22-W4M). Both phases will last approximately 10 years (the actual mining period will be largely influenced by market demand) to coincide with Strathcona County's maximum development permit duration of 10 years.

The proposed development will consist of the following main activities: gravel extraction, processing, washing and pit dewatering. Operations will typically be structured such that active mining will typically involve only a relatively small area at any given time. The whole gravel extraction operation will, however, result in the disturbance of the vast majority of the lands within the boundaries of the site (excluding a 30m undisturbed buffer adjacent to all non-decommisioned pipeline rights-of-ways within the mining area and a 3m buffer adjacent to all property boundaries).

All mined lands will be reclaimed to an agricultural end land use or end pit lake (EPL). Gravel mining by necessity creates a deficit of underlying materials, requiring the creation of EPLs, in this case one EPL in each quarter section. Additional end pit lake design detail is provided as part of the wetland compensation plan in Section 5.2.

For additional details regarding project activities and the gravel extraction process, please refer to the project report prepared by Sameng Inc..

### 1.4 Scope of Assessment

This document complies with the scope of the biophysical assessments established by Strathcona County Policy SER-009-032, (2005, updated in 2010) and will be used as a resource for development planning and permitting. Accordingly, the objectives of this assessment were to:

- describe and assess the quality of vegetation and wildlife habitat areas;
- qualitatively assess wildlife corridors and ecological connectivity between subject property and adjacent lands;
- document water bodies and surface drainage within the study area;
- classify and delineate wetlands on the subject property and identify their functions and values;
- determine if any special status species are present or likely to be present on the study area;
- identify natural features with the highest conservation merit; and
- develop conservation recommendations for consideration during planning and reclamation.

### 1.5 Study Limitations

Most of the field studies associated with this project were conducted at the optimal time of year for each specific survey type. The only exception to this was for SW 25-54-22-W4M; Spencer Environmental did not receive permission to access this property until the middle of July 2010. This affected the types of wildlife surveys on the property. We chose to not survey for calling amphibians because those surveys are typically conducted in April or May and all calling activity would have ceased by mid-July. We did choose, however, to conduct a breeding bird survey (BBS) within the property to obtain any data available even though BBSs are optimally completed from late-May through to mid- to late-June. Birdsong (and associated detection through surveying) tends to decrease abruptly by mid-July. Bird data collected for this parcel should be considered accordingly.

# 2.0 SETTING

## 2.1 Study Area

The study area used for investigations completed in support of this report is shown on Figure 2.1. In general, the study area is bordered to the east by Range Road 220, to the south by Township Road 544 and by agricultural fields to the north and west. Range Road 221 runs through the study area and a railway line enters the SE corners of NE 25-54-22-W4M and SW 25-54-22-W4M (Figure 2.1).

Lands within the study area are almost entirely cultivated. The only exceptions are several wetlands and a few areas of upland habitat scattered throughout the area, most of which occur in association with an adjacent wetland. Further, shelterbelts parallel some of the fencelines (i.e., quarter section lines) within the study area.

As shown of Figure 2.1, the whole of the study area will not be subject to mining. Areas that are to be excluded from mining include a 30m undisturbed buffer adjacent to all non-decommisioned pipeline rights-of-ways and residences, and a 3m buffer adjacent to all other property boundaries.

## 2.2 Climate

The study area's proximity to Fort Saskatchewan makes use of that city's weather station ideal. The average annual temperature (calculated from 1959 to 2006) is 2.8°C with an average annual precipitation of 465.2 mm. In the past 11 years, precipitation levels have exceeded the long term average in only three years. Over the past 3 years (since 2007) areas of Central Alberta has experienced some of the lowest precipitation levels of the past 50 years (a climate graph is available in Appendix A). The consistent low levels of precipitation associated with this drought have resulted in greatly reduced water levels in area wetlands.

## 2.3 Physiographic Description

The study area lies within the Central Parkland Subregion of the Parkland Natural Region (Natural Regions Subcommittee 2006). This transitional Subregion covers a broad area situated between Grasslands Natural Region to the south and the Boreal Forest Natural region to the north. Surficial deposits range from hummocky moraines to glaciolacustrine deposits and outwash. Elevations vary from 500 m at the Saskatchewan border to 1100 m in the western portion of the region. Numerous streams that are part of the Saskatchewan River system cut across the Subregion. Lakes and wetlands, many of which are slight to strongly saline, are scattered throughout the Subregion.


**Figure 2.1. Project Study Area**

Air Photo Date: October 2008
Date Map Created: 10 January 2011

## 2.4 Previous Studies

The Strathcona County Municipal Development Plan (MDP), Bylaw 1-2007 depicts the majority of the study area as comprising a High Priority Environmental Management Area (PEMA). Much of the rest of the study area consists of Medium PEMAs. The MDP acknowledges that the PEMA mapping represents a “broad and conceptual illustration” of environmental priorities “and is not intended to provide site specific direction to land use regulation.” The investigations included as part of this assessment provided much more comprehensive and site-specific information.

According to the *Significant Natural Features and Landscapes of Strathcona County* (Westworth 1987) no provincially, regionally or locally significant features are located within the study area. The *Prioritized Landscape Ecology Assessment of Strathcona County* (GEOWEST 1997) identified a total of 8 wildlife habitat units within the study area. Six of the eight units were wetlands and the remaining two habitat units were uplands. The six wetland units were further categorized to include 2 swamps, 2 marshes and 2 sloughs. The upland units were both categorized as upland poplar.

# 3.0 METHODS

## 3.1 General Approach

Our general approach to this assessment involved the following:

- Review of historical aerial photographs to evaluate the permanency and origin of the wetlands and the influences of past land uses on the wetlands.

- Literature and database reviews.

- A site reconnaissance visit on 18 May 2010 to locate wetlands and to assess the extent of fieldwork that would be required.

- Amphibian call surveys conducted on 19 May 2010 at select wetlands located throughout the study area, except for SW-25-54-22 W4M, which, at the time of the survey, we did not have permission to access.

- Breeding bird surveys conducted on 8 June 2010 at select wetlands located throughout the study area, except for SW-25-54-22 W4M which, at the time of the survey, we did not have permission to access. Once access to the land was granted, a bird survey was completed at one wetland within that quarter section on 9 July 2010.

- A plant community typing, wetland classification and rare-plant survey conducted between 11 July and 21 July 2010 at all wetlands within the study area.

- Meetings with the prime engineering consultant for Reperio, Sameng, to discuss project details and develop a wetland compensation approach.

- Meetings with Alberta Environment and Strathcona County to discuss wetland compensation and to ensure that the project complies with both provincial and municipal wetland legislation.

- Review of project specific reports pertaining to other biophysical aspects of the study area (i.e., groundwater).

## 3.2 Methods for Detailed Investigations

### 3.2.1 Literature and Database Review

The following information sources were reviewed for data pertinent to the study area:

- A Survey of Wetland Wildlife Resources, Strathcona County #20, Alberta (Griffiths 1987).

- Significant Natural Features and Landscapes of Strathcona County (D. A. Westworth and Associates 1987).

- Prioritized Landscape Ecology Assessment of Strathcona County, Alberta (Geowest Environmental Consultants Ltd. 1997)

- Assessment of Environmental Sensitivity and Sustainability in Support of the Strathcona County MDP Review (Spencer Environmental Management Services Ltd. 2005).

- Beaver Hills Initiative Land Management Framework: Phase 2 Final Report (Spencer Environmental Management Services 2007).

- Fish and Wildlife Management Information System (FWMIS) database for listed wildlife species records for the study area and immediately and surrounding sections. The search was conducted on 28 June 2010.

- Alberta Conservation Information Management System (ACIMS) database for rare plant species or unusual plant community records for the study area The search was conducted on 07 July, 2010.

- A search of the Agricultural Region of Alberta Soil Inventory Database (AGRASID) for all relevant data on soil types within the study area.

- Environment Canada's National Climate Data and Information Archive for historical precipitation and temperature data.

### *3.2.2 Historical Aerial Photograph Analysis*

The purpose of the historical aerial photograph analysis was to describe the temporal changes in land use on the study area, investigate the historical extent of wetlands and to assess the level of disturbance experienced by subject wetlands in the past. To that end, twelve historical aerial photographs were examined spanning the years 1949 to 2008 (Table 3.1; Appendix B). To the degree possible, photographs representing years/periods of low and high wetland water levels were selected based largely on total annual precipitation data from Environment Canada precipitation records from 1959 to 2009 (Appendix A); however, the availability of suitable quality aerial photography also influenced the years selected for assessment. Precipitation records were also examined for the year prior to aerial photographic records to accommodate for the influence of winter precipitation on the nature of wetlands the following spring. As no weather station exists in Strathcona Country; data from Environment Canada's Fort Saskatchewan weather station have been used.

**Table 3-1. Historical aerial photographs of the study area that were examined (1949-2008)**

| Year | Month | Scale | Annual Precipitation (mm) | |
|---|---|---|---|---|
| | | | Previous Year | Year of Photo |
| 1949 | N/A | 1:40,000 | N/A | N/A |
| 1962 | May | 1:31,680 | 425.5* | N/A |
| 1970 | August | 1:80,000 | 371.3* | 375.7* |
| 1974 | September | 1:24,000 | 516.0 | 479.6 |
| 1978 | May | 1:25,000 | 442.8* | 557.2 |
| 1982 | August | 1:30,000 | N/A | N/A |
| 1987 | July | 1:30,000 | N/A | 352.8* |
| 1992 | July | 1:20,000 | 569.9 | 408.5* |
| 1993 | May | 1:20,000 | 408.5* | 451.8* |
| 1996 | September | 1:40,000 | 465.7 | 697.9 |
| 2001 | May | 1:20,000 | 478.5 | N/A |
| 2006 | August | 1:40,000 | 336.6* | 465.2 |
| 2008 | October | 1:20,000 | N/A | N/A |

* indicates that the precipitation level is below the long term (1959-2006) average of 465.2 mm; precipitation data are from Environment Canada's weather station in Fort Saskatchewan.

### *3.2.3 Field Investigations*

#### *3.2.3.1 Initial Feature Identification*

The first step in natural feature identification prior to the initiation of detailed fieldwork was the review of recent (2008), high resolution digital aerial photography of the study area. Based on that review, areas considered to have potential to support native upland or wetland vegetation were targeted for a brief reconnaissance inspection on 18 May 2010. The objectives of that reconnaissance were to confirm the results of the initial aerial photography review and identify which features remain on the landscape and require field surveys.

#### *3.2.3.2 Vegetation and Rare Plant Survey*

Between 11 July and 21 July 2010 plant community and rare plant surveys were completed for the subject lands. All areas supporting native vegetation were investigated to characterize the plant communities and to complete an inventory of vascular plant species.

The main objectives of the vegetation surveys were to: delineate and identify plant communities; classify wetlands; locate rare plants (defined as species ranked as S1 or S2 by ANHIC) and/or unusual plant communities. For each plant community, all vascular plant species observed were recorded, and each species was ranked as dominant, frequent, occasional or rare (uncommon) within the site. Qualitative notes were taken regarding relief, depth of standing water and weed abundance. Plant communities were distinguished based on species composition, assigned an identifier number (Site #) in the field, and, as best as possible, mapped in the field on a recent aerial photograph at a scale of approximately 1:4500. Representative sites were photographed.

Whenever a plant species could not be identified in the field, a specimen was collected. Those specimens were later examined using a dissecting scope and various floras to determine their identity. When necessary, identification of unusual specimens was verified at the University of Alberta Herbarium. When all specimens had been identified, the site data were compiled in an Excel spreadsheet for further analysis.

#### *3.2.3.3 Wetland Delineation*

Wetlands were delineated using information collected during the plant community surveys and our aerial photograph analysis. Based on the boundaries of plant communities mapped in the field, wetland boundaries were established at the outer perimeter of all contiguous wetland plant communities. In all cases, wetland boundaries represented the point at which upland vegetation became dominant. Similarly, and as was the case with many of the subject wetlands, where cultivation extended to the edge of a wetland, creating an abrupt, un-natural edge to wetland, the wetland boundary was drawn at the point where cultivated species became dominant. Once established, wetlands boundaries were then digitized into a GIS using a recent (2008), high resolution digital aerial photograph as the base image and the field-mapped plant community boundaries as a guide.

#### *3.2.3.4 Wetland Classification*

We classified wetlands within the study area using a modified Stewart and Kantrud (1971) wetland classification system. The seven wetland classes under the Stewart and Kantrud system range from Class I (ephemeral ponds) to Class VII (fen ponds). In the previously glaciated prairie region where the Stewart and Kantrud (1971) wetland classification system is applicable, wetlands typically occur in isolated depressions on the landscape and often include multiple, concentric rings of different vegetation zones in response to the changing degrees of inundation and soil saturation levels associated with the transition towards drier, adjacent upland areas. Accordingly, the class of a wetland is distinguished by the vegetation zone occurring in the central or deepest part, and occupying at least 5% of the wetland area (Stewart and Kantrud 1971). Brief descriptions of Class I through Class V wetlands, which are the types most likely to occur within the study area, are included below (adapted from Stewart and Kantrud 1971; Class VI and VII wetlands are not commonly found in the general area of the study area). In our modified classification system, we also recognize a Class VIII wetland - shrub wetland. This wetland type is also described briefly below.

***Class I – Ephemeral Ponds***

Low prairie vegetation dominates the central, deepest area of Class I wetlands, and typically includes Kentucky bluegrass (*Poa pratensis*), slender wheatgrass (*Agropyron trachycaulum*) and buckbrush (*Symphoriocarpos occidentalis*). The soil is very porous, so the rate of bottom seepage is very rapid after spring thaw. As a result, surface water in Class I wetlands is typically maintained for only a brief period in the early spring before the bottom ice seal disappears (Stewart and Kantrud 1971). Because these wetlands dry up so rapidly in the spring, they are often tilled and cultivated when they occur in agricultural settings. Tilled low prairie sites usually persist as dried soil, and may become temporarily flooded following heavy precipitation.

#### *Class II – Temporary Ponds*

Wet meadow vegetation dominates the central, deepest areas of Class II wetlands. These wetlands typically hold surface water for a few weeks in the spring after snowmelt, and for several days after heavy rainstorms, but quickly dry up and lack surface water for the majority of the growing season. As a result, many wet meadow wetlands are tilled and cultivated when conditions allow. Wet meadow wetlands are typically dominated by low, fine-textured graminoid plant species (e.g., fowl bluegrass). The relatively dry condition of Class II wetlands facilitates the establishment of weedy species and, accordingly, they are often very weedy in character, particular when situated in agricultural settings. Common weedy species of wet meadow wetlands include common dandelion, alsike clover, smooth perennial sowthistle, creeping thistle and creeping wildrye.

#### *Class III – Seasonal Ponds and Lakes*

Class III wetlands normally hold surface water for an extended period in spring through to early summer, but tend to dry up in late summer or the fall (Stewart and Kantrud 1971) and the centre typically supports a shallow marsh community dominated by sedges (e.g., awned and bottle sedges), wetland grasses (e.g., tall mannagrass) and other grass-like plants (e.g., sloughgrass). In an agricultural setting, despite being wetter than Class II wetlands, Class III wetlands can also be very weedy, supporting a number of similar non-native species.

#### *Class IV – Semipermanent Ponds and Lakes*

Deep-marsh vegetation dominates the centre of Class IV wetlands, which retain surface water through the spring and summer and often into late fall or winter (Stewart and Kantrud 1971). The centre of these wetlands are typically dominated by tall and coarse emergent plant species; common dominant species include common cattail, bulrush and burreed. Other common, but less robust emergent species include common spikerush, awned sedge and tall mannagrass. The permanency of surface water in deep marshes is also often sufficient to support submerged or floating plants (e.g., common duckweed). In central Alberta, deep marsh zones are typically too wet (inundated for too long) to support many of the exotic plant species common to wetlands. Deep marsh wetlands can still, however, support weedy species in their outer, drier shallow marsh and wet meadow vegetation zones.

#### *Class V – Permanent Ponds and Lakes*

Class V wetlands are permanent open water sites (ponds and lakes) with fairly stable water levels. Water permanence and depth in the central, deepest part of Class V wetlands restricts the growth of emergent plant species. Instead, submerged and/or floating vegetation forms are the only common plant forms that typically establish within this zone. The central zone of Class V wetlands (as with other marsh wetlands) is often surrounded by concentric rings of different vegetation zones in response to the changing degrees of inundation and soil saturation levels associated with the transition towards drier, adjacent upland areas. Salinity in permanent open water wetlands ranges from slightly brackish to subsaline (Stewart and Kantrud 1971).

***Class VIII – Shrub Wetlands***

Shrub wetlands occur on saturated soils that often flood during the spring and after high rainfall events, but can dry out throughout the summer and in periods of drought. Shrub wetlands often form riparian areas adjacent to creeks, rivers, lakes and other wetland types and can occur in transition between uplands and meadow marshes. Unlike Class I through Class V wetlands, shrub wetlands include a consistent shrub layer across much of their area. Willow (*Salix sp.*) is, by far, the dominant shrub species in shrub wetlands in east-central Alberta. Among the many willow species, pussy willow, meadow willow and Bebb willow are often the most common. Even though the willow shrubs often form a dense canopy, shrub wetlands can support a diverse understorey of plant species more typical of shallow marsh or wet meadow sites. Common understorey species include field mint, arrowhead sweet-coltsfoot, awned sedge, bluejoint reedgrass and sloughgrass. Shrub wetlands are generally 'permanent' wetlands in the sense that, irrespective of climatic conditions, they are always clearly defined by the presence of a tall shrub layer.

#### *3.2.3.5 Functional Upland Zone (FUZ)*

To assist in assessing wetland function and in establishing appropriate environmental reserves and buffers, we also assessed the functional upland zone (FUZ) for each wetland; that is, the probable contribution of immediately adjacent uplands to wetland function. Upland areas surrounding wetlands are widely recognized as having a direct impact on the health, sustainability and functionality of wetlands (Westworth and Associates 1993; Connecticut River Joint Commissions 2000; Fischer and Fischenich 2000; Fischer *et al* 2000; North American Wetlands Conservation Council 2001; Environment Canada 2001; Alberta Environment 2003). Adjacent uplands can function as sediment filters, pollution filters, shoreline stabilizers, visual screens for wildlife (Connecticut River Joint Commissions 2000; Fischer and Fischenich 2000) and wildlife habitat. The contribution of adjacent uplands to wetland function is important when determining the boundaries of wetlands to be retained in development and when assessing wetland loss for *Water Act* approval.

All uplands do not contribute equally to wetland function, particularly when adjacent lands are modified by human use. The extent to which uplands contribute to wetlands is greatly influenced by land use and the resultant vegetation structure and composition. Accordingly, for this assessment, Spencer Environmental evaluated the probable contribution of the adjacent uplands to wetland function by considering land use, general land condition and the type of vegetation present on lands adjacent to each wetland. The width of upland examined was set as 30 m surrounding the delineated wetlands, as this is the distance generally indicated in scientific literature and in many government publications as the minimum upland width providing adequate protection for aquatic habitat, water quality control and some riparian edge habitat for wetland species.

Following evaluation of land use and vegetation within the 30 m setback, a Functional Upland Zone (FUZ) width was determined for each wetland as follows. Where the 30 m buffer supported native vegetation that was relatively undisturbed, the FUZ was set at a maximum setback of 30 m. In areas lacking native upland vegetation, but supporting herbaceous vegetation with good cover (e.g. hayfield), or where native pasture was actively grazed, the FUZ was reduced to a width of 10 m. On cultivated lands, the FUZ was restricted to a width of 5 m, reflecting a lesser capacity for those lands to contribute to wetland function. Specifically, cultivated lands offer less nesting or protective cover, have less organic litter, are more likely to be disturbed by farm machinery and tend to support a higher abundance of weedy species. Further, the lesser amount of ground cover, and resulting increase in proportion of exposed soil, provides less erosion control and water quality protection.

#### *3.2.3.6 Amphibian (Frog/Toad) Survey*

A breeding frog/toad call survey was conducted during the night of 19 May 2010 at wetlands within NE 26, SW 26 and SW 36-54-22-W4M (Figure 3.1). Following standard Alberta Volunteer Amphibian Monitoring Program protocol (Alberta Conservation Association 2006), the surveys were conducted from 30 minutes after sunset until approximately 12:00 midnight during suitable weather conditions (wind no higher than three on the Beaufort wind scale, light or no rain, and temperatures at a minimum of 5ºC). The surveyors waited for 2 minutes after arrival at the survey station to allow for any amphibians to settle. That 2-minute waiting period was followed by 5 minutes of listening. The surveyor took note of the species heard, their location (i.e., what wetland site) and estimated the number of individuals present using the following call level codes:

1. Frog(s) or toad(s) can be counted; no overlapping calls (i.e., one to three animals)
2. Individual frogs and toads can be counted; some calls overlapping (i.e., four to seven animals)
3. Individuals cannot be counted, full chorus; calls overlapping (i.e., eight or more animals)

Amphibian species that do not vocalize, such as salamanders, are not detected by this type of survey.

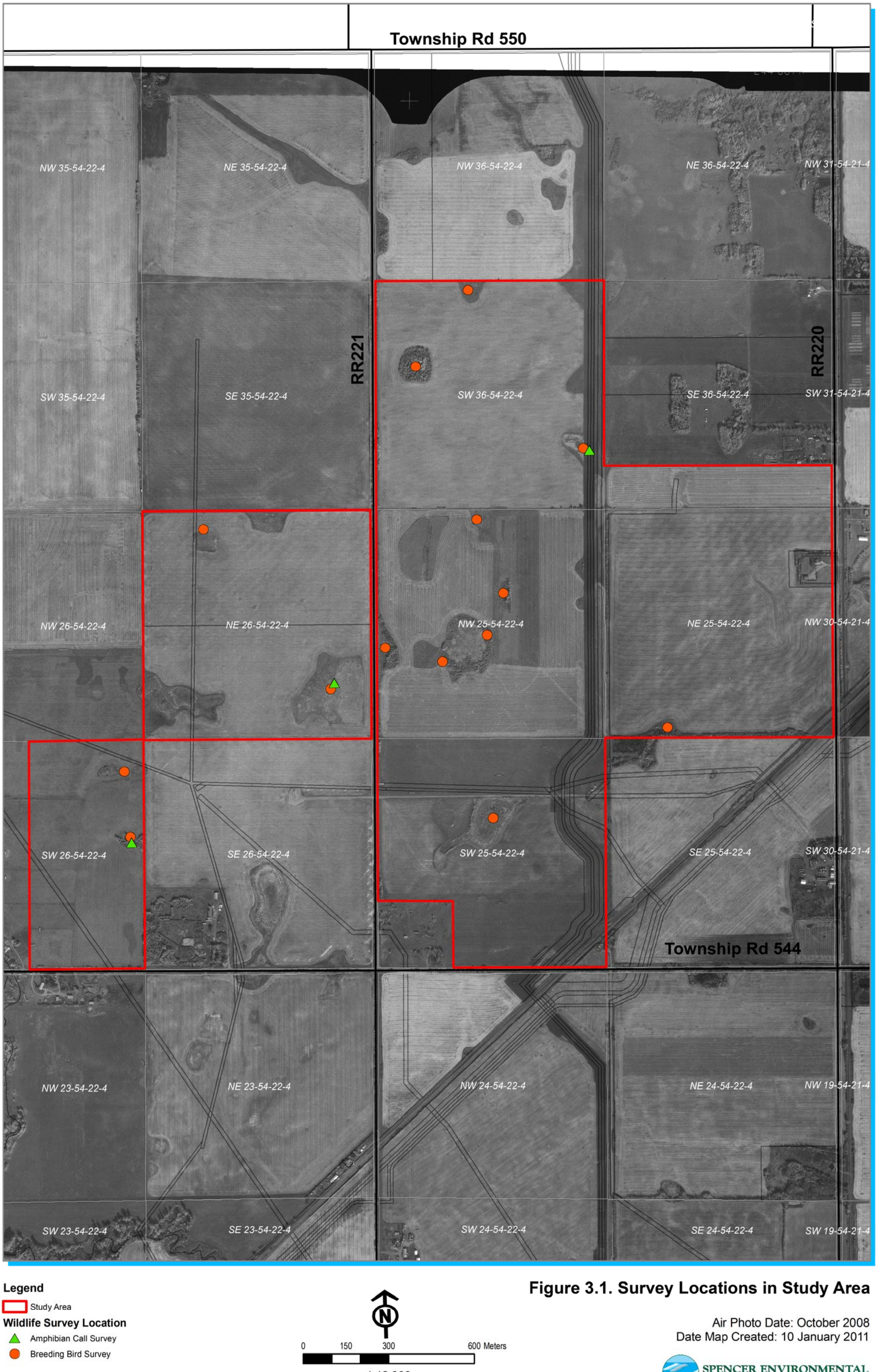



**Figure 3.1. Survey Locations in Study Area**

Air Photo Date: October 2008
Date Map Created: 10 January 2011

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### 3.2.4 Breeding Bird Survey

To characterize breeding bird abundance and species richness at the subject wetlands, breeding bird surveys were conducted on 8 June 2010. A total of 14 stations (Figure 3.1) were surveyed at wetlands throughout the subject property. Although no surveys were specifically conducted in upland habitats, several of the wetland survey locations were positioned to also encompass immediately adjacent areas of upland habitat. Upon arriving at each point count station, the surveyors waited one minute to allow the birds to settle. Following that, an 8-minute, 100m fixed-radius point count survey was completed in which all birds seen and heard were recorded. Birds recorded within the 100m, but outside of targeted sites (e.g., in an agricultural field surrounding a targeted wetland) were noted as such for consideration during analysis.)

### 3.2.5 Clubroot Fungus Control Protocol

With the understanding that the study area is vulnerable to infestation by clubroot fungus, we undertook precautionary measures during all project related fieldwork intended to minimize the risk of clubroot fungus transfer. Specifically, between each field, surveyors removed loose dirt from their boots and then disinfected their boots using a weak, diluted active ingredient bleach solution. This method closely follows best management practices outlined in the Alberta Clubroot Management Plan (Alberta Clubroot Management Committee 2010).

# 4.0 EXISTING CONDITIONS

## *4.1 Topography and Geology*

The dominant landform in the Central Parkland Subregion is undulating glacial till plains, with approximately 30% as hummocky, rolling and undulating uplands. The western portion of this subregion – where the study area is located – contains tertiary sandstone and mudstones. Surficial materials are dominantly medium to moderately textured, moderately calcareous glacial till (Natural Regions Committee 2006). The ground surface within the study area is generally flat-lying at an elevation of between 630m to 643m above mean sea level (Hydrogeological Consultants Ltd. 2010), with a slight drop in elevation from the southeast towards the northwest of between 5m and 10m.

The bedrock geology in the study area is primarily the Belly River Group, with the Bearpaw Formation occuring on the southeast side of the project area. The Belly River Group is made up of grey to greenish grey, thick bedded, feldspathic sandstone, grey clayey siltstone, grey and green mudstone and concretionary ironstone beds. The Bearpaw Formation is made up of dark grey blocky shale and silt shale, greenish glauconitic and grey clayey sandstone, thin concretionary ironstone and bentonitic beds. The formations are upper cretaceous in age and are non-marine to marine, respectively.

## *4.2 Soils*

#### *4.2.1.1 Regional*

Within the Central Parkland Subregion, Black and Dark Brown Chernozems are typically found under grassland vegetation, while Dark Grey Chernozems and Luvisols are typically found in moister aspen woodlands. Humic and Orthic Gleysols are the most common soil types associated with wetlands in the Central Parkland Subregion (Natural Regions Committee 2006).

#### *4.2.1.2 Study Area*

***Canadian System of Soil Classification***

According to the Agricultural Regional of Alberta Soil Inventory Database (AGRASID), the soils within the study area consist of the following:

- For the north and central areas (SW 36, part of SE 36, NW 25 and part of NE 26-54-22-4), soils are Gleyed Black Chernozems on fine textured clays and silty-clay, water-laid sediments.

- For the central and west areas (SW 26, parts of NE 26, SW 25, NE 25 and SE 36-54-22-W4M), soils are Eluviated Black Chernozems on fine textured clay and silty-clay, water-laid sediments.

- For the southeast areas (part of SW 25 and NE 25-54-22-W4M), soils are Eluviated Black Chernozems on medium textured loam-clay and till.

- For the east area (part of NE 25-54-22-W4M), soils are Orthic Dark Gray Chernozems on very fine textured materials over medium textured loam and clay.

***Canada Land Inventory (C.L.I.) Soil Rating System***

The soils located within the study area comprise three CLI land capability classes (Figure 4.1). They are as follows:

- Class 1 for part of NE 25 and SW 25-54-22-W4M.
- Class 2 for the SW 26 and parts of the NW 25 and SW 36-54-22-W4M.
- Class 4 for parts of NE 26, NW 25 and SW 36-54-22-W4M.

Class 1 soils “have no significant limitations in use for crops”, Class 2 soils “have moderate limitations that restrict the range of crops or require moderate conservation practices” and Class 4 soils “have severe limitations that restrict the range of crops or require special conservation practices” (Canada Land Inventory 2008). Topsoil throughout the study area averages approximately 32cm in depth.

Strathcona County’s Municipal Development Plan (Bylaw 1-2007) includes an agricultural objective to “protect, wherever possible, agricultural land which has a CLI soil class ranking of 1 or 2.” This underlies the importance of proper soil stockpiling and careful reclamation of the mining area to ensure that these agricultural values are not degraded in the post-mining landscape.

## *4.3 Hydrology*

### *4.3.1 Surface Water*

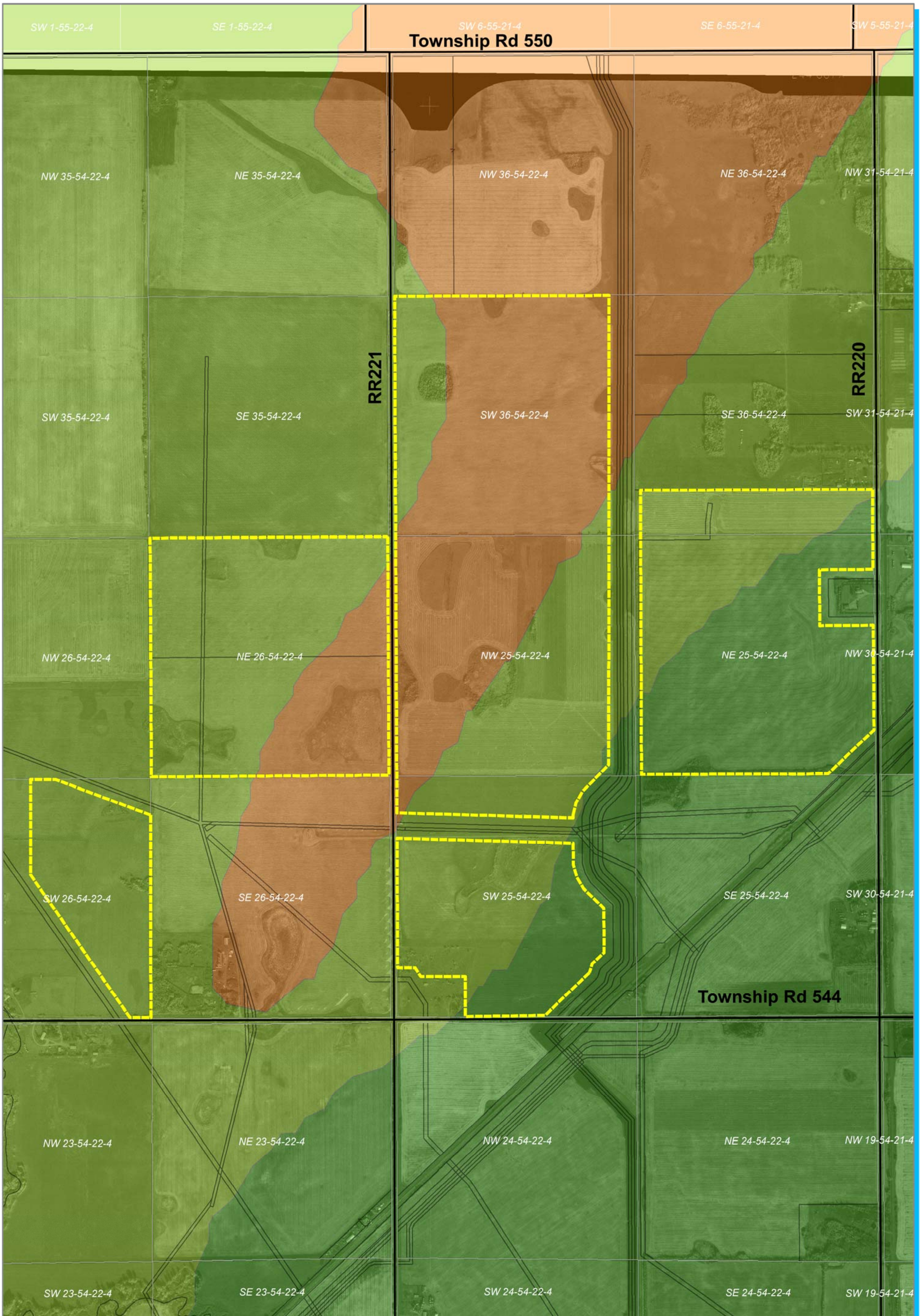
There are no permanent watercourses within the study area. The only water bodies present are several wetlands that range from ephemeral through to semi-permanent. Depending on climatic conditions and annual precipitation totals, these wetlands may contain surface water for as little as a couple of weeks following spring snowmelt, or may hold surface water into the fall and even through to winter freeze up. The wetlands receive their water either from surface water flow within individual, local catchments and/or groundwater sources (see Section below). Wetlands are discussed in much greater detail in Section 4.4.2.1..

Surface water flow across the study area follows the general topography of the land, sloping gently from the southeast towards the northwest. Throughout most of the aerial photograph record for the study area there is no indication of defined surface flow paths. That suggests that surface flow likely consists primarily of sheetflow (i.e., flow that occurs overland in places where there are no defined channels; water spreads out over a large area at a uniform depth). Some hydrological mapping available from Alberta Sustainable Resource Development (2010) does, however, suggest that there are two shallow swales that may function as surface drainage pathways in NE 26 and SW 36-54-22-W4M. The mapping of these features suggest that they may provide for some connection between wetlands both in and out of the study area, but the aerial photography record suggests that the surface drainage function provided by these swales is intermittent and likely only present for a short period of time during very wet conditions (e.g., at the peak of spring snowmelt). In fact, the ability of the swales to function as drainage pathways may have been degraded by continual and long-term cultivation and the swales might, instead, simply act as localized low areas where surface water temporary pools during wet conditions.

### *4.3.2 Groundwater*

Groundwater investigations (Hydrogeological Consultants Ltd. 2010) completed for this project indicate that the groundwater depth throughout much of the study area varies between 2m and 6m below the surface, with groundwater levels being the deepest towards the southeast corner of the study area.

According to the Prairie Farm Rehabilitation Association (2006), the study area is primarily a regional groundwater recharge zone. In contrast to this, more recent groundwater mapping of the subject area using Landsat thermal imagery suggests that the subject area functions primarily as a groundwater discharge zone (Sass and Cree *unpublished data*; using methods outlined in Clark *et al.* 2009). Hydrological Consultants Ltd. (2010) suggests that areas where the groundwater is within 2m of the surface could represent areas of groundwater discharge. Several wetlands within the study area overlap with such areas (i.e., Sites 8, 9, 10, 12, 13, 16, 17, 21, 31 and 33; see Figure 4.2), meaning that those wetlands may function as areas of groundwater discharge.




**Legend**

Lands to be Mined

**CLI Land Capability Class**

1 - Soils have no significant limitations

2 - Soils have moderate limitations

4 - Soils have severe limitations

N

0 150 300 600 Meters

1:12,000

# Figure 4.1. CLI Land Capability Classes

Air Photo Date: October 2008

Date Map Created: 10 January 2011

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## 4.4 Vegetation

### 4.4.1 Regional Description

Within the Central Parkland Subregion, dominant native vegetation is represented by stands of trembling aspen and balsam poplar, interspersed with rough fescue grasslands (Natural Regions Committee 2006). Both trembling aspen and balsam poplar forests have a well-developed and diverse shrub layer, dominated by species such as common snowberry, Saskatoon serviceberry, chokecherry, prickly rose, red-osier dogwood and willow. Much of the native vegetation with this Subregion has been cleared for urban and agricultural development, but remnant native communities still exist (Natural Regions Committee 2006). Lakes and wetlands are scattered though the Subregion.

### 4.4.2 Study area

#### 4.4.2.1 Wetlands

Throughout the study area, a total of 21 wetland plant community sites covering an area of 19.88 ha were identified during the summer of 2010 (Table 4.1, Figure 4.2). Because of a few instances where unique wetland plant communities were located immediately adjacent to one another, the 21 communities encompassed 17 separate wetlands (Figure 4.3). This number of wetlands was significantly lower than had been expected based on our preliminary review of aerial photography. Many areas that appeared likely to support a wetland based on aerial photographs, were found to be dry, cultivated and lacking any evidence of wetland vegetation in the summer of 2010. Field investigations were only completed at wetlands present in 2010.

The majority of wetlands consisted of typical marsh wetland habitat following the Stewart and Kantrud (1971) wetland classification system, including 6 Class II wetlands (wet meadow centres), 8 Class III wetlands (shallow marsh centres) and 2 Class IV wetlands (deep marsh centres). One Class VIII (shrub wetland) is also present. All of the wetlands occur in isolated depressions on the landscape. While all of the wetlands will be fed by surface water from within their local catchment area, some of the wetlands which are located in areas with shallow groundwater (i.e., <2m below surface) may also represent areas of groundwater discharge.

Combined, the 17 wetlands supported 118 plant species. Of those, 88 (75%) species were native and 30 (25%) were non-native/exotic species, including 4 designated as noxious by Alberta's Weed Act (2010; Table 4-2). At a plant community level, however, non-native species contributed, on average, 35% to total species richness. Seven non-native species were present in more than half of all sites and 4 non-native species (creeping thistle, perennial sowthistle, smooth brome and quackgrass) were recorded as abundant or dominant in at least 25% of all sites (Table 4-2). The presence and abundance of non-native species is representative of the generally degraded nature of the wetlands on the study area. In many of the sites, cultivation extended right to the wetland edge and, in some cases, cultivation and/or tilling had extended through large portions of the wetland. Where wetlands were located in pasture instead of cultivated fields, livestock had significantly impacted the wetlands by way of grazing and trampling. In addition to these agricultural impacts, pipeline construction, proximity to roadways and recent low precipitation levels all likely contributed to the high proportion of non-native species observed at subject wetlands.

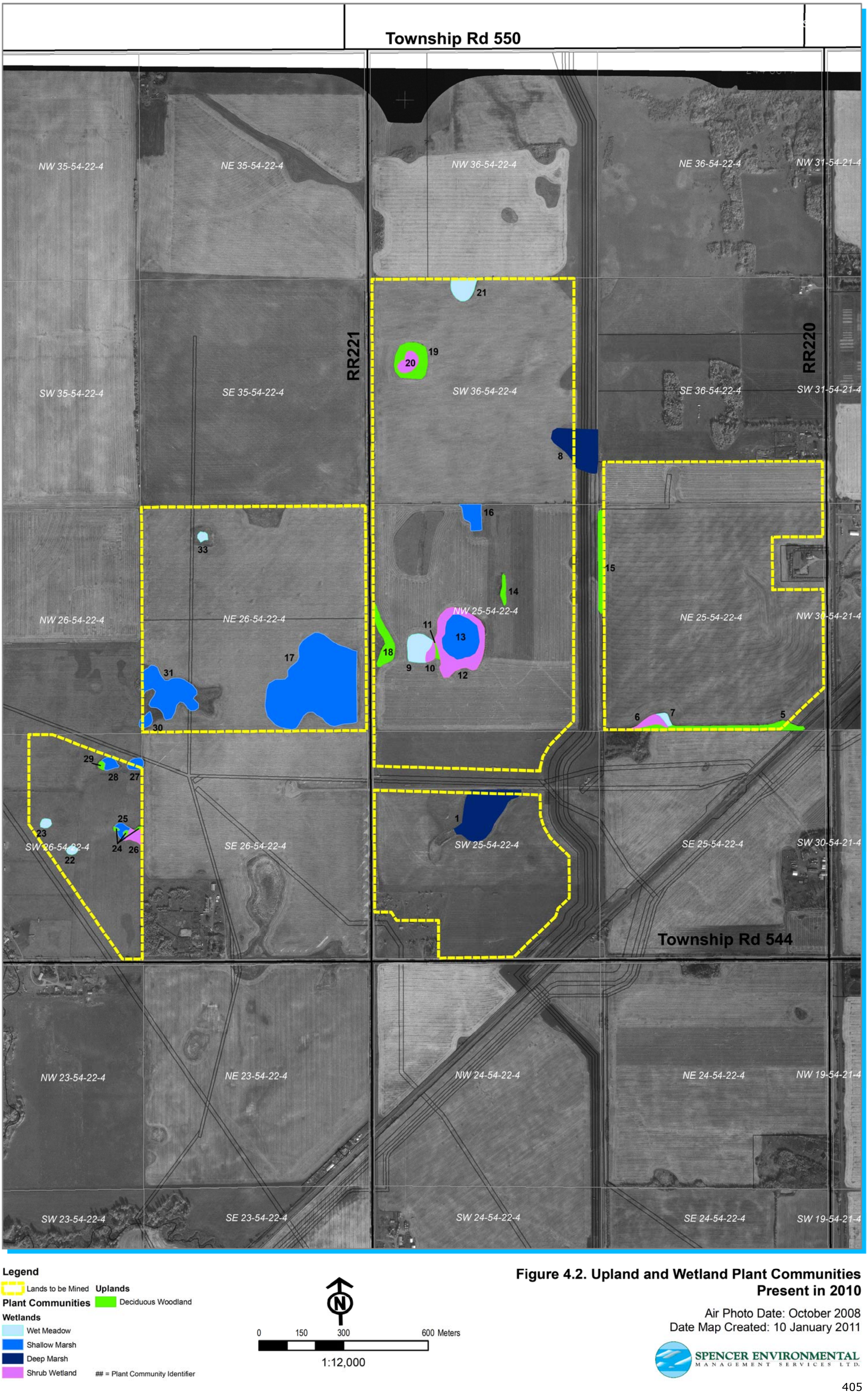


**Figure 4.2. Upland and Wetland Plant Communities Present in 2010**

Air Photo Date: October 2008
Date Map Created: 10 January 2011

**Table 4-1. Wetland plant communities located within lands to be mined**

| Wetland Plant Community Type | Site ID | Size (ha) | Total species richness | # of non-native species | % non-native species |
|---|---|---|---|---|---|
| **SW 25-54-22-W4M** | | | | | |
| Deep marsh | 1 | 2.17 | 44 | 11 | 25 |
| *¼ Sec. Subtotal* | | *2.17* | -- | -- | -- |
| **SW 26-54-22-W4M** | | | | | |
| Wet meadow | 22 | 0.10 | 9 | 6 | 67 |
| | 23* | 0.11 | n/a | n/a | n/a |
| | 25 | 0.15 | 19 | 8 | 42 |
| Shallow marsh | 27 | 0.07 | 21 | 10 | 48 |
| | 28 | 0.18 | 18 | 7 | 39 |
| Shrub swamp | 26 | 0.23 | 25 | 7 | 28 |
| *¼ Sec. Subtotal* | | *0.84* | -- | -- | -- |
| **NE 26-54-22-W4M** | | | | | |
| Shallow marsh | 17 | 7.89 | 23 | 7 | 30 |
| | 30 | 0.15 | 18 | 9 | 50 |
| | 31 | 2.11 | 24 | 8 | 33 |
| | 33 | 0.09 | 12 | 4 | 33 |
| *¼ Sec. Subtotal* | | *10.24* | -- | -- | -- |
| **NW 25-54-22-W4M** | | | | | |
| Wet meadow | 9 | 0.73 | 26 | 9 | 35 |
| Shallow marsh | 13 | 1.68 | 32 | 11 | 34 |
| | 16 | 0.53 | 29 | 8 | 28 |
| Shrub swamp | 10 | 0.14 | 21 | 7 | 33 |
| | 12 | 1.61 | 23 | 3 | 13 |
| *¼ Sec. Subtotal* | | *4.69* | -- | -- | -- |
| **NE 25-54-22-W4M** | | | | | |
| Wet meadow | 7 | 0.10 | 15 | 5 | 33 |
| Shrub swamp | 6 | 0.30 | 26 | 9 | 35 |
| *¼ Sec. Subtotal* | | *0.40* | -- | -- | -- |
| **SW 36-54-22-W4M** | | | | | |
| Wet meadow | 21 | 0.58 | 22 | 8 | 36 |
| Deep marsh | 8 | 0.59 | 34 | 15 | 44 |
| Shrub swamp | 20 | 0.37 | 30 | 3 | 10 |
| *¼ Sec. Subtotal* | | *1.54* | -- | -- | -- |
| **OVERALL TOTALS** | | **19.88** | **118** | **29** | **--** |

* did not have permission to access this wetland so no plant survey could be completed

**Table 4-2. Summary of non-native/exotic plant species recorded within the Josephburg study area (including wetland and upland sites)**

| Scientific Name | Common Name | # of sites where present (of 29) | % of sites where present (of 29) | # of sites where dominant or abundant (of 29) |
|---|---|---|---|---|
| ***Cirsium arvense*** | **creeping thistle** | 24 | 82.8 | 13 |
| ***Sonchus uliginosus*** | **perennial sowthistle** | 22 | 75.9 | 11 |
| *Bromus inermis ssp. inermis* | smooth brome | 20 | 69.0 | 8 |
| *Galeopsis tetrahit* | brittlestem hempnettle | 19 | 65.5 | 3 |
| *Agropyron repens* | quackgrass, wildrye | 19 | 65.5 | 13 |
| *Taraxacum officinale* | common dandelion | 18 | 62.1 | 2 |
| *Thlaspi arvense* | stinkweed, pennycress | 18 | 62.1 | 1 |
| *Poa pratensis* | Kentucky bluegrass | 12 | 41.4 | 1 |
| *Crepis tectorum* | annual hawksbeard | 8 | 27.6 | 0 |
| *Chenopodium album* | lambs-quarters, goosefoot | 5 | 17.2 | 0 |
| *Polygonum convolvulus* | black twining-knotweed | 5 | 17.2 | 0 |
| *Trifolium hybridum* | alsike clover | 4 | 13.8 | 0 |
| *Brassica campestris* | rape mustard; canola | 3 | 10.3 | 0 |
| ***Linaria vulgaris*** | **common toadflax** | 3 | 10.3 | 0 |
| ***Matricaria perforata*** | **scentless false-mayweed** | 3 | 10.3 | 0 |
| *Melilotus officinalis* | yellow sweetclover | 3 | 10.3 | 0 |
| *Axyris amaranthoides* | Russia pigweed | 2 | 6.9 | 0 |
| *Galium spurium* | false cleavers, bedstraw | 2 | 6.9 | 0 |
| *Medicago sativa* | lucerne medick | 2 | 6.9 | 0 |
| *Stellaria media* | chickweed, starwort | 2 | 6.9 | 0 |
| *Acer negundo* | Manitoba maple | 1 | 3.4 | 0 |
| *Sorbus aucuparia* | European mountain-ash | 1 | 3.4 | 0 |
| *Descurainia sophia* | flixweed, tansymustard | 1 | 3.4 | 0 |
| *Lappula squarrosa* | bristly bluebur | 1 | 3.4 | 1 |
| *Plantago major* | common plantain | 1 | 3.4 | 0 |
| *Polygonum arenastrum* | common knotweed | 1 | 3.4 | 0 |
| *Sonchus asper* | pricly annula sowthistle | 1 | 3.4 | 0 |
| *Tragopogon dubius* | stoutstalk goatsbeard | 1 | 3.4 | 0 |
| *Alopecurus pratensis* | field meadow-foxtail | 1 | 3.4 | 0 |
| *Phleum pratense* | common timothy | 1 | 3.4 | 0 |

Note: species in bold are designated as noxious weeds under the Alberta Weed Act (2010)

#### *Class II (wet meadow centres)*

Six small (<1.0 ha) sites in the study area supported Class II wetlands (Sites 7, 9, 21, 22, 23 and 33). As is typical of this wetland class, there was no surface water at these sites at the time of survey (i.e., mid-summer), although the vegetation suggested that some areas within these sites do flood seasonally following spring snowmelt. These sites supported grass-dominated communities and were typically dominated by moisture-loving grass species and non-native weed species. Fowl bluegrass was the dominant native grass, while quackgrass and smooth brome were dominant, non-native grasses. Although dominant species were relatively consistent among the different wet meadow wetlands, the majority of sub-dominant species were found at only one or two sites. Creeping thistle and/or perennial sowthistle were also dominant in all of the wet meadow sites (Plate 1). Other non-native species that formed important components of the vegetation of some sites included common dandelion and alsike clover.

**Plate 1. Example of a wet meadow site; perennial sowthistle and quackgrass were dominant throughout much of Site 21**

At two sites (Sites 7 and 9), wet meadow wetlands included a mappable shrub component (i.e., identifiable as a distinct community type on the aerial photograph used for mapping purposes) on slightly higher and drier ground adjacent to the wet meadow community (i.e., Sites 6 and 10). In these areas, willow was the dominant shrub species, while other low, moisture-loving shrubs such as red-osier dogwood, wild black currant and wild gooseberry were also common. Beneath the shrubs, forb and gramminoid species typical of wet meadow sites (e.g., fowl bluegrass, hairy hedgenettle, common silverweed) were present.

Class II wetlands (excluding adjacent areas of shrub swamp) supported a total of 50 plant species. Of those, 37 (74%) were native and 13 (26%) were exotic and one, Kentucky bluegrass, includes both a native and an exotic component. At the site level, weeds comprised, on average, 41% of the total plant community species richness of wet meadow sites.

### *Class III (shallow marsh centers)*

Eight wetlands, including the single largest wetland within the study area (Site 17; 7.89 ha) were Class III wetlands (Sites 13, 16, 17, 25, 27, 28, 30 and 31). These sites were generally dominated by sedges and/or wetland grasses. Awned sedge was the most common dominant sedge species (Plate 2), although bottle sedge was the dominant species at a few sites. Among wetland grasses, reed canarygrass was the most abundant species. As is typical of isolated marsh wetlands, many of these sites exhibited vegetation zonation. The central shallow marsh zone of sedge and/or wetland grass was often surrounded by a plant community characteristic of wet meadows, comprised primarily of tall forbs, moisture-loving grasses and the occasional shrub (e.g., meadow willow). Because almost all the Class III sites were surrounded by, or adjacent to cultivated fields, the outer wet meadow zones of the sites were typically very weedy and dominated by species such as creeping thistle, perennial sowthistle, brittlestem hempnettle and quackgrass.

**Plate 2. Example of a shallow marsh site; awned sedge covered most of Site 17**

Two sites (Sites 13 and 25) included a mappable shrub component (i.e., identifiable as a distinct community type on the aerial photograph used for mapping purposes) on slightly higher and drier ground adjacent to the wet meadow community (i.e., Sites 12 and 26).

In these areas, willow was the dominant shrub species and formed a canopy 4-6m in height. Beneath the canopy, the understorey typically included low, moisture-loving shrubs such as red-osier dogwood, wild black currant and wild gooseberry and gramminoid species typical of shallow marsh sites (e.g., awned sedge, reed canarygrass).

Class III sites (excluding adjacent areas of shrub swamp) supported a combined total of 68 plant species, including 51 (74%) native species and 17 (25%) non-native species. At a site level, species richness ranged from a low of 18 to a high of 32, with an average of 23 species. Non-native species represented, on average, 38% of the plant community at these sites. Further, non-native species were found to be dominant in at least some sections of all shallow marsh (Class III) wetlands.

***Class IV (deep marsh centers)***

Only two deep marsh wetlands were identified within the study area (Sites 1 and 8). Deep marsh wetlands typically maintain surface water throughout the spring and summer and often through to the fall and winter (Stewart and Kantrud 1971), however, at the time of the survey (mid-summer 2010) the only surface water present at either site was in a dugout located at the centre of Site 8 (Plate 3). Among the species present at Site 8, hardstem clubrush was the most abundant species characteristic of deep marsh zones. At Site 1, despite not having any surface water, characteristic deep marsh species were present and included common cattail and tall mannagrass (Plate 4). This scenario of a typically inundated area that has drawndown (i.e., dried up) and now supports plants that have established on the exposed soil is considered to be part of a wetland's natural drawdown emergent phase (Stewart and Kantrud 1971).

Extending outwards from the central, deepest area of these two Class IV sites, plant community composition changed to a more typical shallow marsh community (e.g., sloughgrass, rivergrass, awned sedge), then to a wet meadow (e.g., perennial sowthistle, wild mint, marsh yellowcress, willowleaf dock, creeping thistle, pale smartweed) and finally, in some cases, to a community dominated by low prairie species (e.g., stinkweed pennycress, common dandelion, annual hawksbeard).

Combined, the two deep marsh sites supported a relatively diverse list of 62 plant species. Of those, 41 (66%) were native and 21 (34%) were non-native. At a site level the average proportion of non-native species was only slightly higher at 35%.

**Plate 3. Existing dugout located at the center of Site 8, one of 2 deep marsh sites identified within the study area.**

**Plate 4. Common cattail and pale smartweed in a low, but dry area of Site 1.**

***Class VIII (shrub wetland centre)***

One site (Site 20) in the study area was typed as a shrub wetland. This site was characterized by a prominent shrub canopy, dominated by old, mature willows approximately 8-10 m in height. The understorey included low, moisture-loving shrubs and species more typical of wet meadow sites (e.g., fowl bluegrass, hairy hedgenettle, common silverweed).

#### *4.4.2.2 Uplands*

The only upland habitat type located within the study area was deciduous woodland, which occurs in small patches at eight sites throughout the study area. Some of the deciduous woodland sites were treed shelterbelts located along fence and, in other cases, the woodland sites were located in dry areas adjacent to wetlands. In all cases, the upland patches were small and generally linear in shape. As a result of these two factors, the uplands patches consisted entirely of edge habitat (i.e., habitat influenced by being close to an abrupt habitat edge as is the case between a woodland and agricultural field).

Aspen was by far the most common dominant tree species and was present at all of the woodland sites within the property (see Appendix C). At a few sites (Sites 11, 15 and 18) balsam poplar was also abundant. Most of the sites also had well-developed shrub understoreys. The most common tall shrubs were red-osier dogwood and willows, while commonly occurring low shrubs included species such as western snowberry, prickly rose and wild red raspberry. Ground cover consisted primarily of grasses (e.g., smooth brome, Kentucky bluegrass and quackgrass) with a good variety and abundance of non-native, weedy forbs (e.g., stinging nettle, creeping thistle, brittlestem hempnettle, common dandelion, northern bedstraw and perennial sowthistle). The abundance of weeds is likely attributable to the impacts of grazing by horses and cattle, but also the proximity of agricultural fields and farmsteads.

Combined, the woodland sites supported 74 plant species, 44 of which were unique to woodland sites (i.e., not found in wetland sites). Of the 74 species, 58 (78%) were native and the remaining 16 (22%) were non-native species. At a site level, however, the proportion of non-native species was slightly higher at 26%. Site level species richness varied from a low of 13 species to a high of 39 species, with an average of 25 species per site.

#### *4.4.2.3 Functional Upland Zones*

In recognition of the integral relationship between wetlands and surrounding uplands, those upland areas and the wetland margins are considered in wetland management. Therefore, during our delineation of wetlands on the study area, we also delineated the band of immediately adjacent upland habitat that was assumed to contribute to wetland function (Table 4.1; Figure 4.3). Most of the study area wetlands were surrounded by cultivated fields and thus assigned a 5 m functional upland zone (FUZ). For wetlands with areas of immediately adjacent wooded upland habitat, the width of the FUZ in those areas was increased to 30 m, or to the outer margin of the upland habitat, whichever was closer to the wetland margin. Wherever a wetland straddled the boundary of the lands to be mined, the wetland and associated functional upland zone were both restricted to only the areas within the boundary. In total, the combined FUZ of all wetlands within the lands to be mined was 4.09 ha (Table 4-3).

**Table 4-3. Functional Upland Zones associated with wetlands in lands to be mined**

| Wetland type | Wetland (Site ID) | FUZ area (ha) |
|---|---|---|
| Class II | 9/10* | 0.18 |
| | 6/7* | 0.39 |
| | 22 | 0.06 |
| | 23 | 0.07 |
| | 21 | 0.16 |
| | 33 | 0.07 |
| Class III | 25/26* | 0.22 |
| | 12/13* | 0.35 |
| | 27 | 0.04 |
| | 28 | 0.13 |
| | 30 | 0.06 |
| | 17 | 0.61 |
| | 16 | 0.17 |
| | 31 | 0.41 |
| Class IV | 8 | 0.12 |
| | 1 | 0.26 |
| Class VIII | 20 | 0.79 |
| **Total area** | | **4.09** |

* some wetlands consisted of multiple contiguous wetland plant communities

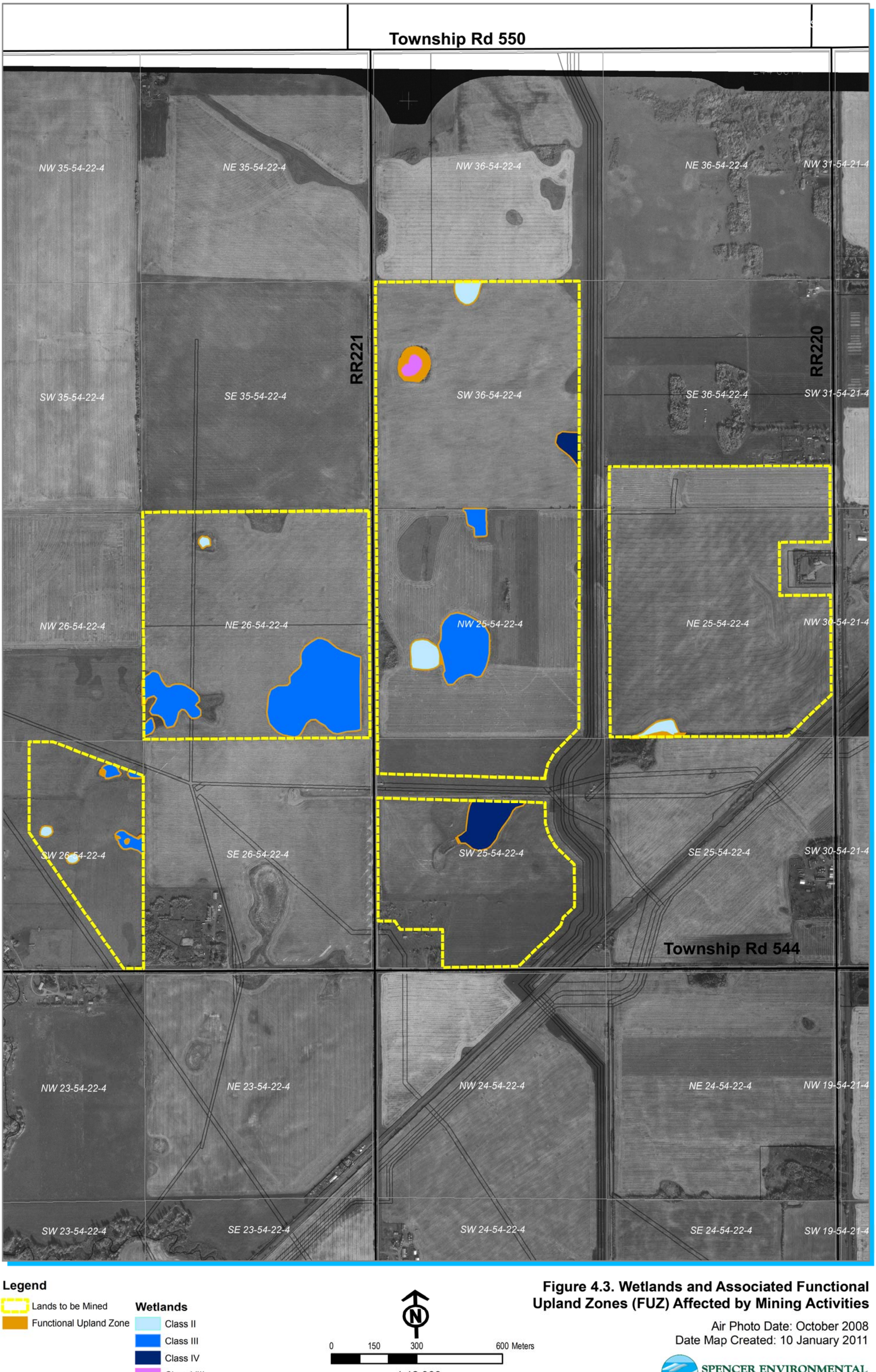


**Figure 4.3. Wetlands and Associated Functional Upland Zones (FUZ) Affected by Mining Activities**

Air Photo Date: October 2008
Date Map Created: 10 January 2011

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### 4.4.2.4 Rare and Uncommon Plant Species

***Database Review***

A search of the Alberta Conservation Information Management System (ACIMS; 2010) – formerly ANHIC – database revealed no existing records of listed plant species (species designated by authorities as being rare or of conservation concern for some other reason) within the study area.

***Rare Plant Survey***

No rare (S1-S2) species were discovered during this survey. S1 species are known from 5 or fewer locations and S2 species are known to have 6-20 occurrences in the province. Eight species classified as S3 by ACIMS were found on the study area (Table 4-4). S3 species are defined as species known to have 20-100 occurrences in the province or being somewhat vulnerable because of a restricted range, relatively small population sizes, or other factors; and are often considered uncommon in the areas where they are found. Section 5.2 provides recommendations relevant to the management of S3 species within the project area.

**Table 4-4: Uncommon (S3) plant species recorded in the Josephburg study area**

| **Common Name** | **Scientific Name** | **Plant Type** | **# of Sites** | **Site(s)** | **S RANK** (ANHIC 2009) |
|---|---|---|---|---|---|
| horned-pondweed | *Zannichellia palustris* | aquatic | 1 | 8 | S3 |
| brook cinquefoil | *Potentilla rivalis* | wetland forb | 6 | 1, 8, 13,17, 31, 33 | S3 |
| Pennsylvania buttercup | *Ranunculus pensylvanicus* | wetland forb | 4 | 1, 6, 7, 31 | S3 |
| manyhead sedge | *Carex sychnocephala* | wetland graminoid | 1 | 33 | S3 |
| western water-horehound | *Lycopus asper* | wetland forb | 1 | 12 | S3 |
| tall meadowrue | *Thalictrum dasycarpum* | upland forb | 1 | 19 | S3 |
| turned sedge | *Carex retrorsa* | wetland graminoid | 1 | 28 | S3 |

## 4.5 Wildlife

### 4.5.1.1 Birds

A total of 13 bird species was recorded at wetlands and immediately surrounding upland habitat during the breeding bird surveys conducted on 8 June and 9 July 2010 (Table 4-5). Of the species identified within the study area, the Baltimore oriole is the only special status species designated by Alberta Sustainable Resource Development (2005). The Baltimore oriole is listed as 'Sensitive'.

**Table 4-5. Species recorded during breeding bird surveys in summer 2010 (14 point counts encompassing 15 wetland sites)**

| Species name | Total count | # of sites where present | % of sites where present |
|---|---|---|---|
| Alder flycatcher | 1 | 1 | 6.7 |
| American Goldfinch | 1 | 1 | 6.7 |
| Baltimore oriole* | 1 | 1 | 6.7 |
| Black-billed magpie | 1 | 1 | 6.7 |
| Brown-headed cowbird | 2 | 2 | 13.3 |
| Clay-colored sparrow | 18 | 8 | 53.3 |
| European starling | 2 | 1 | 6.7 |
| House wren | 4 | 3 | 20.0 |
| Red-winged blackbird | 5 | 1 | 6.7 |
| Savannah sparrow | 18 | 9 | 60.0 |
| Song sparrow | 10 | 7 | 46.7 |
| Vesper sparrow | 2 | 2 | 13.3 |
| Yellow warbler | 4 | 3 | 20.0 |
| **Total # Species** | **13** | **-** | **-** |

* species listed as 'Sensitive' by Alberta Sustainable Resource Development (2005)

Considering the large extent of the study area, a total species richness of 13 is low, but generally representative of the small area and low diversity of available natural habitat. The highest species richness for a single survey site was 5, recorded at two locations where there were small elements of wet meadow/shallow marsh wetland, shrub wetland and adjacent upland all in close proximity to each other (i.e., Site complexes 24/25/26 and 5/6/7; Figure 4.2).

By far the most abundant species were savannah sparrow, clay-colored sparrow and song sparrow. The savannah sparrow is an abundant species common to a wide variety of open, field-like habitats. When located in cultivated fields, Class 1 to 3 wetlands often provide some additional vegetative structure and complexity relative to the surrounding crops, making them attractive as small islands of nesting habitat for the savannah sparrow. The clay-colored sparrow is a species common to open, shrubby habitats. The song sparrow prefers shrubby habitats surrounding wetlands and other water bodies and, because of this, is often considered a facultative wetland species. In addition to the song sparrow, only two other of the recorded species are considered to be either wetland obligate or wetland facultative species: the red-winged blackbird and alder flycatcher. The red-winged blackbird is highly dependent on the presence of emergent vegetation, most specifically common cattail, and was accordingly found in the only wetland that supported cattail-dominated deep marsh habitat (Site 1). The alder flycatcher is a species that prefers fairly extensive wet shrublands and, in this case, was recorded in the largest expanse of such habitat in the study area (Site 12). The rest of the recorded bird community is composed of generalist species that are capable of inhabiting small patches of natural or semi-natural habitat in heavily agricultural environments.

#### 4.5.1.2 Mammals

No project specific surveys were completed for mammals. Incidental observations made within the study area during other fieldwork included the sighting of a cow and calf moose. Considering that the study area lacks sufficient habitat to support moose year-round, the observed moose were likely moving through the parcel. Moose are expected to occur within the project study area only occasionally and for short periods of time. Tracks of deer and coyote were also seen in the field and one coyote was observed in NE 25-54-22-4. Observed coyote behaviour suggested a den was present in the shelterbelt situated along the quarter section south boundary. Although these species likely use the lands within the study area much more frequently than moose, the study area would still only form one part of a larger home range for either species.

In addition to the large-bodied, wide-ranging species already discussed, the study area likely provides suitable habitat for a variety of small- and medium-bodied species (e.g., snowshoe hare, porcupine, northern pocket). In particular, small-mammal species such as the deer mouse, meadow vole and Richardson's ground squirrel are well-adapted to agricultural habitats and, as a result, are likely the most common and abundant mammal species within the study area.

#### 4.5.1.3 Amphibians and Reptiles

Amphibian call surveys were conducted at the three wetlands that supported visible water or moist soils. Surveys recorded two species of amphibians: the wood frog and boreal chorus frog. Boreal chorus frogs were the more common and abundant of the two species, recorded at 2 of the 3 survey stations (Sites 8 and 17; Table 4-6). The only record for wood frog came from a single individual at Site 8. No other amphibian species were recorded during the amphibian surveys.

**Table 4-6. Breeding Frog/Toad Survey Results, 19 May 2010**

| Site Number | Species | Land Location | Calling Code |
|---|---|---|---|
| 25/26 | none | SW 26 | 0 (no activity) |
| 17 | Boreal chorus frog | NE 26 | 1 |
| 8 | Boreal chorus frog | SW 36 | 3 |
| | Wood frog | SW 36 | 1 |

Both the boreal chorus frog and wood frog are common and abundant throughout central Alberta in wetlands that maintain surface water until late spring or later. It is very likely that under more normal climatic conditions (i.e., wetter conditions), many additional wetlands within the subject property would provide suitable frog breeding habitat. It is also likely that boreal chorus frogs and/or wood frogs were present in 2010 at Wetland 1, however, permission to access that site was not available during frog breeding season.

No project specific surveys were completed for reptiles. Based on provincial range the only reptile species with the potential to occur within the study area are the plains and red-sided garter snakes. Both species have wide habitat preferences, but are most often found in close proximity to bodies of water such as wetlands, streams and dugouts (Russell and Bauer 2000). Based on the available habitat, it is possible that either species may occur within the study area.

#### *4.5.1.4 Fish*

The only water bodies present within the study area are shallow, isolated wetlands. Any water present within these wetlands almost certainly freezes completely each winter. Because of the lack of any permanent fish habitat, fish are not expected to occur within the study area.

#### *4.5.1.5 Summary of Wildlife Habitat*

Previous habitat mapping conducted for Strathcona County (Geowest 1997) shows that the study area contains only a few sparsely scattered habitat patches. All investigations related to this project have supported those previous findings. The study area contains several isolated wetlands and a few small patches of wooded upland habitat. The majority of the wetlands are relatively small, temporary to seasonal in nature (i.e., Class 2 to 3), degraded as a result of agricultural activity and characterized by a high proportion of non-native, weedy plant species. The wetlands within the study area, including the two Class 4 wetlands, have also been stressed as a result of the recent, extended drought period. Lower amounts of precipitation have resulted in lower water levels. This has facilitated the cultivation of some of the temporary and seasonal wetlands and, at some of the more permanent wetlands, has facilitated the encroachment of upland weed species whose establishment is typically (under average, wetter conditions) inhibited by conditions that are too wet.

As reported separately in the above sections, the overall low abundance of native wildlife habitat and the generally poor quality of the habitat that is available results in a comparatively low richness of wildlife species present within the study area. Our wildlife surveys recorded mainly common, generalist species and species that thrive in highly disturbed, agricultural environments. Relatively few habitat-specialist or sensitive species were recorded.

In wetter, more normal/average conditions, it is likely that the diversity of wetland habitat available within the study area would be greater than it is currently (e.g., more deep marsh habitat). However, the areas where this change would be most noticeable would be relatively small in size and would likely not have a large influence on the wildlife habitat value of the study area as a whole.

### *4.5.2 Special Status Species*

#### *4.5.2.1 Observed*

Only one special status wildlife species was observed during the course of fieldwork completed in support of this assessment: a single male Baltimore oriole (listed as Sensitive by Sustainable Resource Development 2005). Although the site complex (Sites 24/25/26) where the bird was observed does provide suitable breeding habitat, it is just as likely that the bird was nesting in the wooded habitat located a short distance to the southeast and just outside the boundaries of the study area.

#### *4.5.2.2 Historical Records*

The Alberta Fish and Wildlife Management Information System, holds no records of special status species within the study area boundaries. In 1995, 1996 and 1997, active peregrine falcon nests were recorded to west of the study area, along the North Saskatchewan River. In 1989, a short-eared owl was observed in the quarter-section immediately west of NW 13-53-23 W4M. (Alberta Sustainable Resource Development and Alberta Conservation Association 2007). The lack of records for the study area could be a function of the private land ownership, which typically precludes access for data collection.

#### *4.5.2.3 Potential Occurrence*

Based on habitat requirements, habitat availability in the local project area, and provincial distributions, we identified 32 special status species with the *potential* to occur on the study area (Appendix D). Of the 32 species, 27 species are listed provincially as '*Sensitive*' but have no federal designation. The likelihood of the 32 identified species to occur on project lands was assessed as low, moderate or high, based on several factors including, but not limited to, the limited distribution of the species, the area and quality of available habitat, local records of occurrence and species' sensitivities to human disturbance. Table 4-6 lists a subset of the 32 species that includes any special status species recorded within the study area during fieldwork (see *Observed* section above) and all species that have the more vulnerable provincial designations of *'May Be At Risk'* or '*At Risk'* and/or the federal designations of *'Special Concern'*, *'Threatened'* or *'Endangered'* (i.e., according to the Species at Risk Act and/or the Committee on the Status of Endangered Wildlife in Canada) and were assessed as having a moderate to high potential for occurrence on project lands. The remaining special status species, those considered to have a low potential for occurrence, are referenced only in the appendix. The five special status species having moderate to high potential for occurrence are discussed in the following sections.

#### *4.5.2.4 Avifauna*

Three of the five special status species listed in Table 4-7 are birds. The occurrence of the Balitmore oriole is discussed above in the *Observed* section. The horned grebe is a wetland-obligate (requires wetland habitat) species that prefers emergent vegetation for nesting and foraging (Fisher and Acorn 1998). Of the many wetlands within the study area, there is only one site (Site 1) that currently holds the potential to provide suitable habitat for horned grebes. Although this wetland has not had much surface water present over the past few years owing to long-term drought, with more average (or wetter) climatic conditions this site would likely include sufficient deep marsh habitat to support the nesting of horned grebes. Considering the above, and their relatively common occurrence in suitable habitat in the Edmonton area, the potential occurrence of the horned grebe is rated as moderate.

The least flycatcher is a species common to deciduous woodland habitat in the Edmonton area. Although there is little in the way of woodland habitat within the study area, the small area of deciduous woodland (Site 19) located in SW 36-54-22 W4M includes the habitat components necessary to support nesting least flycatchers. Considering that suitable habitat is present and that the least flycatcher is a very common and abundant species of available woodland habitat, its potential occurrence is rated as high.

# Table 4-7. Select special status species with potential to occur in the study area

| Common Name | Scientific Name | Provincial Status (General Status of AB Wild Species) | Wildlife Act Designation and New Species Assessed by ESCC [a] | COSEWIC [b] Designation | SARA [c] Designation | Species Recorded in Study Area | Potential Habitat Use [d] | Likelihood of Occurrence |
|---|---|---|---|---|---|---|---|---|
| Long-tailed Weasel | *Mustela frenata* | May be At Risk | | Not at Risk | | | B | Moderate |
| Boreal Toad | *Anaxyrus hemiophrys* | Sensitive | | Special Concern | Schedule 1 (Special Concern) | | B | Moderate |
| Horned Grebe | *Podiceps auritus* | Sensitive | | Special Concern | | | B | Moderate |
| Least Flycatcher | *Empidonax minimus* | Sensitive | | | | | B | High |
| Baltimore Oriole | *Icterus galbula* | Sensitive | | | | **x** | B | High |

[a] Alberta's Endangered Species Conservation Committee
[b] Federal ranking by Committee on the Status of Endangered Wildlife in Canada
[c] Federal Species at Risk Act ranking.
[d] Assessed qualitatively relative to their status as a special status species, seasonal behaviour and habitat availability on the study area

### *4.5.2.5 Mammals*

Special status mammals with high to moderate potential for occurrence were limited to the long-tailed weasel. That species prefers agricultural areas and preys on small mammals such as voles and ground squirrels (Pattie and Fisher 1999). Suitable long-tailed weasel habitat is available in the local study area, however, this is a wide-ranging species and, if present, the proposed project area may comprise only part of its territory. Considering the above, we have rated this species likelihood of occurrence on the study area as moderate.

### *4.5.2.6 Herpetiles*

The boreal toad is the only special status amphibian or reptile species considered to have a moderate to high chance of occurring within the subject area. The boreal toad is provincially ranked as *Sensitive* but federally ranked as *Special Concern*. The boreal toad breeds in a variety of aquatic habitats (e.g., wetlands, ponds, streams, lakes) and hibernates through the winter in upland hibernacula, often in pre-existing burrows and often in coniferous tree stands (Russell and Bauer 2000, Browne and Paszkowski 2010). Site 1 and, to a lesser extend Site 8 (because of the lack of emergent vegetation and generally lower habitat quality), both semi-permanent, deep marsh wetlands could potentially provide suitable breeding habitat for this species, which has been recorded recently in other parts of Strathcona County (Browne 2009). On this basis, the potential for the boreal toad to occur within the study area is rated as moderate.

## *4.6 Historical Aerial Photography Review*

Agriculture has been the dominant land use activity across the entire study area since the beginning of the aerial photograph record, beginning in 1949 (see Appendix B). Historically, many of the wetlands on the study area have been periodically cultivated and the visible extent of most wetlands has fluctuated in response to precipitation patterns (and corresponding agricultural activities), but the relatively consistent location and general configuration of the wetlands suggests that they have not experienced any significant and/or permanent changes related to infilling or draining of wetlands. The aerial photograph record from recent years shows some of the most consistent change as prolonged drought has facilitated the continued cultivation of several wetlands that had historically been left relatively undisturbed. The aerial photograph record also indicates that in recent years (2006) several potential wetland areas within the study area were impacted by the installation of a pipeline. Because of the recent changes brought about by a combination of drought, agricultural activity and other anthropogenic disturbances, relative to 1949, there has been an overall loss of wetland area within the study area.

Despite the long-term prevalence of agriculture across the landscape, the historical aerial photograph record suggests that some of the wetlands (i.e., Sites 1, 6, 7, 12, 13 20, 27, 28) have remained physically unaltered since 1949. In almost all cases, these wetlands are either shrub wetlands or are wet meadow/shallow marsh wetlands surrounded by a shrub wetland community. The abundance of shrubs at these sites makes them comparatively difficult or less suitable to cultivate/till when dry, relative to non-wooded wetlands. The deep marsh wetland located at the centre of SW 25-54-22-W4M (Site 1) is the only non-wooded wetland that appears to have avoided cultivation throughout the aerial photograph record (although it wan't present in 1949; since establishment is has been undisturbed).

### *4.7 Ecological Connectivity*

Ecological connectivity allows for wildlife movement between patches of required habitat, genetic exchange for flora and fauna and nutrient circulation between ecosystems. Habitat patches are connected through habitat corridors and/or permeable matrices which function as travel pathways for organisms. Since the specific habitat choices, nutrient requirements, methods, and distances of movement differ between organisms, ecological connectivity in any given area is variable, dynamic and species-specific (Hilty, J.A. *et al* 2006).

The study area lands contain little in the way of natural habitat patches. The habitat that is available consists primarily of temporary and seasonal wetlands (i.e., Class 2 and 3), which were found, for the most part, to be highly degraded, small in size and, because of these things, of overall poor habitat quality. The study area also contains a few small upland areas adjacent to wetlands and a few shrubby, wooded shelterbelts. Despite their poor quality, the available habitat patches may function to some degree as ecological stepping stones for a restricted number of wildlife species. A stepping stone can be defined as a vegetated area that may provide resources to sustain an organism for some time, but is generally used as a temporary stop while moving through the matrix route toward more suitable habitat patches (modified from Forman 1995). The agricultural land that forms the matrix between the scattered habitat patches is relatively permeable to wildlife movement. In this context, many of the medium- to large-bodied wildlife species common to the study area (e.g., deer, coyote) can travel easily within and across the study area. Thus, the scattered wetlands and small areas of associated upland habitat may provide some temporary resources (e.g., food, cover) that contribute to their function as stepping stones for some types of wildlife movement (e.g., the regional movement of wide-ranging terrestrial species and migrating birdlife). The observation of moose traveling through the study area in the summer of 2010 provides an example of wildlife movement that may benefit from the small habitat patches scattered throughout the study area during longer, more regional movements. Further, many of the wetlands are close enough that seeds are likely transferred between sites through wind-based and/or animal-based seed dispersal. The wooded shelterbelts, although generally very narrow (<10 m), may serve as travel corridors for small mammals and some songbirds.

Ecological connectivity between the study area and the surrounding lands of rural Strathcona County is generally low. In a similar fashion to the study area itself, the surrounding lands are dominated by agriculture and support few natural habitat patches which, in turn, support a relatively low level of functionality with respect to ecological connectivity. The only exception to this is Ross Creek, by far the most noteworthy natural feature in the vicinity of the study area in terms of regional connectivity. Ross Creek approaches as close as approximately 230m to the southwest corner of the study area and has been described as a permanent creek (Geowest 1997), an important drainage feature and a wildlife travel corridor (D. A. Westworth and Associates 1987). The creek generally runs in a NW-SE direction, originates from Trapper's Lake, immediately west of Elk Island National Park (12km southeast of the study area), and ultimately drains into the North Saskatchewan River approximately 6km northwest of the study area in Fort Saskatchewan. Considering its beginning and end points, Ross Creek functions as a regionally significant hydrological connection. Furthermore, the treed/shrubby riparian zone located along much of the creek likely also serves as an important connection between Elk Island National Park and the surrounding agricultural lands for a wide variety of wildlife species. Intact riparian corridors are generally recognized in scientific literature as productive wildlife habitat and important corridors. The presence of Ross Creek just outside the boundaries of the study area is of note as it may result in some wildlife venturing onto the study area while following the creek as a movement corridor.

# 5.0 CONSERVATION RECOMMENDATIONS

## *5.1 Implications of the Proposed Project*

The proposed project is a gravel extraction operation. Because of the inherent nature of the gravel extraction process, with the exception of some narrow buffers surrounding the perimeter of the parcel and pipeline right-of-ways, all lands located within the boundaries of the areas identified as lands to be mined (Figure 2.1) will be disturbed during gravel extraction. Accordingly, it will not be feasible to retain any of the natural features currently present within the study area. Because of this, the focus of our conservation recommendations is effective wetland compensation and reclamation, rather than retention and integration of existing natural features.

### *5.1.1 Anticipated Wetland Impact*

The proposed gravel extraction operation would ultimately result in the complete removal of all wetlands located on lands to be mined (Figure 2.1). In total, the area of wetland loss would be 19.88 ha.

Pursuant to both the Province's Interim Wetland Policy and related Wetland Compensation Guide, and the County of Strathcona's wetland conservation policy, the proponent would be required to compensate for the loss of wetland habitat at a ratio of 3:1 (wetland area created/restored : wetland area lost). A 3:1 ratio means that the proponent would be responsible for the creation/restoration of 59.64 ha of compensatory wetland habitat.

## *5.2 Proposed Wetland Compensation*

As a necessary by-product of the proposed gravel extraction project, the post-mining landscape would include an end pit lake (EPL) in each mined quarter section (Figure 5.1). The EPLs will all be deep depressions, with bottom elevations below the groundwater table and thus will be permanent, open water lakes that are groundwater fed. Each EPL would also capture surface water runoff from within its own localized catchment area (Figure 5.1), formed by recontouring the surrounding lands to feather into existing ground levels around the periphery of the study area.

The presence of EPLs as permanent, open water bodies and the need to create wetland habitat on site provides an opportunity to design the EPLs with wetland margins, thus creating complementary open water and wetland habitat. The wetland habitat will be created through a combination of shoreline slope contouring and active efforts to facilitate wetland habitat creation. In addition, each EPL will include a naturalized wetland buffer (i.e., functional upland zone) around its periphery. Following are more specific details of the proposed compensation plan:

- Shoreline slopes of 10:1 (horizontal run : vertical rise) will extend from 2m below anticipated full supply level (FSL) to 1m above FSL (Figure 5.2). These slopes will result in areas of shallow water around the periphery of the EPLs, which, with the influence of additional methods described below, should be capable of supporting a wetland plant community dominated by robust, native emergent vegetation and submerged aquatic plants below FSL.

- Above FSL, the 10:1 slopes will extend inland for 10 m (Figure 5.2). This area will be seeded with a native wet meadow seed mix and/or planted with some native wetland/riparian shrubs, primarily willow. Along the shoreline, these 10:1 slopes would likely result in a narrow strip of land that would become occasionally flooded in response to fluctuating EPL water levels following spring melt and heavy rains. Because of its periodic inundation and/or saturated soil conditions, this narrow band of land would likely develop into a transitional vegetation community with a species composition that may be similar to a shallow marsh or wet meadow (e.g., dominated by sedges, wetland grasses and forbs).

- Native wetland soils salvaged from wetlands removed during earlier stages of gravel extraction will be placed along the shoreline of EPLs in a band extending from 1m above FSL to 1m below FSL. If wetland soils are in short supply, they will be placed in wide nodes spread regularly throughout that zone. Salvaged soils and, to the extent possible, wetland plants, will be placed directly from their source whenever possible, but some stockpiling of soils before use in landscaping may sometimes be necessary, particularly in the early stages of each mining phase. Placement of salvaged soils and wetland plants should help to inoculate the EPLs with native wetland plant species as the soils should contain an abundant propagule bank. Not all currently existing wetlands are, however, suitable for soil salvage (i.e., some existing wetlands have too many weeds). Before salvaging soils, the proponent should consult with a biologist regarding appropriate sources of wetland soils and to help identify the best location for their placement during reclamation.

- In some locations (i.e., portions of 3 of the 6 EPLs), the area of naturalized vegetation above FSL will extend beyond the baseline 10 m width and will be widened for a total naturalized strip of up to 30 m (Figure 5.1 and 5.2). In those areas (i.e., areas inland of the baseline 10 m strip), naturalization would include plantings of upland shrubs and deciduous trees (i.e., aspen, poplar) and/or seeding with a native upland grass/forb seed mix.

- The band of naturalized vegetation surrounding the EPLs will be protected from future disturbance using some type of land protection easement, such as a Conservation Easement. The actual protection mechanism employed will require further discussion with Strathcona County and possibly Alberta Environment. Lands outside of the protected zone will support agricultural land uses (e.g., cultivation) in the post-mining landscape. Protection of the lands immediately surrounding the EPLs will help to ensure that they remain undisturbed and are allowed to establish into healthy riparian and/or wet meadow communities.

- Slopes of 20:1 will extend out from 1m above FSL to feather into existing ground levels at the periphery of the study area

- Slopes of 3:1 will extend from 2m below FSL down to bedrock.

- Once the land surrounding the EPLs is recontoured to the appropriate slope grades, topsoil will be placed to a minimum depth of approximately 300mm to mimic current topsoil depths. The actual depth of replaced topsoil will, however, likely be greater than this. Topsoil will not be applied to areas of EPLs that are expected to be deeper than 2 m. Not placing topsoil in these areas will leave an excess of topsoil for placement in the remaining, suitable areas. To use up an excess of topsoil it would be necessary to place soil to a greater depth than it was originally.


| Section | End Pit Lakes | | | | | Wildlife Corridor |
|---|---|---|---|---|---|---|
| | Full Supply Level (FSL) | | | Naturalized Area above FSL | Wetland Compensation | |
| | Area (ha) | Elevation (m) | Volume (m³) | Area (ha) | Total Area (ha) | Area (ha) |
| SW36 54-22-4 | 14.09 | 629.00 | 508812 | 1.61 | 15.70 | 2.85 |
| NW25 54-22-4 | 14.81 | 629.75 | 547469 | 3.39 | 18.20 | 1.15 |
| SW25 54-22-4 | 3.52 | 631.00 | 55208 | 0.84 | 4.36 | 0.85 |
| NE26 54-22-4 | 10.14 | 629.00 | 474073 | 3.86 | 14.00 | 0.00 |
| NE25 54-22-4 | 9.47 | 631.00 | 634804 | 3.11 | 12.58 | 1.43 |
| SW26 54-22-4 | 0.48 | 627.75 | 2579 | 0.29 | 0.77 | 0.00 |
| **Total** | **52.51** | | **2,222,945** | **13.10** | **65.61** | **6.28** |

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Client

REPERIO RESOURCES

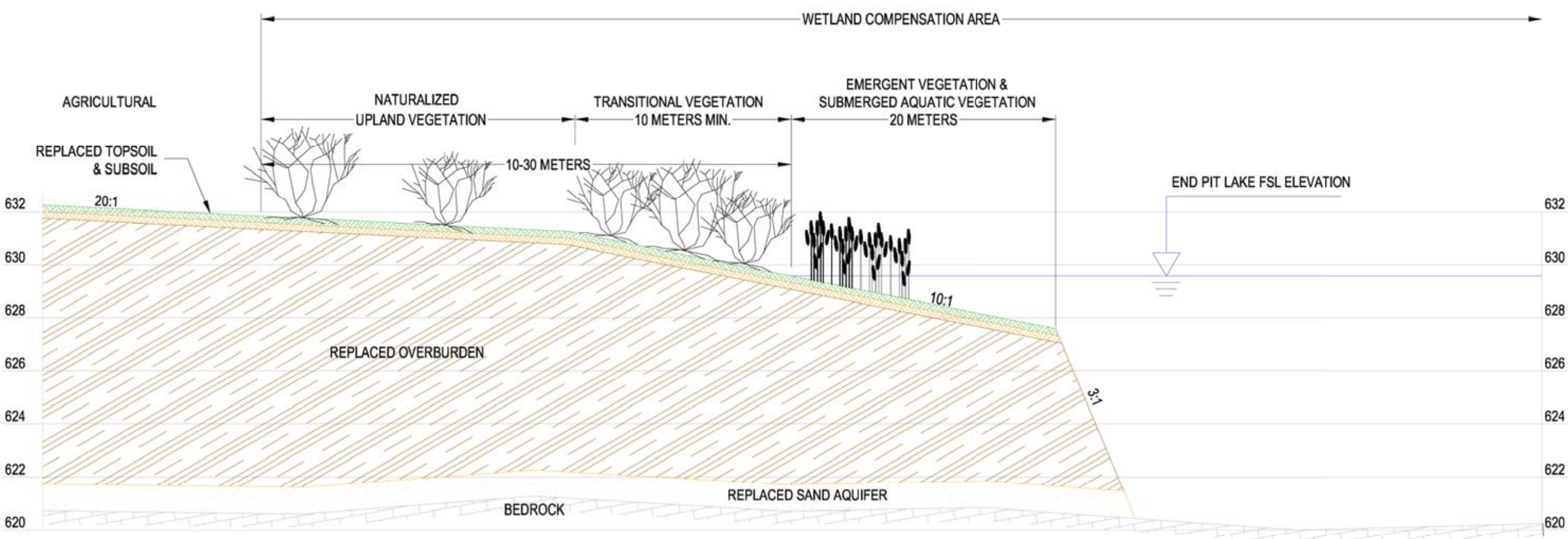
Project

JOSEPHBURG GRAVEL EXTRACTION
OPERATION AREA MASTER PLAN

Title

**Figure 5.1**
OVERALL RECLAMATION PLAN

| Scale 1:12,000 | Date JANUARY 2011 |
|---|---|
| | Figure No. |




**CONCEPTUAL SHORELINE CROSS-SECTION OF A NATURALIZED END PIT LAKE**

| PREPARED BY | CLIENT | PROJECT |
|---|---|---|
| sameng inc. better water \| better world<br>#1500, 10025-106 St., Edmonton, Alberta T6J 1G3<br>Ph: (780)482-2557, Fax: (780)482-2538<br>Email:services@sameng.com | REPERIO RESOURCES | JOSEPHBURG GRAVEL EXTRACTION OPERATION AREA MASTER PLAN<br>TITLE: **Figure 5.2** CONCEPTUAL SHORELINE CROSS-SECTION OF A NATURALIZED END PIT LAKE<br>DATE: JANUARY 2011 \| SCALE: NTS \| FIGURE No. 14 |

Following completion of mining, reclamation of the landscape and naturalization of the EPLs, the study area is expected to provide a level of wetland function that is equivalent to, and in some cases superior to that of the existing wetlands. This is likely to be most true with respect to provision of wildlife habitat. The wetlands currently within the subject property support a relatively low diversity of wildlife species, particularly in terms of wetland-dependent species. The paucity of wetland species observed during 2010 is likely at least partly a function of recent drought conditions, however, even in wetter conditions, because of the small size of the wetlands and lack of functional upland habitat, few of them would be expected to support a wide variety of wetland species and even fewer would be likely to support breeding waterfowl species. In contrast, the creation of 6 EPLs, ranging in size from 0.5 ha to 14.8 ha, will provide permanent, suitable habitat for a diversity of waterfowl and wetland dependent songbirds. Areas of deep open water in combination with areas of robust emergent vegetation should support many of central Alberta's common diving duck species (e.g., Redhead, Lesser Scaup), while the shallower periphery of the EPLs would be preferred by species of dabbling duck (e.g., Mallard, Blue-winged Teal, Northern Shoveler) and species such as grebes and American Coot. The surrounding slopes will be seeded with a native wet meadow mix and should develop into a grassy, herbaceous community with sufficient cover to provide nesting habitat for many of the dabbling ducks, which typically nest in surrounding upland habitat instead of within the wetland itself. Establishment of a continuous emergent zone around any of the EPLs will attract waterbird species such as the Sora and wetland dependent songbirds such as the Red-winged Blackbird and/or Marsh Wren.

The larger EPLs would also likely function to some extent as staging areas during the spring and fall migration for waterfowl, geese and swans. Large, permanent wetlands are often favored by migrating species. Each EPL would in its own right provide suitable staging habitat, but the close proximity of all of the EPLs to each will create a relatively dense cluster of large, permanent, open water wetlands that is not currently present within in the general area of the study area. The density of these features will further enhance the attractiveness of the area to migrating species.

The 6 EPLs would combine for a total area of 52.51 ha. The area of naturalized vegetation above the normal water level of each EPL would total another 13.10 ha. Cumulatively, the proposed compensation plan comprises 65.61 ha of functional wetland habitat. Considering the proponent's need to compensate for an impact of 19.88 ha, the proposed plan represents a compensation ratio (wetland area created/restored: wetland area lost) of 3.3:1.

In addition to the creation of wetland habitat through naturalization of the EPLs, the proposed compensation plan also includes the development of a 10 m wide (or greater) surface drainage swale/wildlife corridor that will extend south to north through SW and NW 25-54-22-4 and SW 36-54-22-4 (Figure 5.1). The swale will provide two main functions: first, it will maintain the predevelopment surface flow pattern from south to north through the study area and secondly, the swale will provide for some structural connectivity between the EPLs and surrounding lands. The swale will directly connect to naturalization areas surrounding 3 of the EPLs by way of a narrow naturalized corridor. To reinforce and facilitate the connectivity function, the swale would be naturalized through native seeding and/or plantings of native shrubs and would remain uncultivated. The swale would provide some cover and temporary habitat that should facilitate the movement of species such as boreal chorus and wood frogs, meadow voles, weasels and savannah sparrows. Through its provision of small mammal habitat, predatory species such as red fox and coyote may also move along its length in search of prey. Across the entire study area, the naturalized drainage swale/wildlife corridor will combine for a total area of 10.34 ha.

**Table 5-1. Details of end pit lake (EPL) wetland compensation areas**

| Mining Phase | Location | EPL area @ FSL* (ha) | EPL naturalized area above FSL area** (ha) | Total area of wetland compensation (ha) |
|---|---|---|---|---|
| 1 | SW 36-54-22-W4M | 14.09 | 1.61 | 15.70 |
| 1 | NW 25-54-22-W4M | 14.81 | 3.39 | 18.20 |
| 1 | SW 25-54-22-W4M | 3.52 | 0.84 | 4.36 |
| 2 | NE 26-54-22-W4M | 10.14 | 3.86 | 14.00 |
| 3 | NE 25-54-22-W4M | 9.47 | 3.11 | 12.58 |
| 4 | E ½ SW 26-54-22-W4M | 0.48 | 0.29 | 0.77 |
| **Totals** | | **52.51** | **13.80** | **65.61** |

* Full Supply Level (FSL) based on non–pumping groundwater; FSL is equivalent to the expected normal water level (NWL) for the EPLs
** The naturalized area associated with each EPL is based on a naturally seeded/planted buffer on slopes surrounding the perimeter of each EPL. Widths of this area will range from 10m to 30m.

### *5.3 Proposed Wetland Compensation Monitoring Program*

Alberta Environment now typically requires that all wetland compensation plans associated with *Water Act* approvals include a monitoring program component and have indicated that that will be the case for the proposed gravel extraction project. To that end, the proponent is committed to developing a wetland monitoring program to the satisfaction of Alberta Environment. A detailed monitoring program will be submitted to Alberta Environment under separate cover prior to completion of extraction activities in the first full quarter section or according to dates outlined in the approval. The following is provided as an initial indication of what a wetland monitoring program might look like.

In general, the objective of the monitoring program, as with most wetland compensation monitoring programs, will be to assess the level of wetland function provided by the naturalized EPLs. Because many of the chemical and hydrological functions of wetlands are difficult and costly to monitoring, the wetland monitoring program will focus on biological functions, generally more suited to efficient monitoring. Monitoring programs typically focus on a few, very specific elements of the biological community. The chosen components act as indicators of the overall biological community and, by extension, can be used as a surrogate measure for the condition of the entire wetland. The specific biological indicators and parameters that will be monitored as part of this program will be identified during preparation of the monitoring plan report. Other details regarding the sampling intensity, schedule and duration of monitoring will also be determined at that time and will be guided by the conditions outlined in the *Water Act* approval. In general, however, the initiation of monitoring would closely follow the timing of the reclamation process. Monitoring in parallel with the reclamation process would also allow for monitoring results to be interpreted and applied to improving reclamation success for EPLs to be created later on in the reclamation process.

### *5.4 Additional Recommendations*

The following recommendations address measures that should be undertaken to facilitate environmentally-sensitive development and compliance with all environmental legislation and policies:

- Strathcona County requires that a qualified biologist complete an owl survey prior to any upland vegetation clearing between 15 February and 31 March to determine if actively nesting owls are present. Clearing would be allowed to proceed if nesting owls were not present, however, if an active nest was discovered, a buffer protecting the nest site would be established within which clearing would not be allowed to proceed until the young have successfully fledged and are no longer dependent on the nest site.

- Do not clear vegetation during the period of 15 April to 31 July to avoid disturbance to breeding wildlife protected under the provincial *Wildlife Act* and the federal *Migratory Birds Convention Act.* If these dates cannot be complied with, removal of vegetation should only occur if a qualified biologist has inspected each site to be cleared and determined that no active nests or dens are present. The discovery of an active nest would be handled the same was as described in the bullet above.

- Do not disturb wetlands during the period 15 April to 01 September, inclusive, unless in the opinion of a wetlands specialist the areas to be disturbed do not support breeding or young of the year birds or amphibians.

- Prior to the initiation of any soil stripping and/or grading, we suggest contacting Strathcona County regarding whether or not clubroot fungus is known to exist within the areas to be mined. In 2010, Strathcona County undertook a program in which all canola fields and fields found with volunteer canola were inspected for the presence of clubroot fungus. Strathcona County will disclose information regarding their findings upon written request. Should clubroot fungus be known to exist within the study area, best management practices detailed in the Alberta

Clubroot Management Plan (Alberta Clubroot Management Committee 2010) should be implemented.

- If wetlands supporting any S3 plant species are to be removed (see Table 4.4), attempt to salvage the soils from those sites and re-use the soils as part of the EPL reclamation with the intention of creating opportunities for those plants to re-establish.

# 6.0 REGULATORY FRAMEWORK

In addition to the need for this Biophysical Assessment for Strathcona County, any plans to disturb/alter wetlands within the lands to be mined will trigger approvals from municipal, provincial and federal agencies, as described below.

## *6.1 Municipal Approvals*

### *6.1.1 Municipal Development Plan*

Under the requirements of the MGA, each Alberta municipality must create a broad level Municipal Development Plan (MDP) and more specific Land Use By-laws (LUB) to manage development and growth within their jurisdictions. The MDP must then be updated on a regular basis. In May 2007 Strathcona County approved a revised MDP. The new MDP contains specific chapters dedicated to sustainability and growth management, and, environmental management, and adopts specific sustainability principles that will govern future growth. Biophysical or environmental assessments are also noted as required under certain conditions in the MDP. The MDP also outlines several measures specific to compliance with Strathcona County's Wetland Policy (see section 6.1.2).

Additional specific measures pertinent to this project include timing windows associated with working in wetlands and tree clearing. Disturbance to wetlands is prohibited during the period 15 April to 01 September, inclusive. Tree clearing is prohibited during the critical wildlife breeding season of 15 April to 31 July, inclusive. Stripping/tree clearing activities require a County-issued permit. If tree clearing or disturbance to wetlands is proposed within the restricted activity periods, the County will not allow those activities to proceed unless the proponent has commissioned a professional biologist to conduct the appropriate surveys and they can produce a letter indicating that no active nests and/or wildlife dens were found in the area to be cleared. These windows are similar (but not identical) to recommended restricted clearing periods issued by the provincial and federal governments.

### *6.1.2 Wetland Conservation Policy (SER-009-036)*

Strathcona County approved its Municipal Wetland Conservation Policy in early 2009. The policy requires development proponents to compensate for the loss of all wetland areas at a minimum area-based ratio of 3:1 (wetland area replaced: wetland area lost). Further, the policy requires that compensation occur on-site (i.e., within the boundaries of the proposed development). Acceptable means of compensation may include the construction of naturalized stormwater management facilities (mimicking wetland types typical of the Central Parkland Subregion), wetlands constructed in conjunction with other retained natural areas and the expansion of wetlands that are to be retained in their natural state. In the event that Provincial compensation requirements are greater than those of the County, the jurisdiction of the Province supersedes that of the County. The study area contains many wetlands and, as a result, the County's Policy will apply.

## 6.2 Provincial Approvals

### 6.2.1 Alberta Water Act and Interim Wetland Policy

Alberta's *Water Act* is the primary piece of legislation governing the use and management of Alberta's water resources, including water held in permanent and temporary wetlands, irrespective of land ownership. Approval is required for all activities that may impact water and the aquatic environment, including wetlands. In the case of this project, approval would be required for any proposed draining/filling of the wetlands on the study area.

Linked to the *Water Act* is the document *Wetland Management in the Settled Area of Alberta – An Interim Policy* (1993), which states that, when destruction or disturbance of wetlands is authorized under the *Water Act*, compensation is required. In recognition of the integral relationship between wetlands and surrounding uplands, it also states that the upland areas surrounding a wetland as well as the wetland margins will be considered in wetland management decisions.

### 6.2.2 Alberta Public Lands Act

The province owns the bed and shore of all waterbodies that are permanent and naturally occurring, unless the title has been specifically granted to a private landowner. This includes permanent and naturally-occurring wetlands and watercourses. The *Public Lands Act* defines a permanent water body as one that exhibits persistent evidence of a bank, bed and shore and a tendency to return to normal water levels under ordinary circumstances after periods of drought or flood. Development within a Crown-owned wetland or other waterbody can be authorized under the *Act*, however, compensation for any loss would be required and any wetlands or watercourses created as compensation must revert to Crown ownership. In the case of the proposed development, the *Public Lands Act* should be considered in the context of draining/filling of wetlands.

In this case, determination of Crown ownership of any of the study area wetlands is still outstanding. The request for determination was submitted to Alberta Public Lands in mid-July 2010.

### 6.2.3 Alberta Wildlife Act

The Alberta *Wildlife Act* prohibits disturbance to a nest or den of prescribed wildlife species. The habitat of many prescribed wildlife species is present within the study area. Although permitting is not required under that *Act*, violations may result in fines. To avoid violations, Alberta Sustainable Resource Development (ASRD) recommends avoiding clearing vegetation during 15 April to 15 July. If it becomes apparent this restricted period cannot be complied with, removal of vegetation should only occur if a qualified biologist has inspected each site to be cleared and determined that no active nests or dens are present. If an active nest is found, ASRD should be contacted to determine if a buffer around the nest can be established to allow partial clearing of the area.

##### 6.2.3.1 Historic Resources Act

Any development with potential to disturb historical resources requires clearance by Alberta Culture and Community Spirit, pursuant to the *Historical Resources Act*. A Historical Resources Overview (HRO) has been completed for this project and submitted to Alberta Culture and Community Spirit. They provided the proponent with a clearance letter indicating that a Historic Resources Impact Assessment is not required for this project.

## 6.3 Federal Authorizations

### 6.3.1 Migratory Birds Convention Act

Environment Canada administers the *Migratory Birds Convention Act (MBCA),* which prohibits the disturbance of active nests of bird species covered under the *Act,* many of which could potentially occur within the study area. With respect to construction, the *Act* provides guidelines for enforcement only; it is not linked to formal approvals. Violation of the *Act* may, however, result in penalties. An amendment to the *MBCA* further protects disturbance to individual migratory birds and prohibits release of deleterious substances into waters or areas frequented by migratory birds. To ensure compliance with the *Act*, Environment Canada recommends vegetation clearing in this area be scheduled for dates outside of the spring and summer breeding season (15 April to late August). If it becomes apparent that this schedule cannot be met, removal of vegetation should only occur if a qualified biologist has inspected each site to be cleared and determined that no active nests or dens are present. If an active nest is found, clearing should not commence in that vicinity until after the young have fledged, appropriate buffers should be established in consultation with ASRD.

### 6.3.2 Species at Risk Act

The *Species At Risk Act* (*SARA*) is administered by Environment Canada. It prohibits disturbance to listed species and, in some instances, listed species' habitat. Habitat is defined not only as the area where a species naturally occurs and on which it depends to carry out its life processes, but also areas where that species formerly occurred and has the potential to be reintroduced. The *SARA* emphasizes guidelines for enforcement, and harming a Schedule 1 species (Threatened, Endangered or Extirpated) is prohibited. The vegetation and wildlife surveys undertaken for this study complies with the requirements of *SARA.*

# 7.0 SUMMARY AND CONCLUSIONS

Reperio Resources Corp. proposes to develop a gravel extraction operation on approximately 5 ½ quarter sections of land situated in the north half of Strathcona County, east of the City of Fort Saskatchewan. The lands to be mined contain several isolated wetlands and a few small patches of wooded upland habitat, but are primarily agricultural in nature. The majority of the wetlands are relatively small, temporary to seasonal in nature (i.e., Class 2 to 3), degraded as a result of agricultural activity and are characterized by a high proportion of non-native, weedy plant species. The overall low abundance of native wildlife habitat and the generally poor quality of the habitat that is available resulted in a relatively depauperate wildlife community composed primarily of common, generalist species.

Because of the inherent nature of the gravel extraction process, the proposed development plan would ultimately result in the complete removal of all natural features identified within the boundaries of the lands to be mined. In total, the area of wetland loss would be 19.88 ha.

By necessity, the post-mining landscape would include an end pit lake (EPL) in each mined quarter section. To achieve compensation for the inevitable loss of the 19.88 ha of wetland habitat, the shoreline of each EPL would be constructed and reclaimed to encourage the establishment of deep marsh, shallow marsh and wet meadow vegetation. Each EPL would also include an area of naturalized vegetation along the shoreline between 10m and 30m wide. All told, the proposed compensation plan comprises 65.61 ha of functional wetland habitat, plus an additional 6.28 ha of naturalized habitat comprising an overland drainage swale/wildlife corridor. Not only does this account for a created to lost habitat ratio of 3.3:1 in terms of area, but it is expected that the reclaimed landscape, with its large, permanent and naturalized EPLs, will provide a level of wetland function that is equivalent to, if not superior to that provided by the existing wetlands.

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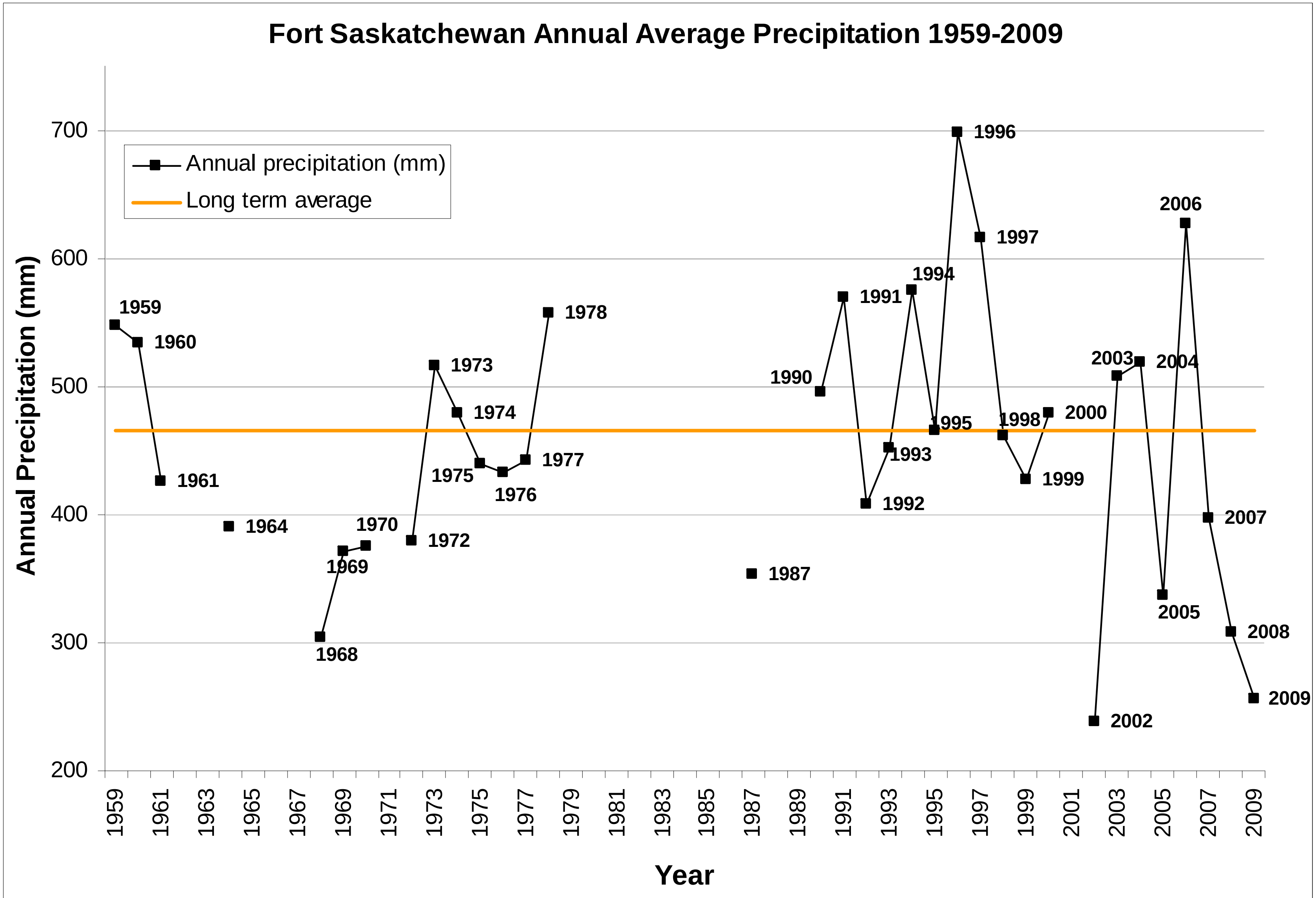
# Appendix A. Fort Saskatchewan Climate Graph (1959-2009)



Note: data from 2007 through 2009 is not available for Fort Saskatchewan; the values shown here are from the City of Edmonton

# Appendix B. Historical Aerial Photograph Record (1949-2008)

**1949**

Climatic condition: n/a

## Legend

Study Area

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

## Legend

Study Area

**May 1962**

Climatic condition: Unknown precipitation following a dry year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

## August 1970

Climatic condition: Year of below average precipitation after a dry year

**Legend**

Study Area

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

## Legend

Study Area

N

**September 1974**

Climatic condition: Year of near average precipitation after a wet year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

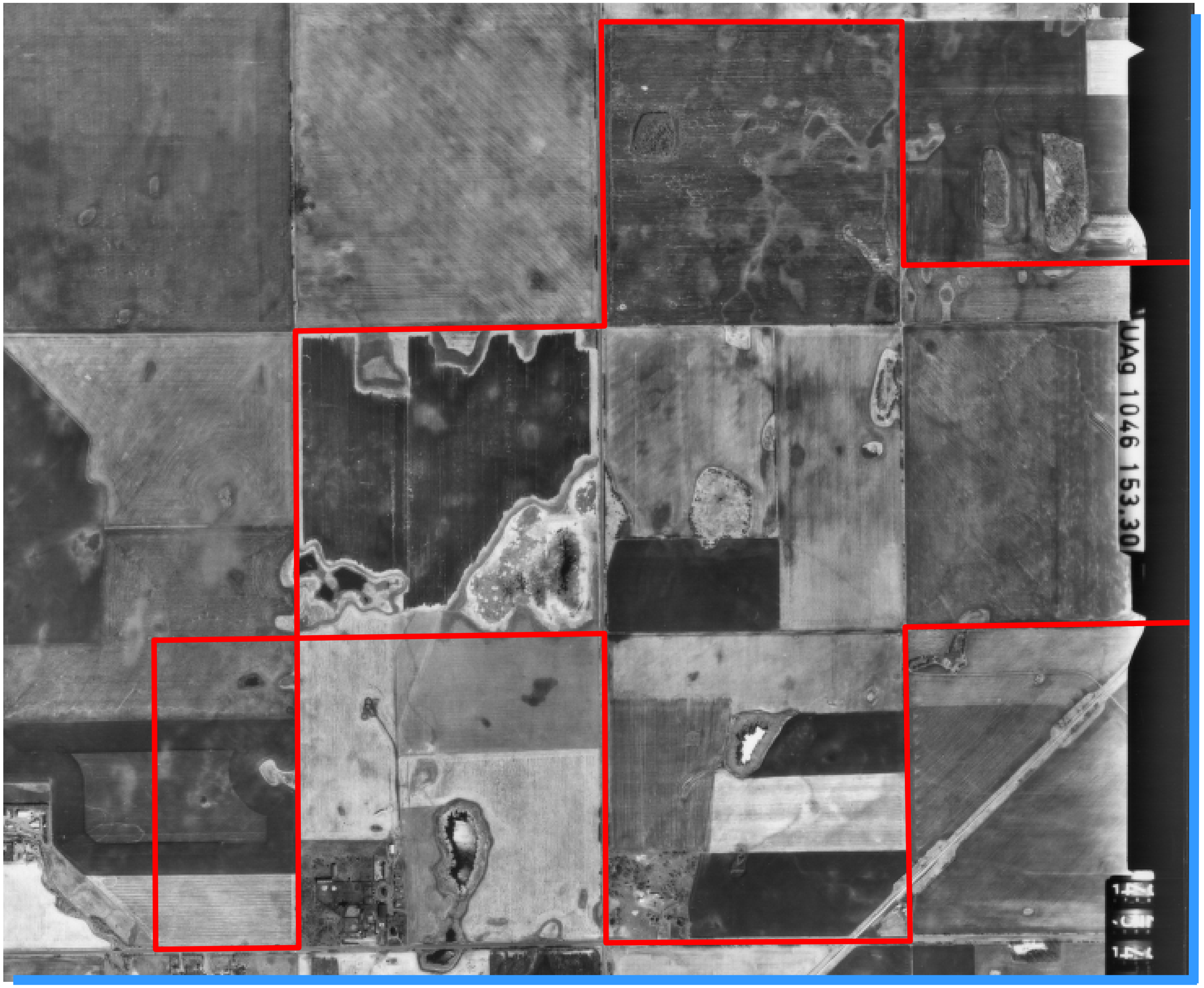
**Legend**

Study Area

**May 1978**

Climatic condition: Year of above average precipitation after a dry year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



**Legend**

Study Area

August 1982

Climatic condition: n/a

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

**July 1987**

Climatic condition: Year of below average precipitation after an unknown year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

**Legend**

Study Area

## July 1992

Climatic condition: Year of below average precipitation after a wet year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

**Legend**

Study Area


**Legend**

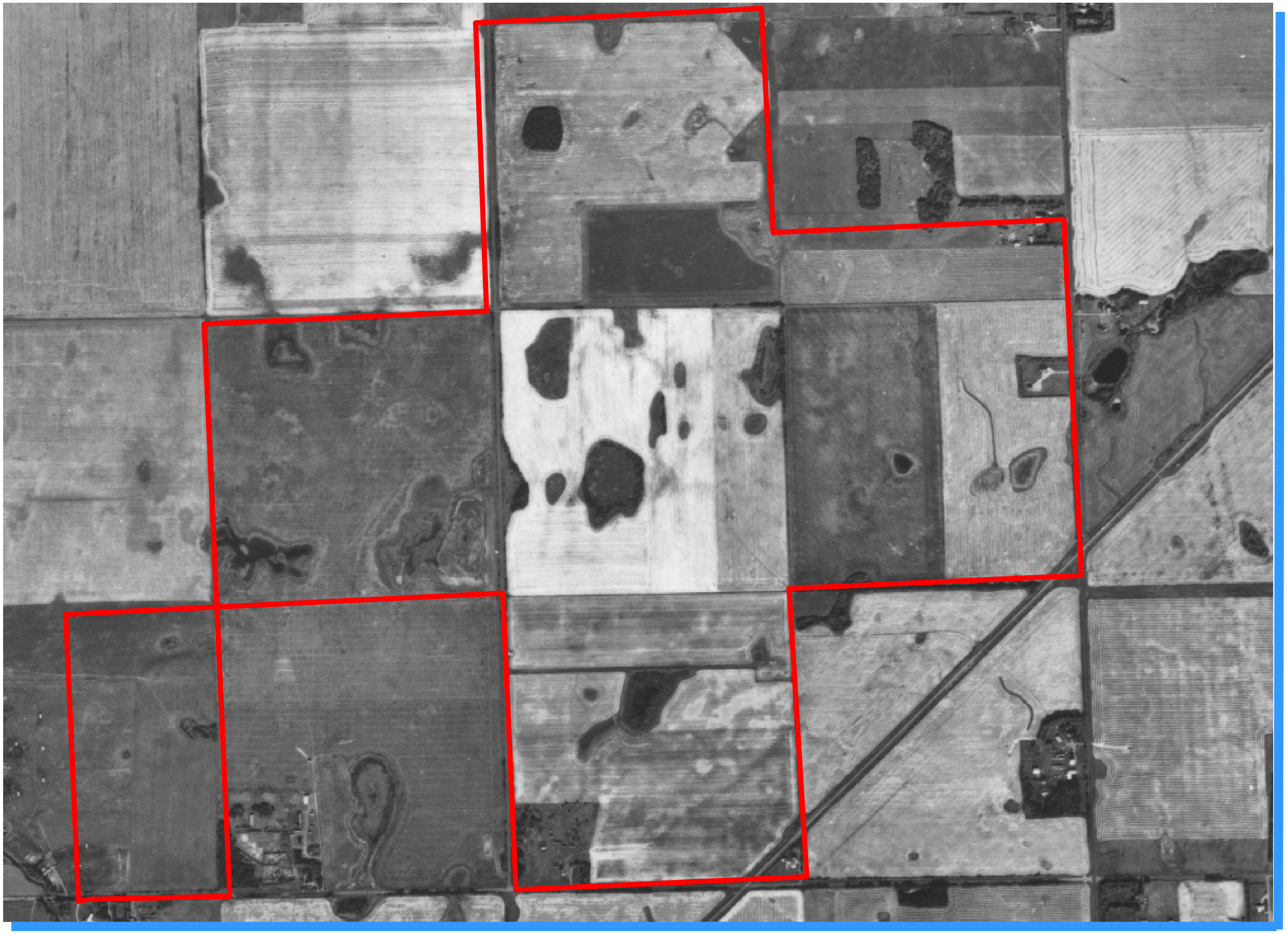
Study Area

N

## May 1993

Climatic condition: Year of near average precipitation after a dry year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.



Legend

Study Area

N

## September 1996

Climatic condition: Year of high, above average precipitation after an average year

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

**May 2001**

Climatic condition: Year of unknown precipitation after a near average year

**Legend**

Study Area

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

**Legend**

Study Area

## August 2006

Climatic condition: Year of average precipitation after a very dry year

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

**May 2008**

Climatic condition: n/a

## Legend

Study Area

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

# Appendix C. Plant Species Inventory

## Josephburg Vegetation and Rare Plant Survey - July 2010

| | | | | Site Numbers | | | | | | | | | | | | | | | | | | | | | | | | | | | | | # of Sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Form** | **Scientific Name** | **Common Name** | **Status** | **23** | **7** | **9** | **21** | **22** | **33** | **13** | **16** | **17** | **25** | **27** | **28** | **30** | **31** | **1** | **8** | **6** | **10** | **12** | **20** | **26** | **19** | **29** | **5** | **11** | **14** | **18** | **24** | **15** | **29** |
| 2 Shrub | *Acer negundo* | maple, Manitoba | Exotic | | | | | | | | | | | | | | | | | | | | | | R | | | | | | | | **1** |
| 2 Shrub | *Sorbus aucuparia* | mountain-ash, European | Exotic | | | | | | | | | | | | | | | | | | | | | R | | | | | | | | | **1** |
| 3 Forb | *Axyris amaranthoides* | Russia-pigweed | Exotic | | | | | | | O | | | | | | | | | | | | | | | O | | | | | | | | **2** |
| 3 Forb | *Brassica campestris* | mustard, rape; canola | Exotic | | | | | | F | | | | | | | R | | | O/A | | | | | | | | | | | | | | **3** |
| 3 Forb | *Capsella bursa-pastoris* | shepherds-purse | Exotic | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Chenopodium album* | goosefoot, lambs-quarters | Exotic | | | | | | | | | F/A | | | F/A | | | R | F/A | | | | | | | O | | | | | | | **5** |
| 3 Forb | *Cirsium arvense* | thistle, creeping | Exotic | | D | D | F/A | | D | D | D | D | D | D | F/A | A | D | | D | O | F | D | D | O | O | O | O | | O | O | O | | **24** |
| 3 Forb | *Crepis tectorum* | hawksbeard, annual | Exotic | | | | | O | | R | | | O | O | | | O | D | | R | | | | | | O | | | | | | | **8** |
| 3 Forb | *Descurainia sophia* | tansymustard, flixweed | Exotic | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | | **1** |
| 3 Forb | *Galeopsis tetrahit* | hempnettle, brittlestem | Exotic | | | O | O | | | O | O | | D | F/A | O/A | O | F/A | F/A | | F/D | | | D | F/D | O/A | D | O | | | F/D | O | O | **19** |
| 3 Forb | *Galium spurium* | bedstraw, false cleavers | Exotic | | | | | | | | | | | | | R | | O | | | | | | | | | | | | | | | **2** |
| 3 Forb | *Gnaphalium uliginosum* | cudweed, low marsh | Exotic | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Lappula squarrosa* | bluebur, bristly | Exotic | | | | | | | | | | | | | | | | | | | | | A | | | | | | | | | **1** |
| 3 Forb | *Linaria vulgaris* | toadflax, common | Exotic | | | | | | | | O/A | | | O/A | | | | | | | | | | | | | | | O | | | | **3** |
| 3 Forb | *Matricaria perforata* | false-mayweed, scentless | Exotic | | | | | | | R | | | | | | | | | O | | | | | | R | | | | | | | | **3** |
| 3 Forb | *Medicago sativa* | medick, lucerne | Exotic | | | | R | | | | | | | | | | | | R | | | | | | | | | | | | | | **2** |
| 3 Forb | *Melilotus officinalis* | sweetclover, yellow | Exotic | | | R | | | | | | | | | | | | | R | | R | | | | | | | | | | | | **3** |
| 3 Forb | *Plantago major* | plantain, common | Exotic | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | **1** |
| 3 Forb | *Polygonum arenastrum* | knotweed, common | Exotic | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | **1** |
| 3 Forb | *Polygonum convolvulus* | twining-knotweed, black | Exotic | | | | | | | | | | | | | O/A | | O | O | O | | | | | | | | | O | | | | **5** |
| 3 Forb | *Sonchus asper* | sowthistle, prickly annual | Exotic | | | | | | | | | | | | | | | | R | | | | | | | | | | | | | | **1** |
| 3 Forb | *Sonchus uliginosus* | sowthistle, perennial | Exotic | | D | D | D | | | D | F/A | O/A | F/A | A | D | O | D | A | D | A | A | O | | F/A | | O | | | O | O | O | O | **22** |
| 3 Forb | *Stellaria media* | starwort, chickweed | Exotic | | | | | | | | | | | | | | | | | | | | | O | | R | | | | | | | **2** |
| 3 Forb | *Taraxacum officinale* | dandelion, common | Exotic | | | O | | D | O | O | | O | F | O | O | F | | A | | R | D | | | | | O | R | | O | O | O | O | **18** |
| 3 Forb | *Thlaspi arvense* | pennycress, stinkweed | Exotic | | O | O | O | O | | O | O | O | O | O | O | O | O | A | O | O | O | R | | | | F | | | | | | | **18** |
| 3 Forb | *Tragopogon dubius* | goatsbeard, stoutstalk | Exotic | | | | | | | R | | | | | | | | | | | | | | | | | | | | | | | **1** |
| 3 Forb | *Trifolium hybridum* | clover, alsike | Exotic | | | | | | | | | | | O | | O/A | O/A | | O | | | | | | | | | | | | | | **4** |
| 4 Gram | *Agropyron repens* | wildrye, quackgrass | Exotic | D | D | D | D | D | D | | D | O | O/A | O/D | D | | D | | D | D | | | | O | O/D | D | | D | | | O/A | | **18** |
| 4 Gram | *Alopecurus pratensis* | meadow-foxtail, field | Exotic | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | | **1** |
| 4 Gram | *Bromus inermis ssp. inermis* | brome, smooth | Exotic | | O | R | F/D | | | O | O/D | R | O/D | O/D | | | O | O | O | R | D | | D | | D | | D | | D | D | D | D | **20** |
| 4 Gram | *Phleum pratense* | timothy, common | Exotic | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | **1** |
| 4 Gram | *Poa pratensis* | bluegrass, Kentucky | Exot/Ntv | | | O | F/D | O | | O | F/A | | | | | | | | | | F/D | | | | O | | O | D | F | O/A | O | | **12** |
| 1 Tree | *Populus balsamifera* | poplar, balsam | Native | | | | | | | | | | | | | | | | | | | | O | | O | | O | D | | O/D | | O/D | **6** |
| 1 Tree | *Populus tremuloides* | poplar, aspen | Native | | | | | | | | | | | | | | | | | | | | | | D | D | D | D | D | D | D | D | **8** |
| 2 Shrub | *Amelanchier alnifolia* | serviceberry, saskatoon | Native | | | | | | | | | | | | | | | | | | | | | | F/A | | | | | O | | | **2** |
| 2 Shrub | *Cornus stolonifera* | dogwood, red-osier | Native | | | | | | | | | | O | | | | | | | O/A | R | A | O | D | A | O | | D | A | D | D | O | **13** |
| 2 Shrub | *Lonicera dioica* | twining-honeysuckle, limber | Native | | | | | | | | | | | | | | | | | | | | | | R | | | O | | | | | **2** |
| 2 Shrub | *Populus balsamifera* | poplar, balsam | Native | | O | | | | | | | | | | | | | | | | | R | F | O | | | | | | | O | | **5** |
| 2 Shrub | *Populus tremuloides* | poplar, aspen | Native | | O | | | | | | | | R | | | | | | | | | R | | O | O | D | O | D | O | A | F | D | **12** |
| 2 Shrub | *Prunus virginiana* | cherry, choke | Native | | | | | | | | | | | | | | | | | | | | | | O | | O | | | | | O | **3** |
| 2 Shrub | *Ribes americanum* | currant, wild black | Native | | | | | | | R | | | | | | | | | | O | | O | O | | O | | | O | | O | | O | **8** |
| 2 Shrub | *Ribes hirtellum* | gooseberry, wild | Native | | | | | | | | | | | | | | | | | | R | | | O | O | | | O | | O | | | **5** |
| 2 Shrub | *Ribes triste* | currant, wild red | Native | | | | | | | | | | | | | | | | | | | | | | R | | | | | | | | **1** |
| 2 Shrub | *Rosa acicularis* | rose, prickly | Native | | | R | R | | | | | | | | | | | | | O | O | | O | | F | | O | O | A | | | F | **10** |
| 2 Shrub | *Rosa woodsii* | rose, Woods | Native | | O | | | | | | O/D | | | | | | | | | | | | | | | | | | D | | O/A | | **4** |
| 2 Shrub | *Rubus idaeus* | raspberry, wild red | Native | | | | | | | | O | | | | | | | | | | | | O | O | D | | F | | O | D | | O | **8** |
| 2 Shrub | *Salix bebbiana* | willow, Bebb | Native | | | | | | | | O | | | | | | | | | | | | | | | | | | | | | D | **2** |
| 2 Shrub | *Salix discolor* | willow, pussy | Native | | | | | | | | | | | | | | | O | | D | | | D | O/D | | | | | | | | D | **5** |
| 2 Shrub | *Salix petiolaris* | willow, meadow | Native | | O | R | | | | | O | | O | O | O/D | | O | O | | D | D | D | | D | | | | O | O | R | O | O | **17** |
| 2 Shrub | *Salix* sp. | willow | Native | | | | | | | | | | | | | | | O | | | | | | | O | O | | | | | O | O | **5** |
| 2 Shrub | *Symphoricarpos occidentalis* | snowberry, western | Native | | | | O | | | | O | | | | | | | | | | R | | | | D | O | | D | D | O | | F | **9** |
| 3 Forb | *Achillea millefolium* | yarrow, common | Native | | | O | O | | | | | | | | | | | | | | O | | | | | | | | | | | | **3** |
| 3 Forb | *Achillea sibirica* | yarrow, Siberia | Native | | | | | | | O | | | | | | | | | | | | O | | | | | | | | | | | **2** |
| 3 Forb | *Actaea rubra* | baneberry, red | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | R | | | **1** |
| 3 Forb | *Agrimonia striata* | agrimony, woodland | Native | | | | | | | | | | | | | | | | | | | | O | | F | | | | | O | O | | **4** |
| 3 Forb | *Anemone canadensis* | anemone, Canada | Native | | | O | | | | | O | | | | | | | | | | | | O | | O | | | O | | O | | O | **7** |
| 3 Forb | *Artemisia biennis* | wormwood, biennial | Native | | | | | O | | | | O | O | O | F | | | O | F | | | R | | | | A | | | | | | | **9** |
| 3 Forb | *Artemisia ludoviciana* | sagebrush, white | Native | | | | R | | | | | | | | | | | | | | | | | | | | | | O | | | | **2** |
| 3 Forb | *Aster ciliolatus* | American-aster, fringed | Native | | | | | | | | | | | | | | | | | | | | O | | O | | | | | | | | **2** |
| 3 Forb | *Aster hesperius* | American-aster, whitepanicle | Native | | | A | O | | | O | O | | | | | | | | | | | O | | | | | | | | | | | **5** |
| 3 Forb | *Aster laevis* | American-aster, smooth | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Aster puniceus* | American-aster, purplestem | Native | | | | | | | R | | | | | | | | | | | | | | | | | | | | | | | **1** |
| 3 Forb | *Aster* sp. | aster | Native | | | | | | | | | | | | | | | | R | | | | | | | | | | | | | | **1** |
| 3 Forb | *Astragalus dasyglottis* | milkvetch, purple | Native | | | | | | | | | | | | | | | | | | D | | | | | | | | | | | | **1** |
| 3 Forb | *Atriplex* sp. | orache | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Callitriche verna* | water-starwort, vernal | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Campanula rotundifolia* | bellflower, bluebell | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Cerastium arvense* | mouse-ear-chickweed, field | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| 3 Forb | *Cicuta maculata* | water-hemlock, spotted | Native | | | F | | | | O | F | | | | | | | | | | O | F | | | | | | | | | | | **5** |
| 3 Forb | *Collomia linearis* | collomia, narrowleaf | Native | | | | | | | | | | | O | | O | O | O | | | | | | | | | O | | | | | | **5** |
| 3 Forb | *Epilobium angustifolium* | fireweed, common | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | O | | **1** |
| 3 Forb | *Epilobium ciliatum* | willowherb, fringed | Native | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | | **1** |
| 3 Forb | *Equisetum arvense* | horsetail, common | Native | | | | | | O | | | | | O | | | | | | O | | | | O/A | | | | | | | | | **4** |
| 3 Forb | *Erigeron philadelphicus* | fleabane, Philadelphia | Native | | | | | | | R | O | | | | | | | | | | O | | | | | | | | | | | | **3** |
| 3 Forb | *Erysimum cheiranthoides* | wallflower, wormseed | Native | | O | F | O | | O | F/A | | F | O | O | O | O | O | O | | O | | | | O | | O | | | | | | | **15** |
| 3 Forb | *Fragaria virginiana* | strawberry, common wild | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | O | | **1** |
| 3 Forb | *Galium boreale* | bedstraw, northern | Native | | | | O | | | | O | | | | | | | | | | | | | | O | | | O | O | O | | | **6** |
| 3 Forb | *Galium trifidum* | bedstraw, small | Native | | | | | | O | O | | O | | | | | | O/A | | | | | | | | | | | | | | | **4** |
| 3 Forb | *Galium triflorum* | bedstraw, fragrant | Native | | | | | | | | | | | | | | | | | | | | O | | O | | | | | O | | | **3** |
| 3 Forb | *Geum aleppicum* | avens, yellow | Native | | | O | | | | | | | | | | | | | | | O | O | O | | | | | | | O | O | O | **7** |

**Josephburg Vegetation and Rare Plant Survey - July 2010**

| Form | Scientific Name | Common Name | Status | Site Numbers | | | | | | | | | | | | | | | | | | | | | | | | | | | | | # of Sites |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 23 | 7 | 9 | 21 | 22 | 33 | 13 | 16 | 17 | 25 | 27 | 28 | 30 | 31 | 1 | 8 | 6 | 10 | 12 | 20 | 26 | 19 | 29 | 5 | 11 | 14 | 18 | 24 | 15 | 29 |
| 3 Forb | *Geum macrophyllum* | avens, largeleaf | Native | | | | | | | | | | | | | | | | | | | | O | | O | | | | | | | | 2 |
| 3 Forb | *Helianthus nuttallii* | sunflower, common tall | Native | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 3 Forb | *Heracleum lanatum* | cowparsnip, common | Native | | | | | | | | | | | | | | | | | | | | O | | O/A | | | | | | | | 2 |
| 3 Forb | *Lathyrus ochroleucus* | peavine, creamy | Native | | | | | | | | | | | | | | | | | | | | O | | | | | | | | O | | 2 |
| 3 Forb | *Lemna minor* | duckweed, common | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Lycopus asper* | water-horehound, western | Native | | | | | | | | | | | | | | | | | | | O | | | | | | | | | | | 1 |
| 3 Forb | *Lysimachia ciliata* | yellow-loosestrife, fringed | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | F | | | 1 |
| 3 Forb | *Mentha arvensis* | mint, wild | Native | | | O | O | | | A | F/A | | | | O | | | D | O | | | O | | O | | | | | | | | | 9 |
| 3 Forb | *Mertensia paniculata* | bluebells, tall | Native | | | | | | | | | | | | | | | | | | | | | | O | | | | | | | | 1 |
| 3 Forb | *Moehringia lateriflora* | grove-sandwort, bluntleaf | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | O | | | 1 |
| 3 Forb | *Petasites vitifolius* | sweet-coltsfoot, vineleaf | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Petasites sagittatus* | sweet-coltsfoot, arrowleaf | Native | | | | | | | | | | | | O | | | O | | | | | O | | O | | | | | | O | O | 6 |
| 3 Forb | *Polygonum amphibium* | smartweed, water | Native | | | | | | | | | | | O | O | O | | | | R | | | | O | | O | | | | | | | 6 |
| 3 Forb | *Polygonum lapathifolium* | smartweed, pale | Native | | | | | | O | | | O | | O | | | | F/A | O | | | | | | | | | | | | | | 5 |
| 3 Forb | *Polygonum* sp. | smartweed | Native | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | 1 |
| 3 Forb | *Potamogeton pusillus* | pondweed, small | Native | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | 1 |
| 3 Forb | *Potentilla anserina* | silverweed, common | Native | | | F/D | R | | | | O | | | | | | | | | | A | O | | | | | | | O | | | | 6 |
| 3 Forb | *Potentilla norvegica* | cinquefoil, rough | Native | | | | | | | O | | O | | | O | O | O | O | | O | | | | | | | | | | | | | 7 |
| 3 Forb | *Potentilla rivalis* | cinquefoil, brook | Native | | | | | | O | F/A | | A | | | | | O/A | D | O | | | | | | | | | | | | | | 6 |
| 3 Forb | *Ranunculus circinatus* | water-crowfoot, firm white | Native | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | 1 |
| 3 Forb | *Ranunculus gmelinii* | water-crowfoot, small yellow | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Ranunculus macounii* | buttercup, Macoun | Native | | | | | | | | | | | | | | | O | | | | R | | | | | | | | | | | 2 |
| 3 Forb | *Ranunculus pensylvanicus* | buttercup, Pennsylvania | Native | | F | | | | | | | | | | | | O | O | | O | | | | | | | | | | | | | 4 |
| 3 Forb | *Ranunculus sceleratus* | buttercup, celeryleaf | Native | | | | | | | | | | | | | | | | R | | | | | | | | | | | | | | 1 |
| 3 Forb | *Rorippa palustris* | yellowcress, marsh | Native | | | | | | O | | | O | | | | | O | D | O | | | | | | | | | | | | | | 5 |
| 3 Forb | *Rubus pubescens* | dewberry | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | O | | | 1 |
| 3 Forb | *Rumex maritimus* | dock, golden | Native | | | | | | | | | | | | | | | O | O | | | | | | | | | | | | | | 2 |
| 3 Forb | *Rumex triangulivalvis* | dock, willowleaf | Native | | O | O | | | | | A | O | O | O | | | O/A | D | | O | | | | O | | R | | | | | | | 11 |
| 3 Forb | *Sagittaria cuneata* | arrowhead, arumleaf | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Scutellaria galericulata* | skullcap, marsh | Native | | | | | | | | | | | | | | | | | | | O | O | O | O | | | O | | | | | 5 |
| 3 Forb | *Senecio congestus* | ragwort, marsh | Native | | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | 1 |
| 3 Forb | *Sisyrinchium montanum* | blue-eyed-grass, common | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Sium suave* | waterparsnip, common | Native | | | | | | | | | O | | | | O | | O | | | | | | | | | | | | | | | 3 |
| 3 Forb | *Smilacina stellata* | false-lily-of-the-valley, starry | Native | | | | | | | | O | | | | | | | | | | | O | O | | | | | | F | | | | 4 |
| 3 Forb | *Solidago canadensis* | goldenrod, Canada | Native | | | | O | | | | | | | | | | | | | | | | O | | O | | | | | | | O | 4 |
| 3 Forb | *Sparganium angustifolium* | burreed, narrowleaf | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 3 Forb | *Stachys palustris* | hedgenettle, hairy | Native | | | O | O | | | O | O | | | O | | R | O | O | | O | | F | F | O | F | | | | | O | O | O | 16 |
| 3 Forb | *Stellaria longifolia* | starwort, longleaf | Native | | | | | | | O | O | | | | | | | | | | | | O | | R | | | | | | | | 4 |
| 3 Forb | *Thalictrum dasycarpum* | meadowrue, tall | Native | | | | | | | | | | | | | | | | | | | | | | R | | | | | | | | 1 |
| 3 Forb | *Thalictrum venulosum* | meadowrue, veiny | Native | | | | | | | | | | | | | | | | | | | | R | | O | | | O | O | | | | 4 |
| 3 Forb | *Typha latifolia* | cattail, common | Native | | | | | | | | | R | | | | | | D | | | | | | | | | | | | | | | 2 |
| 3 Forb | *Urtica dioica* | nettle, stinging | Native | | | | O | | | O | F/A | | O | | | | O/A | O | O | | | | | | A | O | O | F | | F/D | O | O | 14 |
| 3 Forb | *Vicia americana* | vetch, America | Native | | O | O | | | | | O | | | O | | | | | | R | | | O | | O | | | | O | O | O | O | 11 |
| 3 Forb | *Viola canadensis* | violet, Canada | Native | | | | | | | | | | | | | | | | | | | | R | | | | | | | | | | 1 |
| 3 Forb | *Zannichellia palustris* | horned-pondweed | Native | | | | | | | | | | | | | | | | O/A | | | | | | | | | | | | | | 1 |
| 4 Gram | *Alopecurus aequalis* | meadow-foxtail, shortawn | Native | | | | | | | R | | | | | | | | O/D | | | | | | | | | | | | | | | 2 |
| 4 Gram | *Beckmannia syzigachne* | sloughgrass | Native | | | | | | | O | | | | | | | O | A | D | | | | | | | O | | | | | | | 5 |
| 4 Gram | *Calamagrostis canadensis* | reedgrass, bluejoint | Native | | | | | | | R | | | | | | | | | | | | | O/A | | | | | | | | | | 2 |
| 4 Gram | *Carex aquatilis* | sedge, water | Native | | | | | | | | | | | | | | | | | | | | | O | | | | | | | | | 1 |
| 4 Gram | *Carex atherodes* | sedge, awned | Native | | | O | | | | D | D | D | D | D | | O/D | F/D | D | | O/D | | A | | F/D | | O | | O | | | | R | 15 |
| 4 Gram | *Carex deweyana* | sedge, Dewey | Native | | | | | | | | | | | | | | | | | | | | O | O/A | | | | | | | | | 2 |
| 4 Gram | *Carex praticola* | sedge, northern meadow | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 4 Gram | *Carex retrorsa* | sedge, turned | Native | | | | | | | | | | | | R | | | | | | | | | | | | | | | | | | 1 |
| 4 Gram | *Carex* sp. | sedge | Native | | | O | | | | | O | | | | | | | | | | | | | | | | | D | | | | | 3 |
| 4 Gram | *Carex sychnocephala* | sedge, manyhead | Native | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 4 Gram | *Carex utriculata* | sedge, bottle | Native | | | | | | | | | O | O | | O/D | | O | O | | O | | | | | | O | | | | | | | 7 |
| 4 Gram | *Eleocharis palustris* | spikerush, common | Native | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | | 1 |
| 4 Gram | *Glyceria borealis* | mannagrass, northern | Native | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 4 Gram | *Glyceria grandis* | mannagrass, common tall | Native | | | | | | | | | | | | R | | | D | | | | | | | | | | | | | | | 2 |
| 4 Gram | *Hierochloe odorata* | sweetgrass, northern | Native | | | D | | | | | | | | | | | | | | | O | | | | | | | | | | | | 2 |
| 4 Gram | *Hordeum jubatum* | barley, foxtail | Native | | | | | D | | O | | O/A | | | | | O | O/A | F | | | | | | | | | | | | | | 6 |
| 4 Gram | *Juncus balticus* | rush, wire | Native | | | | | | O | | O | | | | | | | | | | O | | | | | | | | | | | | 3 |
| 4 Gram | *Phalaris arundinacea* | canarygrass, reed | Native | | F/D | | R | | | F/D | | D | O | | | D | F/D | O/A | O | O/D | | O | | | | | | O | | | | O | 13 |
| 4 Gram | *Poa palustris* | bluegrass, fowl | Native | | D | A | | A | | O | | O | F/A | | D | A | D | O | A | D | O | D | F | F | | O | | | | O | O | O | 20 |
| 4 Gram | *Scirpus acutus* | clubrush, hardstem | Native | | | | | | | | | R | | | | | | | D | | | | | | | | | | | | | | 2 |
| 4 Gram | *Scirpus validus* | clubrush, softstem | Native | | | | | | | | | | | | | | | O | | | | | | | | | | | | | | | 1 |
| 4 Gram | *Scolochloa festucacea* | rivergrass, common | Native | | | | | | | | | | | | | | | D | | | | | | | | | | | | | | | 1 |
| | | | **Site #** | **23** | **7** | **9** | **21** | **22** | **33** | **13** | **16** | **17** | **25** | **27** | **28** | **30** | **31** | **1** | **8** | **6** | **10** | **12** | **20** | **26** | **19** | **29** | **5** | **11** | **14** | **18** | **24** | **15** | |
| | | | **Site type*** | **WM** | **WM** | **WM** | **WM** | **WM** | **WM** | **SM** | **SM** | **SM** | **SM** | **SM** | **SM** | **SM** | **SM** | **DM** | **DM** | **SW** | **SW** | **SW** | **SW** | **SW** | **DW** | **DW** | **DW** | **DW** | **DW** | **DW** | **DW** | **DW** | **Overall Totals** |
| | | | Wetland or upland | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | W | UP | UP | UP | UP | UP | UP | UP | UP | |
| | | | Total species richness | 1 | 15 | 26 | 22 | 9 | 12 | 32 | 29 | 23 | 19 | 21 | 18 | 18 | 24 | 44 | 34 | 26 | 21 | 23 | 30 | 25 | 39 | 23 | 13 | 20 | 21 | 29 | 24 | 27 | **132** |
| | | | Non-native spp richness | 1 | 5 | 9 | 8 | 6 | 4 | 11 | 8 | 7 | 8 | 10 | 7 | 9 | 8 | 11 | 15 | 9 | 7 | 3 | 3 | 7 | 8 | 9 | 5 | 2 | 7 | 6 | 7 | 4 | **32** |
| | | | Native spp richness | 0 | 10 | 17 | 14 | 3 | 8 | 21 | 21 | 16 | 11 | 11 | 11 | 9 | 16 | 33 | 19 | 17 | 14 | 20 | 27 | 18 | 31 | 14 | 8 | 18 | 14 | 23 | 17 | 23 | **115** |
| | | | % non-native | 100 | 33 | 35 | 36 | 67 | 33 | 34 | 28 | 30 | 42 | 48 | 39 | 50 | 33 | 25 | 44 | 35 | 33 | 13 | 10 | 28 | 21 | 39 | 38 | 10 | 33 | 21 | 29 | 15 | **21.8** |

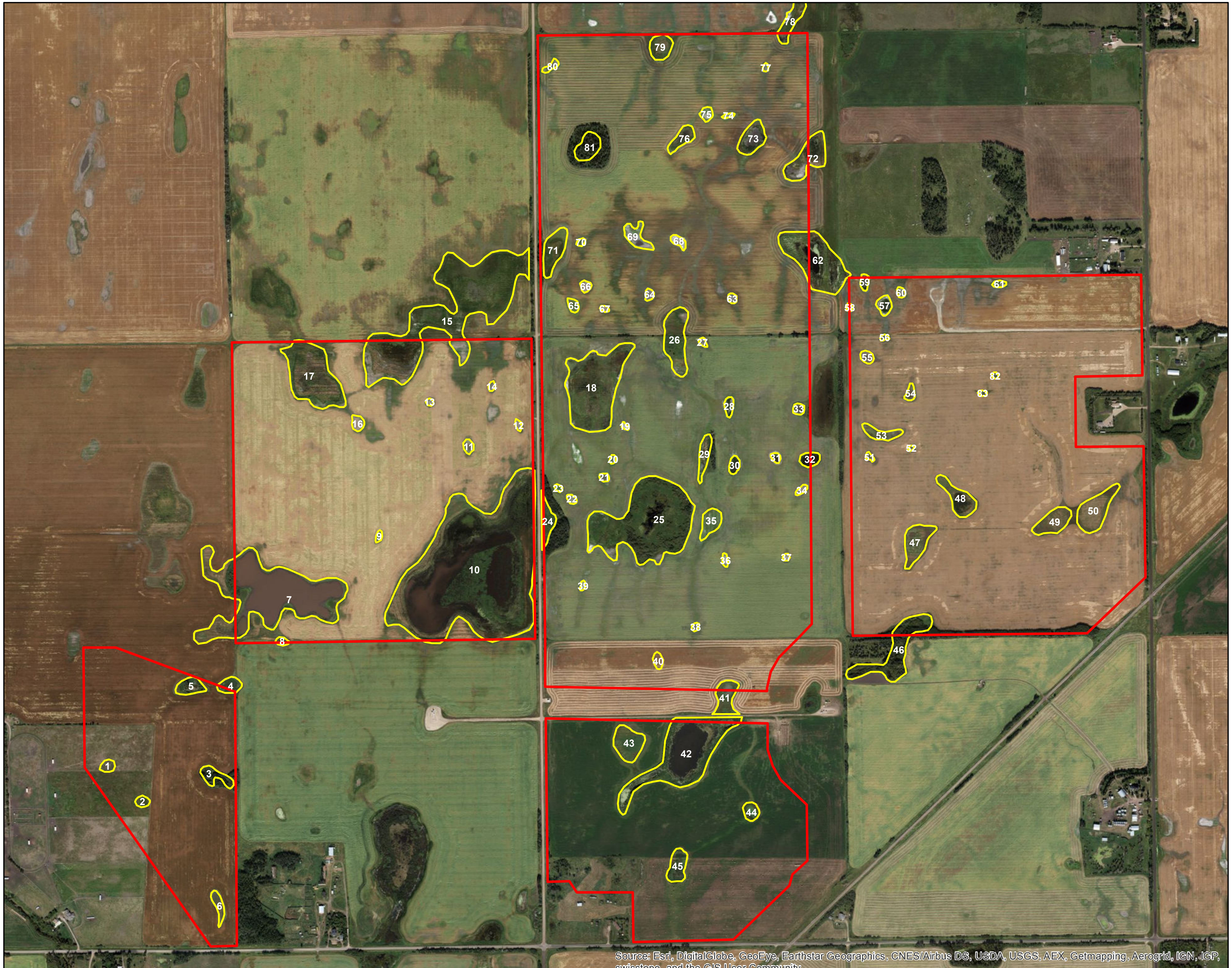
*WM = wet meadow
SM = shallow marsh
DM = deep marsh
SW = shrub wetland;
DW = deciduous woodland

# Appendix D. Special Status Species with the Potential to Occur in the Study Area

**List of special status wildlife species with a potential to occur in the Josephburg gravel extraction subject parcel**

| Common Name | Scientific Name | Provincial Status (General Status of AB Wild Species) | Wildlife Act Designation and New Species Assessed by ESCC | COSEWIC Designation | SARA Designation |
|---|---|---|---|---|---|
| Short-eared Owl | *Asio flammeus* | May be At Risk | | Special Concern | Schedule 3 (Special Concern) |
| Canadian Toad | *Bufo hemiophrys* | May be At Risk | Data Deficient | MP Candidate (SSC) | |
| Long-tailed Weasel | *Mustela frenata* | May be At Risk | | Not at Risk | |
| Northern Bat | *Myotis septentrionalis* | May be At Risk | Special Concern | | |
| Barn Swallow | *Hirundo rustica* | Sensitive | | HP Candidate | |
| Lesser Scaup | *Aythya affinis* | Sensitive | | LP Candidate (SSC) | |
| Northern Harrier | *Circus cyaneus* | Sensitive | | Not at Risk | |
| Horned Grebe | *Podiceps auritus* | Sensitive | | Special Concern | |
| Rusty Blackbird | *Euphagus carolinus* | Sensitive | | Special Concern | Schedule 1 (Threatened) |
| Sprague's Pipit | *Anthus spragueii* | Sensitive | Special Concern | Threatened | Schedule 1 (Threatened) |
| Common Nighthawk | *Chordeiles minor* | Sensitive | | Threatened | Schedule 1 (Threatened) |
| Green-winged Teal | *Anas crecca carolinensis* | Sensitive | | | |
| Pied-billed Grebe | *Podilymbus podiceps* | Sensitive | | | |
| Great Blue Heron | *Ardea herodias* | Sensitive | | | |
| Black-crowned Night Heron | *Nycticorax nycticorax* | Sensitive | | | |
| Swainson's Hawk | *Buteo swainsoni* | Sensitive | | | |
| Sora | *Porzana carolina* | Sensitive | | | |
| Least Flycatcher | *Empidonax minimus* | Sensitive | | | |
| Eastern Phoebe | *Sayornis phoebe* | Sensitive | | | |
| Purple Martin | *Progne subis* | Sensitive | | | |
| Common Yellowthroat | *Geothlypis trichas* | Sensitive | | | |
| Baltimore Oriole | *Icterus galbula* | Sensitive | | | |
| Hoary Bat | *Lasiurus cinereus* | Sensitive | | | |
| Sharp-tailed grouse | *Tympanuchus phasianellus* | Sensitive | | | |
| Canada Warbler | *Wilsonia canadensis* | Sensitive | | Threatened | Schedule 1 (Threatened) |
| Western Toad | *Bufo boreas* | Sensitive | | Special Concern | Schedule 1 (Special Concern) |
| Pileated Woodpecker | *Dryocopus pileatus* | Sensitive | | | |
| Silver-haired Bat | *Lasionycteris noctivagans* | Sensitive | | | |
| Plains Garter Snake | *Thamnophis radix* | Sensitive | MP Candidate | | |
| Red-sided Garter Snake | *Thamnophis sirtalis* | Sensitive | LP Candidate | | |
| Northern Pintail | *Anas acuta* | Sensitive | | | |
| Yellow Rail | *Coturnicops noveboracensis* | Undetermined | | Special Concern | Schedule 1 (Special Concern) |

**Figure 1. Wetland Boundaries - 2016**




**Legend**

Study Area

Wetland Boundaries (2016)

N

0 80 160 320 Meters

1:9,750

Date Map Created: 02 June 2016

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

# Appendix J

Bunt & Associates Transportation Impact Assessment

TRANSPORTATION PLANNERS AND ENGINEERS

# Josephburg Area Gravel Extraction Operation
# Transportation Impact Assessment

## Final Report

Prepared for

Reperio Resources

Date

October 20, 2011

Prepared by

Bunt & Associates

Project No.

3363.01

# CORPORATE AUTHORIZATION

This document entitled "Josephburg Area Gravel Extraction Operation, Traffic Impact Assessment, Final Report" was prepared by Bunt & Associates for the benefit of the Client to whom it is addressed. The information and data in the report reflects Bunt & Associates best professional judgment in light of the knowledge and information available to Bunt & Associates at the time of preparation. Except as required by law, this report and the information and data contained are to be treated as confidential and may be used and relied upon only by the client, its officers and employees. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Bunt & Associates accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

PERMIT TO PRACTICE
BUNT & ASSOCIATES (N. ALBERTA) LTD.
Signature
Date Oct 21, 2011
PERMIT NUMBER: P 7991
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Corporate Permit

PROFESSIONAL ENGINEER
JANELLE B. WILLIS
ALBERTA

Oct. 21, 2011

Engineer's Stamp

# TABLE OF CONTENTS

## EXHIBITS

# TABLES

# 1. INTRODUCTION

Reperio Resources is a privately held Edmonton based company which is focused on the acquisition, exploration, and development of aggregate resource properties in Alberta. Reperio currently owns or leases a total of 5.5 quarter sections of land 2.0 km southwest of the Hamlet of Josephburg in Strathcona County, and wish to begin pit development of the first phase (3 quarter sections) in late 2011 to early 2012. Aggregate reserves associated with the first phase are anticipated to be extracted over the next 10 years, and will serve Sherwood Park, Edmonton, and the Industrial Heartland

In order to obtain County and Provincial approvals, Bunt & Associates was retained by Reperio Resources to complete a traffic impact assessment (TIA) that evaluates the traffic characteristics associated with the first phase of the proposed gravel extraction operation. Specifically, the TIA reviews the potential traffic impacts along the proposed haul route over the next 20 years and identifies any improvements required to maintain appropriate levels of service based on Alberta Transportation and County of Strathcona guidelines.

## 1.1 Study Purpose and Objectives

The operation of the proposed gravel extraction and processing facility has the potential to impact adjacent County and Provincial roadway networks through the addition of employee and truck haul traffic. To provide safe and efficient access capabilities to existing and future land uses, consideration must be given to the incremental increase in site traffic generated by the proposed resource extraction operation.

The primary purpose for completing the study was to ensure that the existing and future roadway network and key study area intersections are appropriately designed and constructed to accommodate all roadway users at safe and satisfactory levels of transportation service.

The primary objectives of the assignment were to:

- Identify anticipated trip generating characteristics of the proposed gravel extraction operation;
- Assess the traffic impacts of the proposed gravel extraction operation on the adjacent roadway network;
- Evaluate the total projected traffic activity along the proposed haul route, including intersection operations at key intersections and access points; and,
- Identify the roadway geometry, cross section, and traffic control required at key intersections and access points to accommodate the additional traffic generated by the operation.

## 1.2 Study Methodology

The analysis and assessment presented in the following sections reflects an understanding of the development site's location attributes, site access requirements and adjacent traffic accommodation issues and concerns. The assessment was completed using the following methodology:

- Examining the existing conditions related to land use, roadways, and traffic conditions, peak flows and operational characteristics adjacent to the resource extraction area;
- Identifying the proposed future roadway network adjacent to the operation area and forecast background traffic conditions;
- Estimating future trips anticipated to be generated by the gravel extraction operation;
- Distributing and assigning of resource extraction generated trips based on the proposed roadway network and access strategy;
- Completing an overall analysis and assessment of the estimated roadway volumes within the study area to identify lane requirements, capacity restrictions, and traffic impacts of the operation; and,
- Identifying roadway improvement requirements and intersection and traffic control mitigation measures to ensure that safe and reasonable levels of traffic service are maintained.

## 1.3 Area of Significant Traffic Impact

It has been assumed that the plan-area generated traffic will predominantly impact Range Road 221, Township Road 550 (Josephburg Road), Highway 830, and Highway 16. The study area selected for assessment purposes predominantly includes these roadways and associated intersections.

# 2. SITE CONTEXT – AREA CONDITIONS

## 2.1 Site Location and Adjacent Land Uses

The overall site is generally located on the east and west sides of Range Road 221, north of Township Road 544, approximately 2.0 km southwest of Josephburg in Strathcona County. The first phase of the gravel extraction operation will concentrate on three quarter sections of land on the east side of Range Road 221, immediately north of Township Road 544, as shown in **Exhibit 2-1**. The site is currently zoned AG – Agriculture: General under the Strathcona County Land Use Bylaw 8-2001. Lands adjacent to the proposed gravel extraction operation are also designated AG – Agriculture: General.

## 2.2 Existing Conditions

### 2.2.1 Existing Roadway Network

The existing roadway network anticipated to be utilized by the gravel extraction operation includes two main Provincial highways, Highway 16 and Highway 830, and multiple County roadways. Photographs of the existing roadways are provided in **Appendix A**.

**Highway 16** is a paved east/west four-lane divided highway located south of the proposed development. The paved surface is approximately 12.1 metres wide eastbound and 11.2 metres wide westbound with shoulders and a posted speed limit of 110 km/h. Lighting is not provided along Highway 16 except at the Highway 830 intersection.

**Highway 830** is a north/south paved roadway approximately 8.7 metres wide north of Highway 16 and 7.3 metres wide south of Highway 16. The posted speed limit along Highway 830 transitions from 80 km/h north of Highway 16, to 100 km/h north of Township Road 534, to 70 km/h south of Township Road 550, and back to 100 km/h north of Township Road 550. Street lighting is not provided along Highway 830 except at the Highway 16 intersection. It is also noted that Highway 830 is a bus route utilized by a number of County schools, and provides multiple direct accesses to residential properties.

The intersection of **Highway 16** and **Highway 830** is a four-legged major road intersection on a four-lane divided highway with stop control on the north and south approaches along Highway 830. Highway 16 has been widened to include exclusive left and right turn bays on the east and west approaches, while Highway 830 includes a single lane on each approach.

**Township Road 550** (Josephburg Road) is a paved two lane rural roadway with an approximate width of 7.5 m. The roadway is a hotmix asphalt surface with a painted yellow centreline. The posted speed limit along Township Road 550 is 80 km/h in the vicinity of the proposed gravel extraction operation.


**Exhibit 2-1**

Scale NTS

# Site Location Plan

The intersection of **Township Road 550** and **Highway 830** is a four-legged unsignalized intersection with stop control on the north and south approaches along Highway 830. Bypass lanes have been constructed on the east and west approaches to allow vehicles to manoeuvre around standing left tuning vehicles, while right turn bays have been constructed along the north and south approaches. To ensure vehicles along Highway 830 are aware of the stop condition at Township Road 550, rumble strips have been utilized on the south approach in addition to stop signs with flashing red lights on both the north and south approaches. No illumination currently exists at the intersection of Township Road 550 and Highway 830.

**Range Road 221** is a rural unimproved gravel roadway accommodating one travel lane in each direction within a width of approximately 7.5 metres. Based on Strathcona County's County Rural Road Specifications, Range Road 221 is a Class III roadway. There is no posted speed limit along Range Road 221 in the vicinity of the site; therefore, it is assumed to be 80 km/h.

**Township Road 550** and **Range Road 221** is an unsignalized T-intersection with stop control on the south approach. Single lane approaches are constructed in all direction with no left or right turn bays.

### 2.2.2 Existing Traffic Characteristics

Intersection turning movement data was collected by Alberta Transportation at the intersection of Highway 16 and Highway 830 in August 2009 and at the intersection of Township Road 550 and Highway 830 in February 2009. As well, Bunt & Associates completed traffic counts at the intersection of Township Road 550 and Range Road 221 in June 2011. **Exhibit 2-2** illustrates the existing AM and PM peak hour intersection turning movements.

Based on the traffic data collected, the AM peak hour at the intersections of Highway 16/Highway 830 and Township Road 550/Highway 830 occurred between 7:00 AM and 8:00 AM, while the PM peak hour occurred between 5:00 PM and 6:00 PM. At the intersection of Township Road 550 and Range Road 221, the AM peak hour was between 7:30 AM and 8:30 AM and the PM peak hour was between 4:15 PM and 5:15 PM. For the purpose of this assessment, the peak traffic volumes at each of the intersections were assumed to occur during the same one hour interval. This allows the assessment of the individual intersection operations to reflect the potential worst case for each of the scenarios analyzed.

The traffic counts completed also included the identification of truck traffic within the measured traffic streams. Based on the surveys completed, truck traffic represented between 11% and 15% of traffic along Highway 16, between 6% and 24% of traffic along Highway 830, and between 2% and 9% along Township Road 550 depending on the time of day. No truck traffic was recorded along Range Road 221 at the intersection with Township Road 550.

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 2-2

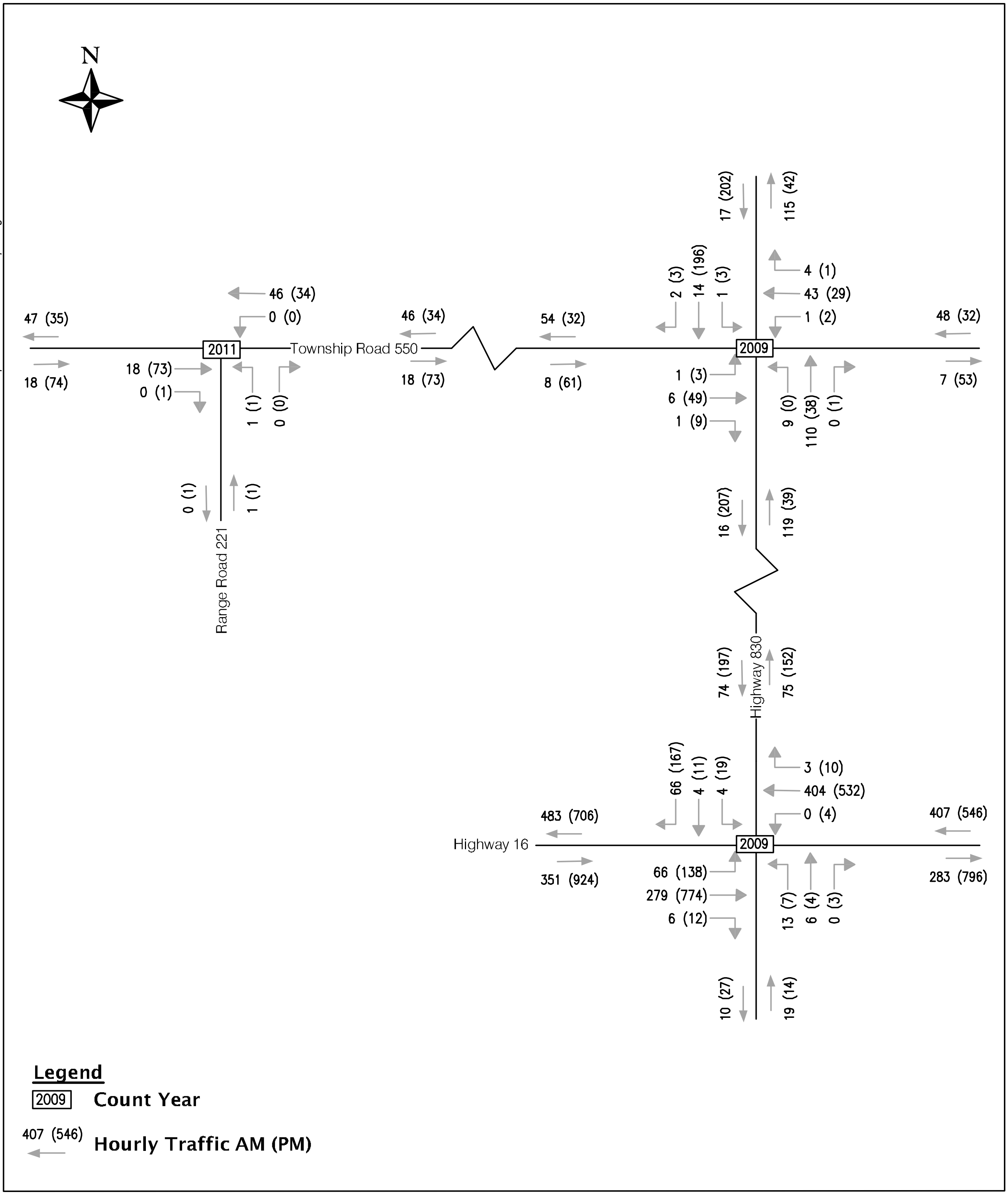



**Exhibit 2-2**

Scale NTS

Project No. 3363.01

# Existing Traffic Volumes - AM (PM) Peak Hour

For this assessment, the existing daily traffic was calculated by multiplying the sum of the AM and PM peak hour volumes by a factor of 5.5. This factor was derived based on a review of the 2009 AADT, AM 100th Highest Hour Estimates, and PM 100th Highest Hour Estimates from AT's traffic count data at the Highway 16/Highway 830 and Township Road 550/Highway 830 intersections. **Exhibit 2-3** illustrates the anticipated existing daily traffic volumes at the intersection.

## 2.3 Horizon Years

The Josephburg Area gravel extraction operation is anticipated to begin pit development in late 2011/early 2012. Therefore, a 2011 horizon has been identified as the start date for the project and a 2031 horizon has been included to ensure that any improvements identified are appropriate for 20 years, or the expected life of the improvements, as per Alberta Transportation's requirements.

## 2.4 Future Conditions

### 2.4.1 Future Roadway Network

Based on a review of Alberta Transportation's 2011 – 2014 Tentative Major Construction Projects 2011/12 – 2013/14 document, no roadway upgrades have been identified for construction along Highway 16 or Highway 830 in the vicinity of the proposed pit development within the three year horizon.

### 2.4.2 Background Traffic Volumes

Background traffic is the component of traffic on the adjacent road system that would be present regardless of the proposed extraction operation proceeding. Background traffic volumes were estimated to correspond to a 2011 horizon and a 2031 long term horizon.

The 2011 background growth is based on general background growth along Highway 16 and Highway 830, while the 2031 background growth is based on general background growth along Highway 16 and Highway 830 and the build out of the Josephburg Road North Industrial Area Structure Plan.

***2011 Background Traffic***

Based on a review of historical growth rates provided by Alberta Transportation, the five year linear traffic growth rate as a percentage of 2010 AADT is 1.458% along Highway 830 and 5.116% along Highway 16. The provincial average for linear highway growth is 2.0% per year.

To provide a conservative estimate of 2011 background traffic growth at the intersection of Highway 16 and Highway 830, the existing (2009) volumes along Highway 16 were increased by 5.116% for 2 years while the volumes along Highway 830 were increased by 2.0% for 2 years. As well, the existing (2009) volumes at the Township Road 550/Highway 830 intersections were increased by 2.0% per year for 2 years to obtain background traffic volumes for the 2011 time horizon. **Exhibits 2-4** and **2-5** illustrate the resulting 2011 background traffic volumes for the AM/PM and Daily time periods respectively.

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 2-3

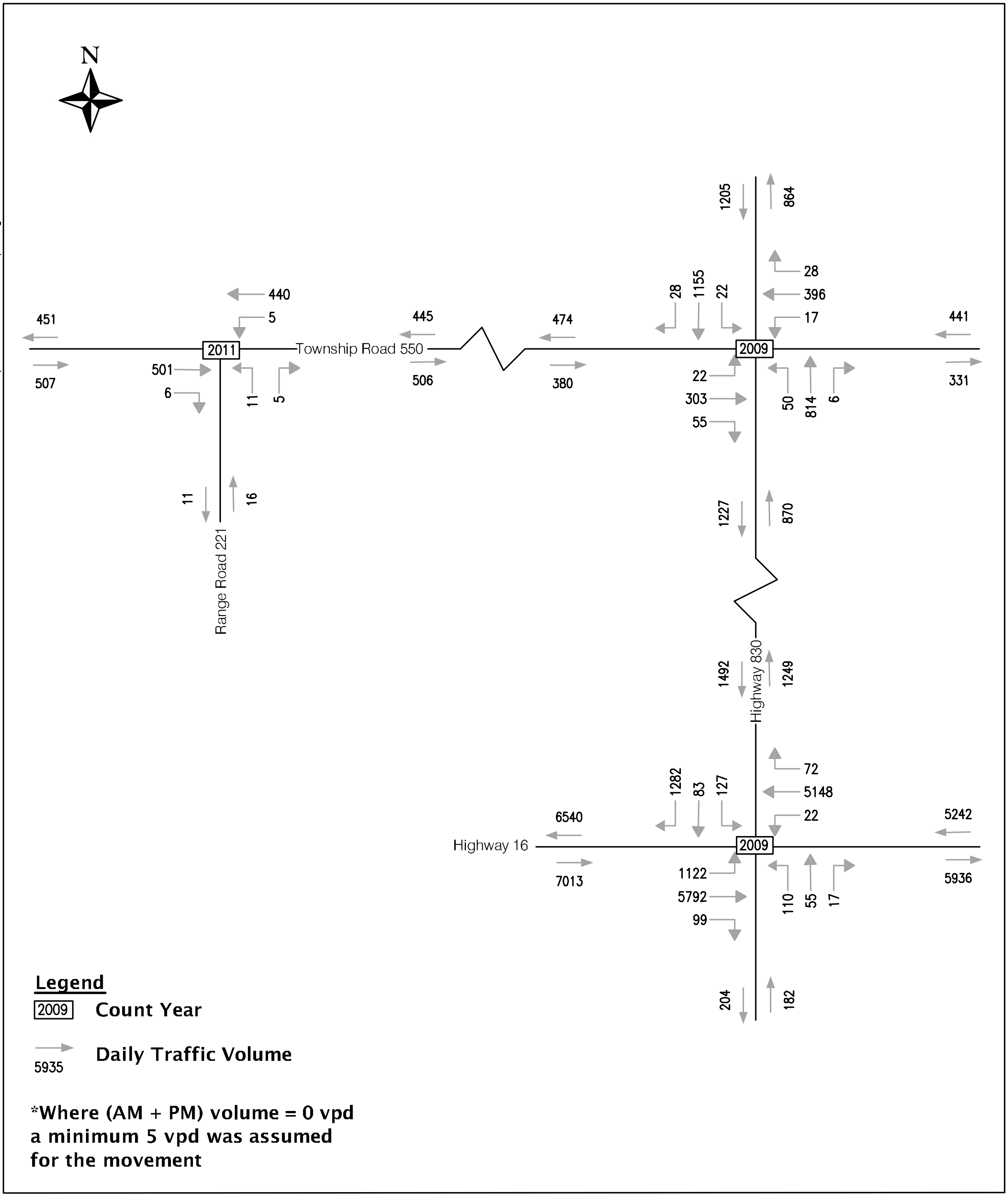



**Exhibit 2-3**

Scale NTS

Project No. 3363.01

bunt & associates

# Estimated Existing Daily Traffic Volumes

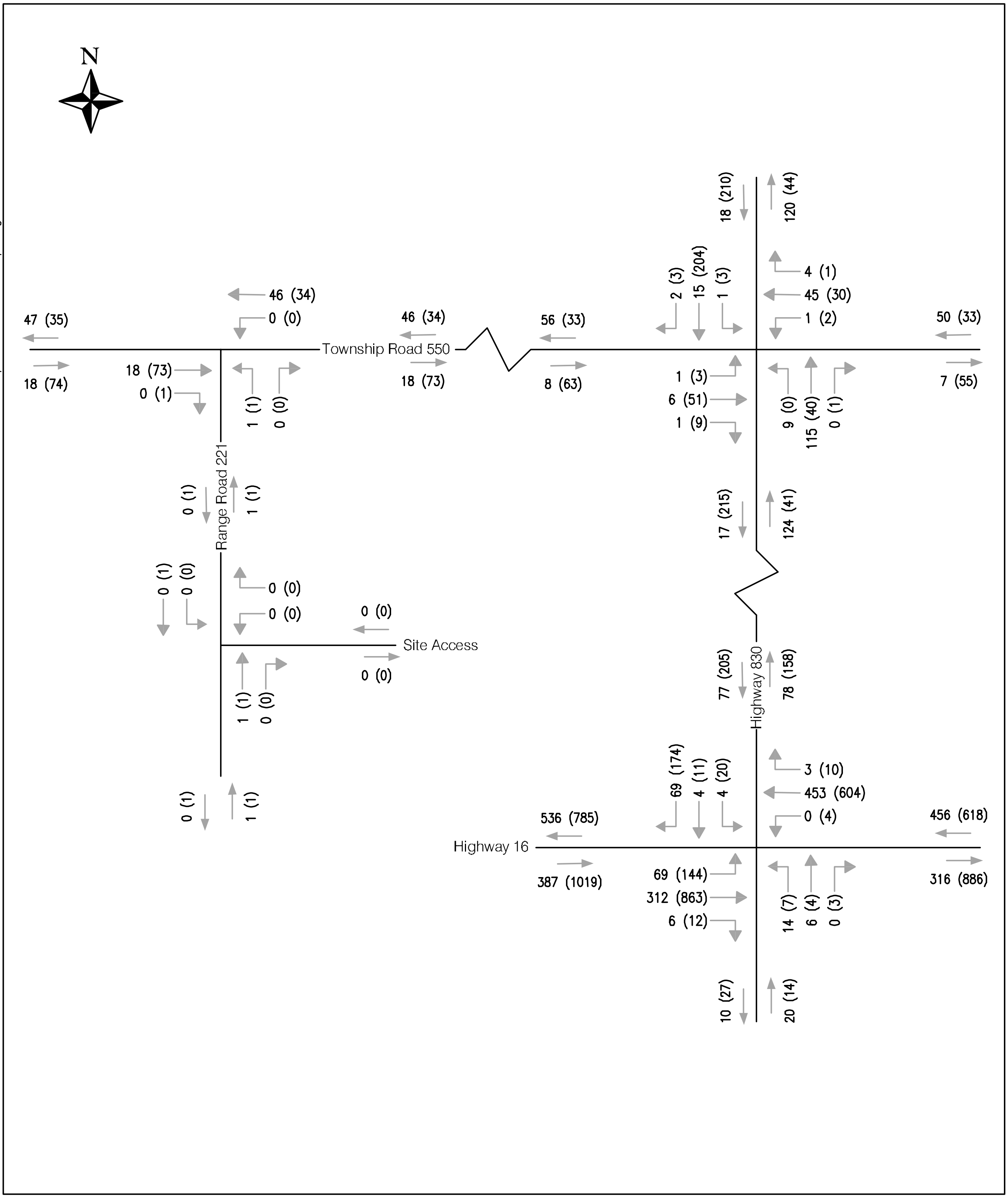
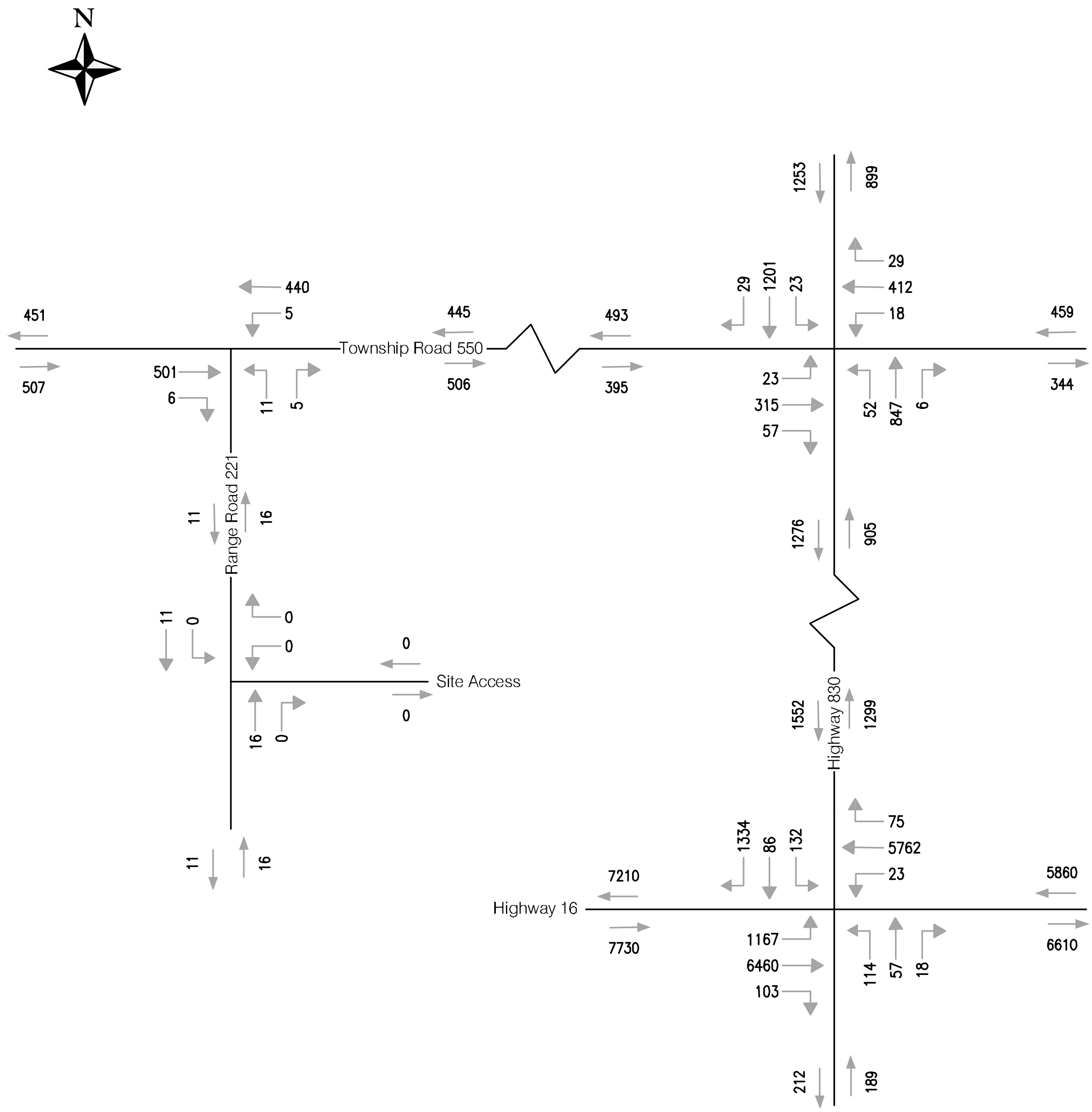



**Exhibit 2-4**

Scale NTS

Project No. 3363.01

## 2011 Background Traffic Volumes
## AM (PM) Peak Hour




***Where (AM + PM) volume = 0 vpd a minimum 5 vpd was assumed for the movement**

**Exhibit 2-5**

Scale NTS

Project No. 3363.01

## 2011 Daily Background Traffic Volumes

***2031 Background Traffic***

Based on a review of historical growth rates provided by Alberta Transportation, the long term linear traffic growth rate as a percentage of 2010 AADT is 1.921% along Highway 830 and 1.870% along Highway 16. However, the provincial average for linear highway growth is 2.0% per year; therefore, the existing (2009) volumes at the intersections of Highway 16/Highway 830 and Township Road 550/Highway 830 were increased by 2.0% per year for 22 years to obtain background traffic volumes for the 2031 time horizon.

Growth generated at the intersection of Township Road 550 and Highway 830 was carried westbound along Township Road 550 and applied to the east and west through volumes at the Township Road 550/Range Road 221 intersection. No growth was applied to north and south volumes along Range Road 221 as the majority of growth along Range Road 221 is anticipated to be limited to the proposed gravel extraction operation.

In addition to general highway growth in the area, site generated traffic volumes associated with the full build out of the Josephburg Road North Industrial Area Structure Plan were included in the 2031 background traffic volumes. AM and PM peak hour site generated traffic volumes were obtained at the intersection of Township Road 550 and Range Road 220 from the Josephburg Road North Industrial Area Structure Plan Transportation Impact Assessment completed by Stantec in 2009. For this assessment, the site generated daily traffic volumes were calculated by multiplying the sum of the AM and PM peak hour volumes by a factor of 5.5.

Josephburg Road North Industrial traffic volumes generated at the Township Road/Range Road 220 intersection were assumed to be through volumes at intersections along Township Road 550 east of Range Road 220. At the Township Road 550/Highway 830 and Highway 16/Highway 830 intersections, turning movements were determined based on the existing distribution of trips at the intersections.

**Exhibits 2-6** and **2-7**, illustrate the resulting 2031 background traffic volumes for the AM/PM and Daily time periods respectively.

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 2-6

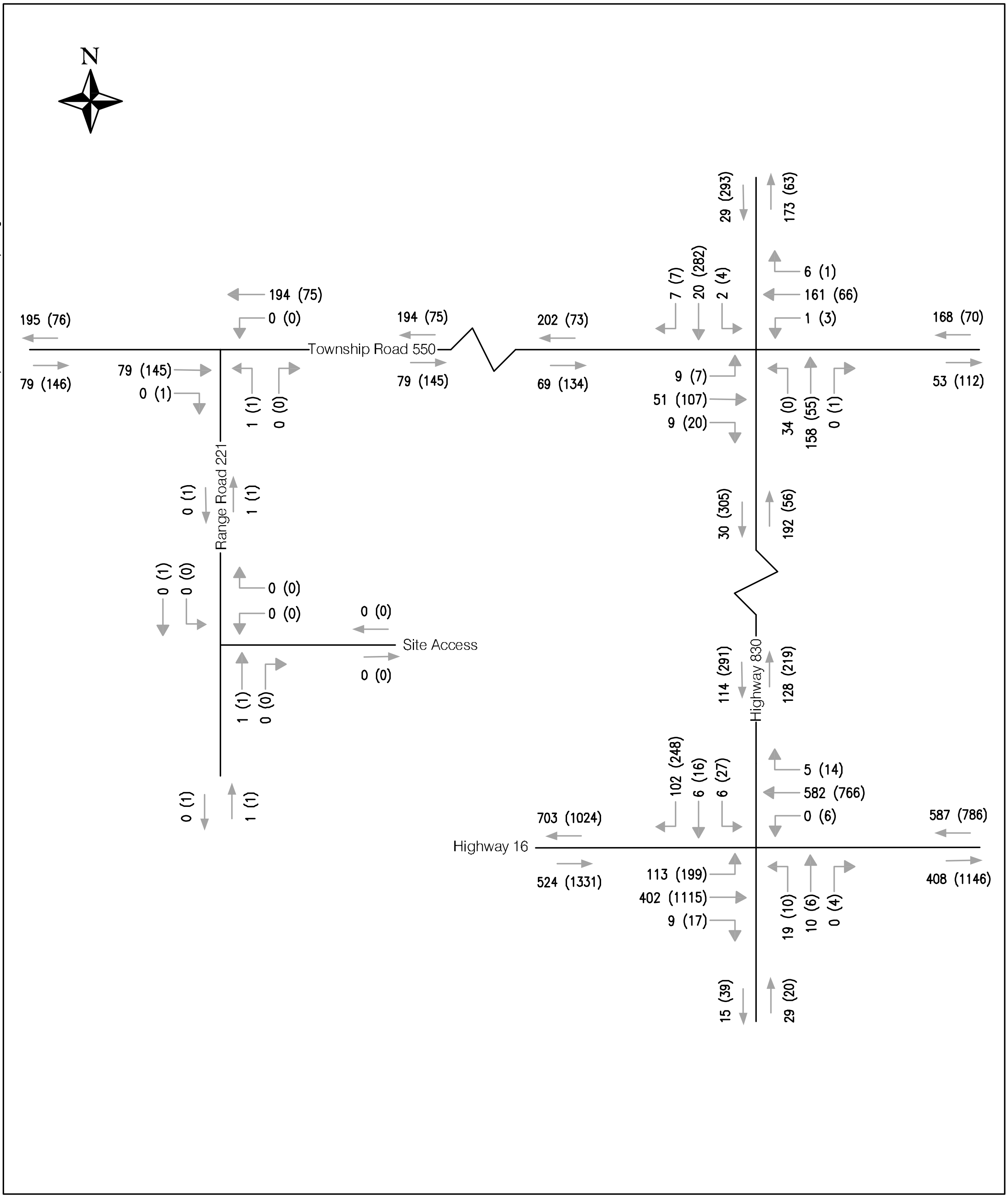



**Exhibit 2-6**

Scale NTS

Project No. 3363.01

## 2031 Background Traffic Volumes
## AM (PM) Peak Hour

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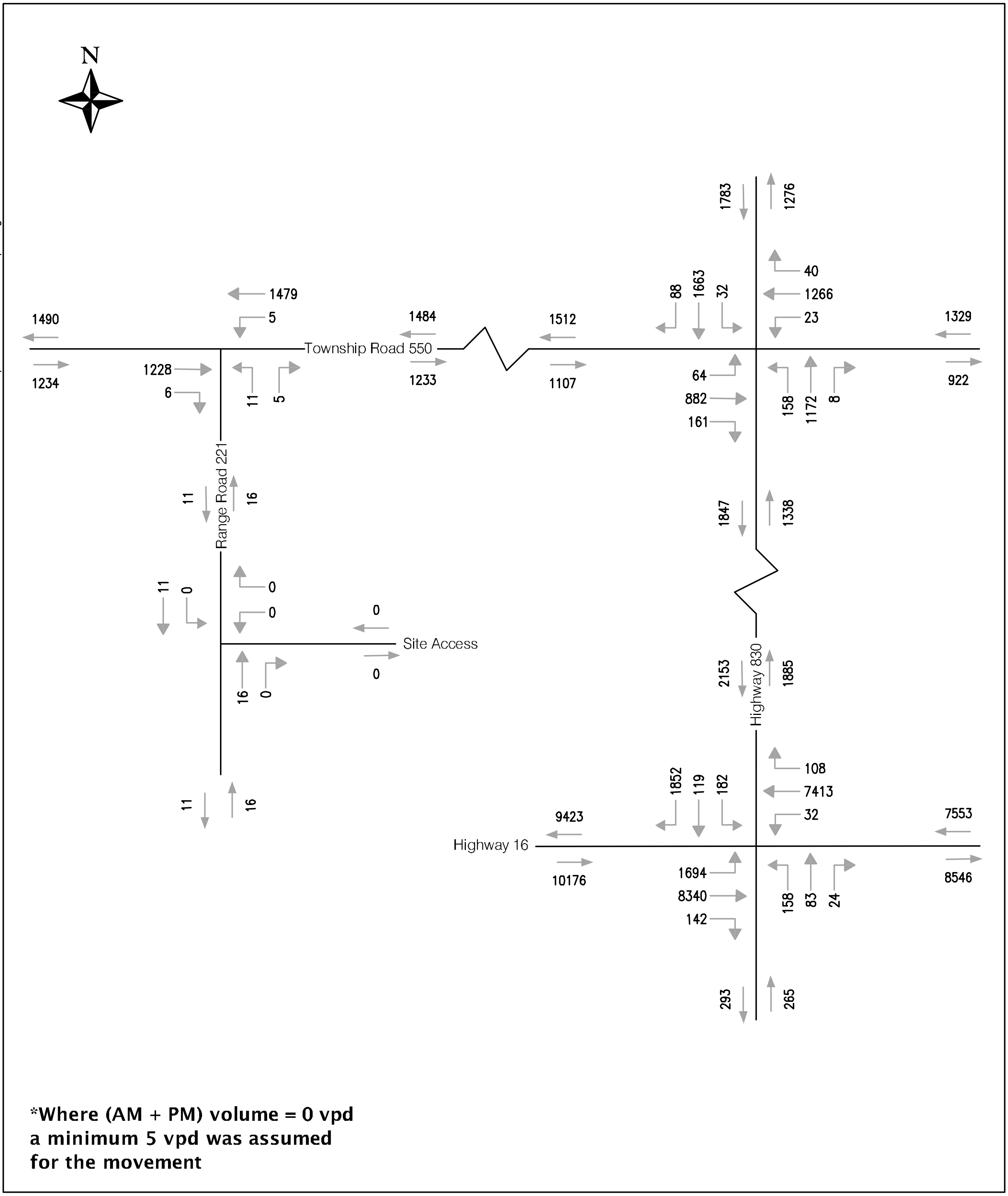


P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 2-7

**Exhibit 2-7**

Scale NTS

Project No. 3363.01

## 2031 Daily Background Traffic Volumes

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# 3. PROPOSED DEVELOPMENT CHARACTERISTICS

## 3.1 Land Use

The proposed development site is currently zoned AG – Agriculture: General under the Strathcona County Land Use Bylaw 8-2001. According to the Bylaw, the purpose of this district is to foster agriculture and conserve agricultural land outside the Urban Service Area by providing for a compatible range of agricultural uses with regulations that maintain large parcel sizes. Aggregate extraction is a discretionary use of the AG district.

## 3.2 Operations

The proposed gravel operation is anticipated to include the extraction and processing of raw materials on-site over the next 10 years. The finished product, which will include about 1 million tonnes of gravel annually as well as some reject sand, will then be hauled to construction sites within local markets, including Sherwood Park, Edmonton, and the Industrial Heartland.

The hours of operation for all gravel pit operations, including on-site activities and hauling will follow the Strathcona County Noise Bylaw 66-99. **Table 3-1** summarizes the proposed operating hours.

**Table 3-1: Hours of Operation**

| | Weekdays | Weekends/Statutory Holidays |
|---|---|---|
| July 1 to August 31 | 7:00 AM to 10:00 PM<br>Monday to Saturday | 10:00 AM to 10:00 PM<br>Sundays and Statutory Holidays |
| September 1 to June 30 | 7:00 AM to 9:00 PM<br>Monday to Thursday<br><br>7:00 AM to 10:00 PM<br>Friday | 10:00 AM to 9:00 PM<br>Sundays and Statutory Holidays<br><br>7:00 AM to 10:00 PM<br>Saturday |

On-site activities are anticipated to include gravel extraction/crushing, stripping operations, and a gravel washing facility. During a typical day, approximately 19 on-site employees are anticipated.

Hauling may occur year round, but peak operating conditions are anticipated to occur in October with a projected monthly distribution of 170,000 tonnes. Based on a monthly distribution of 170,000 tonnes, approximately 202 loads per day are anticipated, which is equivalent to about 404 two-way truck trips per day. The arrival and departure patterns are anticipated to be relatively stable over the course of a typical day (average 30 two-way truck trips/hour in October).

The proposed haul route includes Range Road 221 and Township Road 550, which are existing county roadways. At the Township Road 550/Range Road 221 intersection, the haul route will continue eastbound on Township Road 550. At the Township Road 550/Highway 830 intersection, the majority of haul trucks will continue south along Highway 830 to Highway 16, and west along Highway 16 to Sherwood Park and Edmonton. Although haul trucks are anticipated to primarily be oriented towards Highway 16, on occasion, some haul trucks at the Township Road 550/Highway 830 intersection may continue north along Highway 830 to Highway 15, and east along Highway 15 to the Industrial Heartland. However, for the purpose of this assessment, only the primary haul route was considered as it is anticipated to have the most significant impact on the roadway network. **Exhibit 3-1** illustrates the proposed primary haul route.

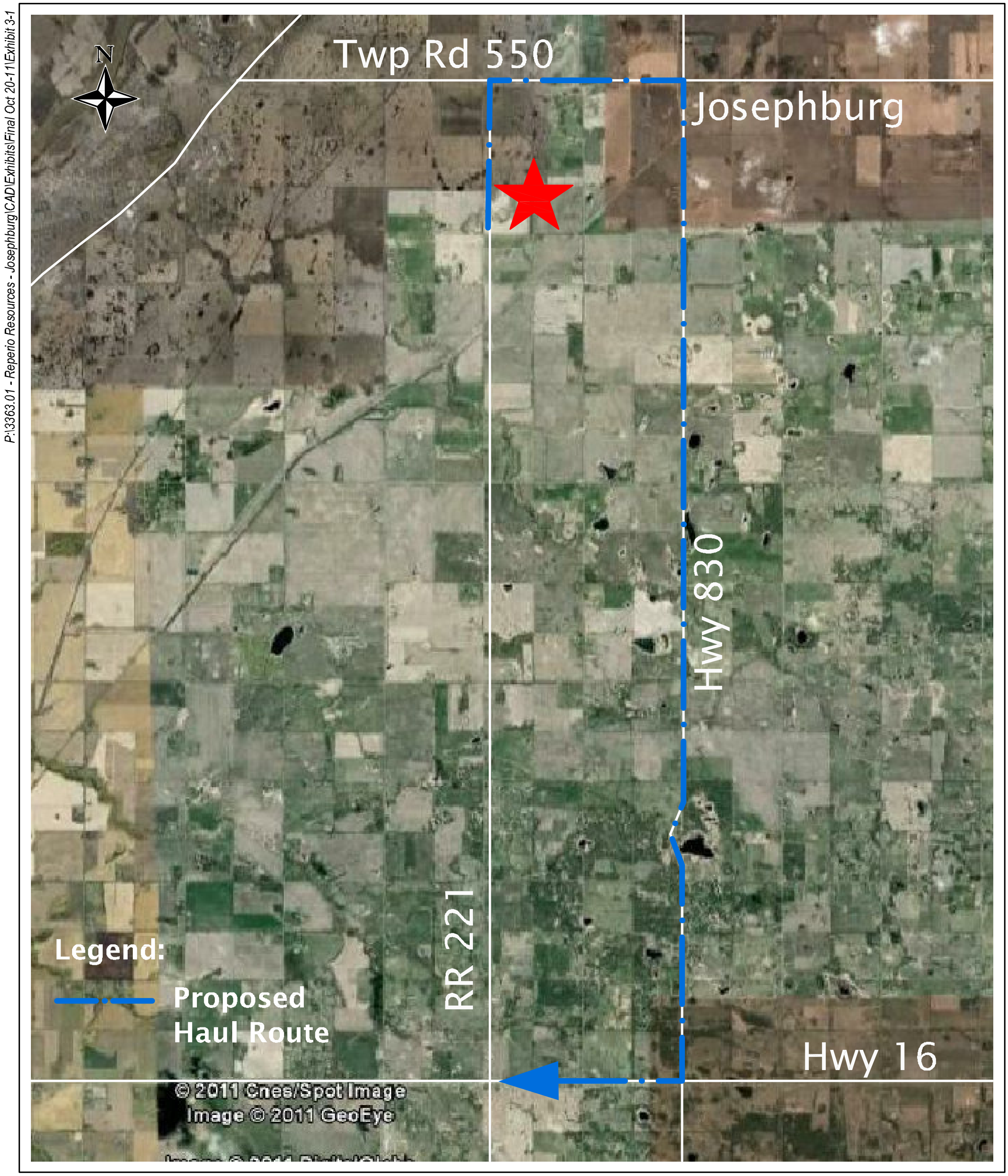



**Exhibit 3-1**

Scale NTS

Project No. 3363.01

## Proposed Primary Haul Route

# 4. SITE TRAFFIC CHARACTERISTICS

## 4.1 Trip Generation

Site generated traffic is anticipated to include on-site employee traffic and truck haul traffic.

### 4.1.1 Employee Traffic

During a typical weekday, it is estimated that 38 two-way trips (19 in, 19 out) will be generated by on-site employees. Based on the proposed work schedule of 7:00 AM to 9:00 PM in October, it is anticipated that the majority of employee trips will occur outside of the peak hours. Therefore, no inbound or outbound trips were assumed for employees in the AM and PM peak hours.

### 4.1.2 Truck Traffic

Daily traffic has been estimated to be in the order of 404 two-way truck trips/day, which is equivalent to approximately 30 two-way truck trips/hour based on a 14 hour work day. Therefore, during the AM and PM peak hours, approximately 15 inbound and 15 outbound trips are anticipated.

### 4.1.3 Total Site Generated Traffic

**Table 4-1** summarizes the total site generated traffic volumes assumed for the assessment.

**Table 4-1: Total Site Generated Traffic**

| Component | Daily | | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|---|
| | In | Out | In | Out | In | Out |
| Employee Trips | 19 | 19 | 0 | 0 | 0 | 0 |
| Truck Haul Trips | 202 | 202 | 15 | 15 | 15 | 15 |
| **Total Trips** | **221** | **221** | **15** | **15** | **15** | **15** |
| % HV | 91% | 91% | 100% | 100% | 100% | 100% |

As shown in Table 4-1, the site is anticipated to generate a total of 442 two-way trips on a typical day in October, 30 two-way trips during the AM peak hour, and 30 two-way trips during the PM peak hour.

## 4.2 Trip Distribution and Assignment

The majority of the truck haul traffic is assumed to be oriented towards Sherwood Park and Edmonton via Highway 16; although, on occasion some truck haul trips may be oriented towards the Industrial Heartland via Highway 15. However, for the purpose of this assessment, only the primary haul route (Range Road 221-Township Road 550-Highway 830-Highway 16) was considered as it is anticipated to have the most significant impact to the roadway network.

The site generated traffic was assigned to the study area intersections based on the above distribution. **Exhibit 4-1** summarizes the AM and PM peak hour site generated traffic, while **Exhibit 4-2** summarizes the daily site generated traffic volume estimates.

## 4.3 Total Traffic

The site generated traffic volumes were superimposed on the 2011 and 2031 background traffic volumes to determine 2011 and 2031 total traffic volumes for use in the assessment. **Exhibits 4-3** and **4-4** illustrate the 2011 AM/PM peak hour and daily total traffic volume estimates respectively, while **Exhibits 4-5** and **4-6** illustrate the 2031 AM/PM and daily total traffic volume estimates respectively.

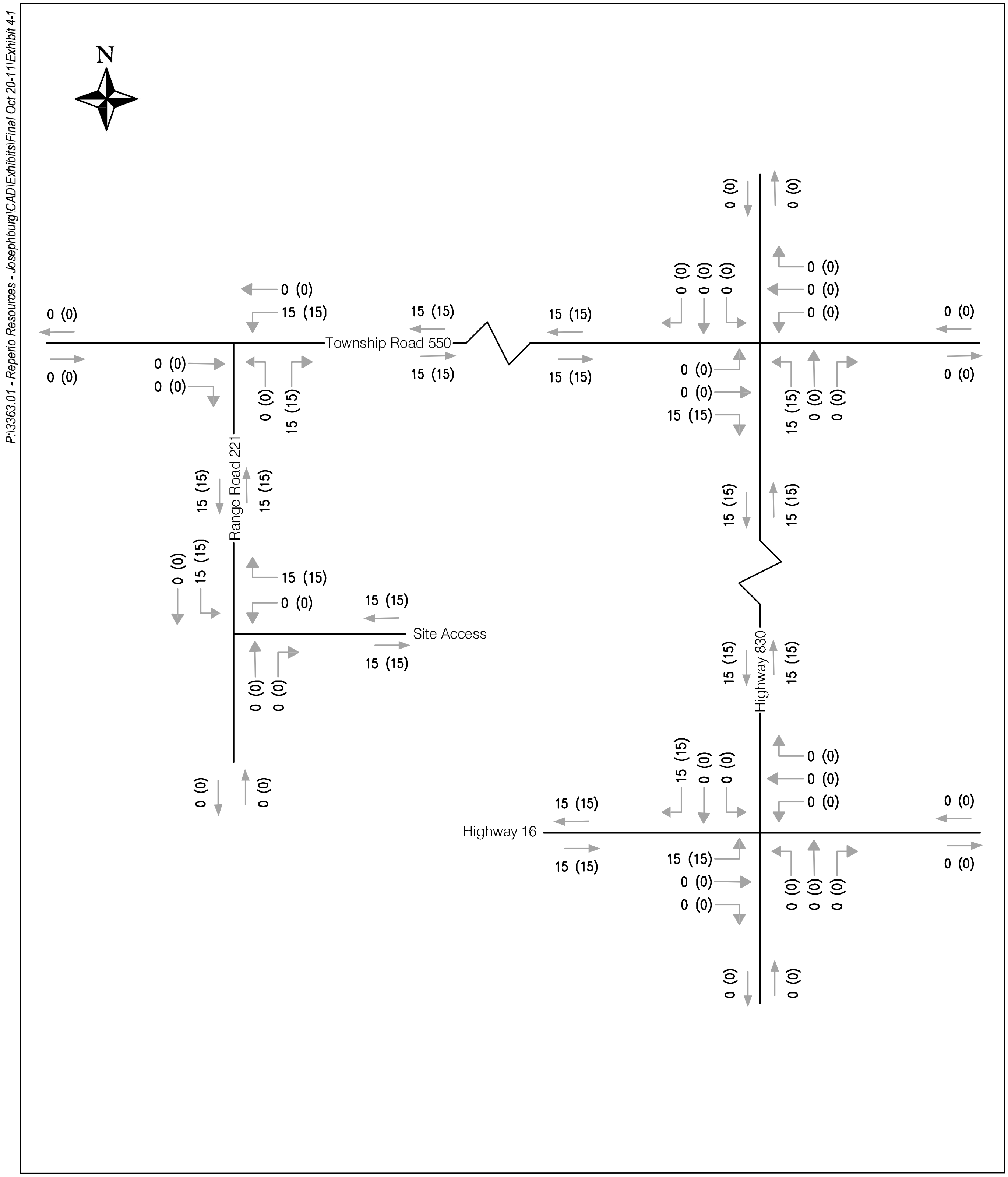



**Exhibit 4-1**

Scale NTS

Project No. 3363.01

## Site Generated Traffic Volumes
## AM (PM) Peak Hour

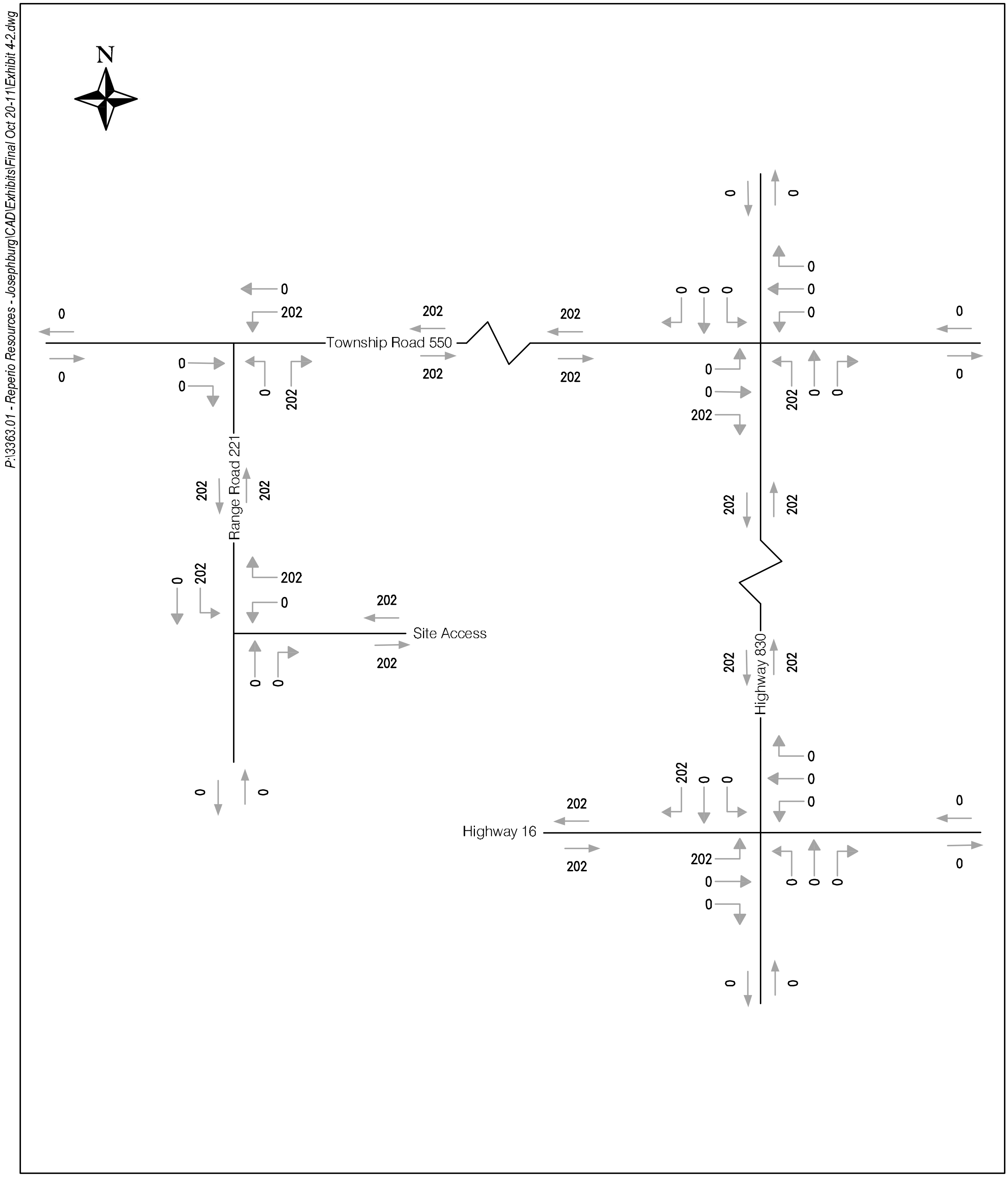



**Exhibit 4-2**

Scale NTS

Project No. 3363.01

# Daily Site Generated Traffic Volumes

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 4-3.dwg

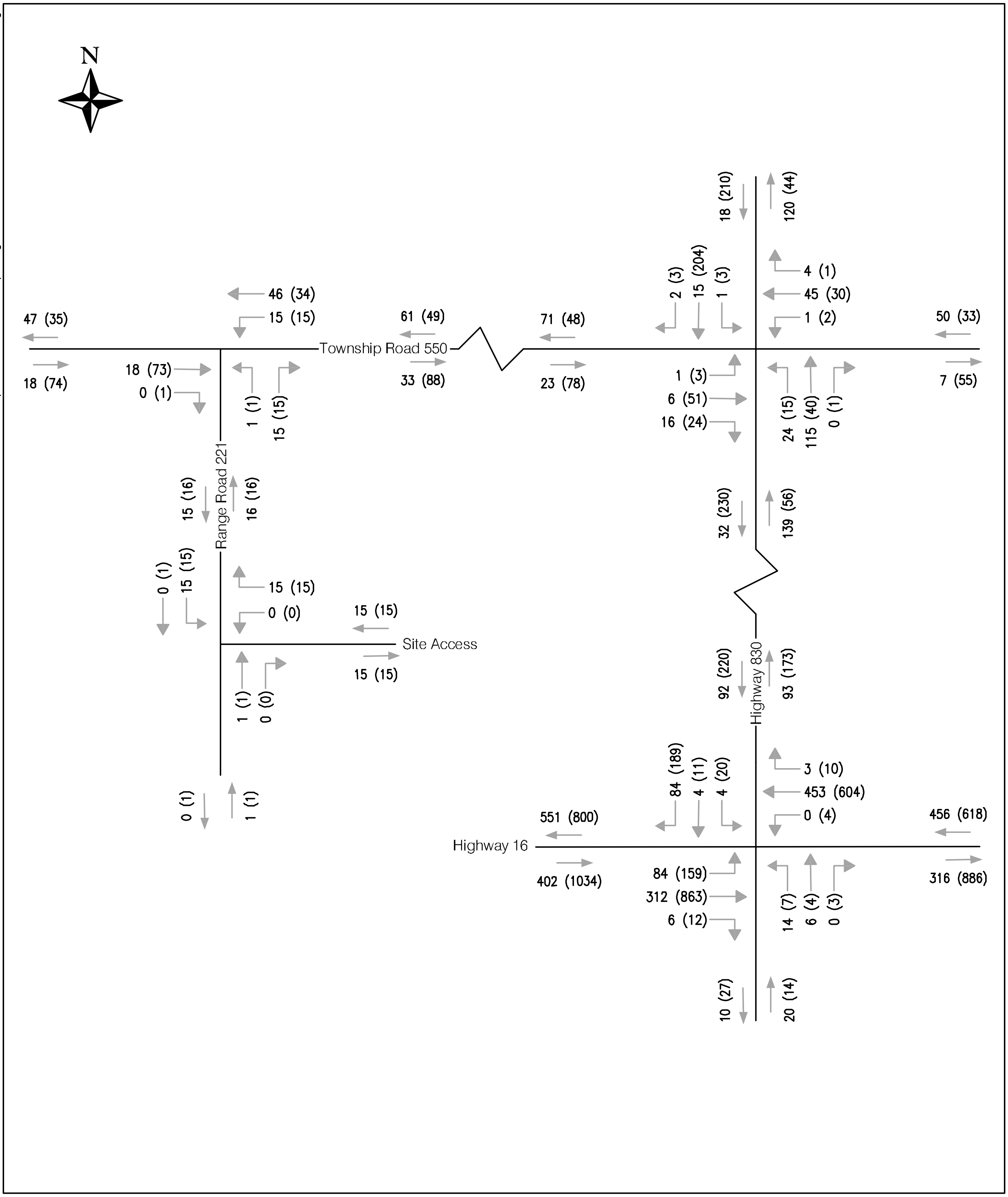


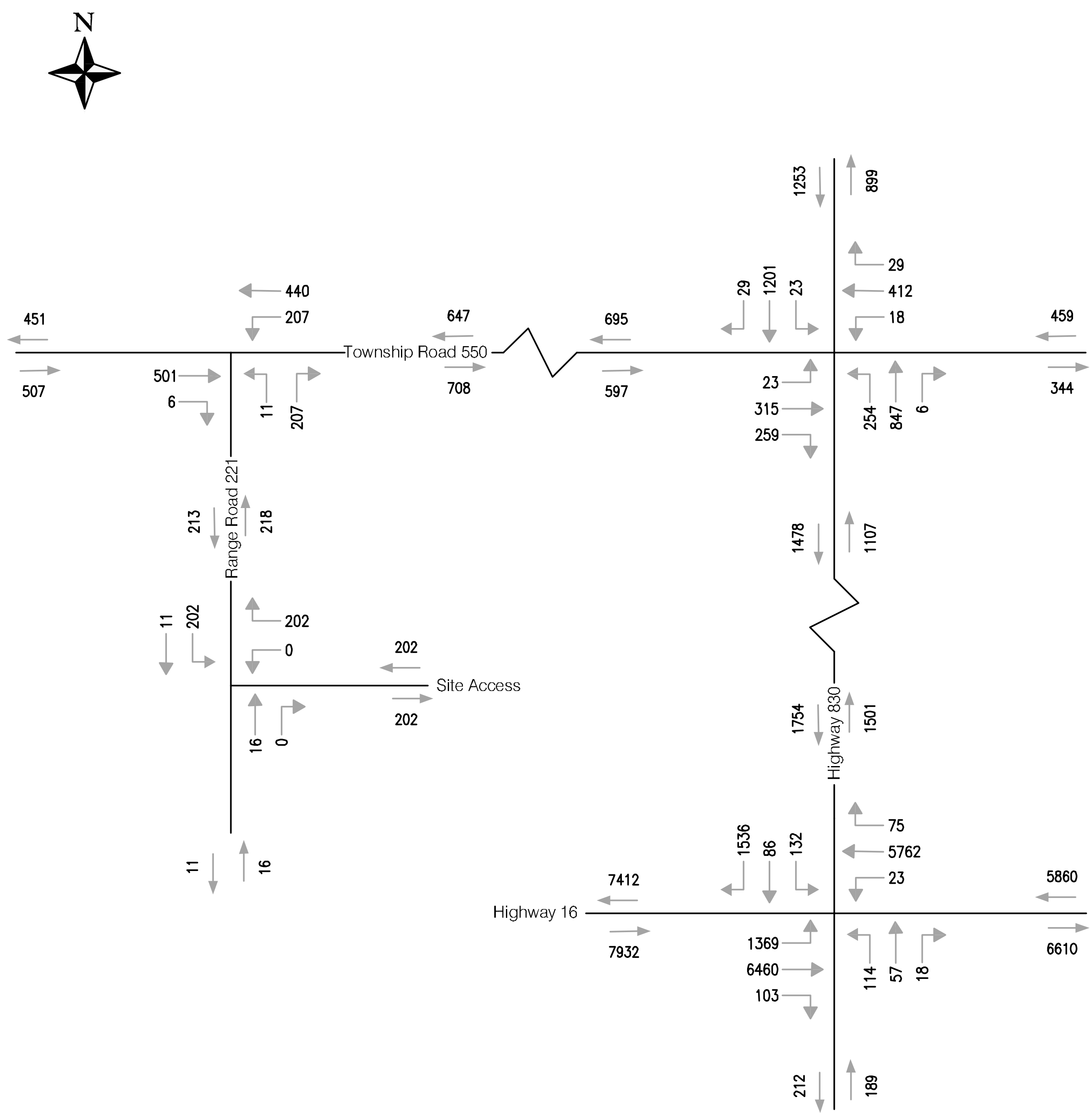

**Exhibit 4-3**

Scale NTS

Project No. 3363.01

## 2011 Total Traffic Volumes AM (PM) Peak Hour

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit 4-4.dwg




***Where (AM + PM) volume = 0 vpd**
**a minimum 5 vpd was assumed**
**for the movement**

**Exhibit 4-4**

Scale NTS

Project No. 3363.01

## 2011 Daily Total Traffic Volumes

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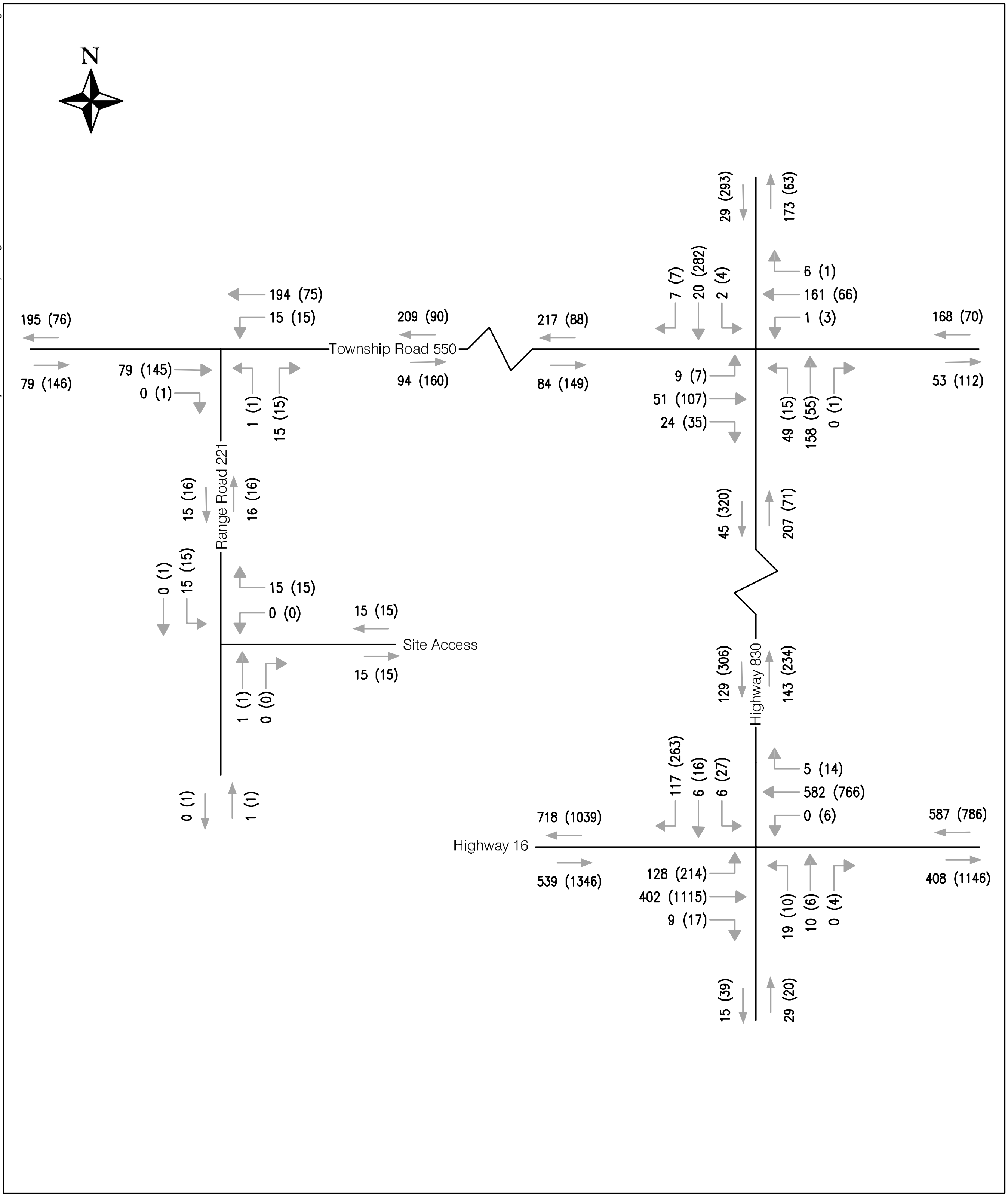


**Exhibit 4-5**

Scale NTS

Project No. 3363.01

# 2031 Total Traffic Volumes
# AM (PM) Peak Hour

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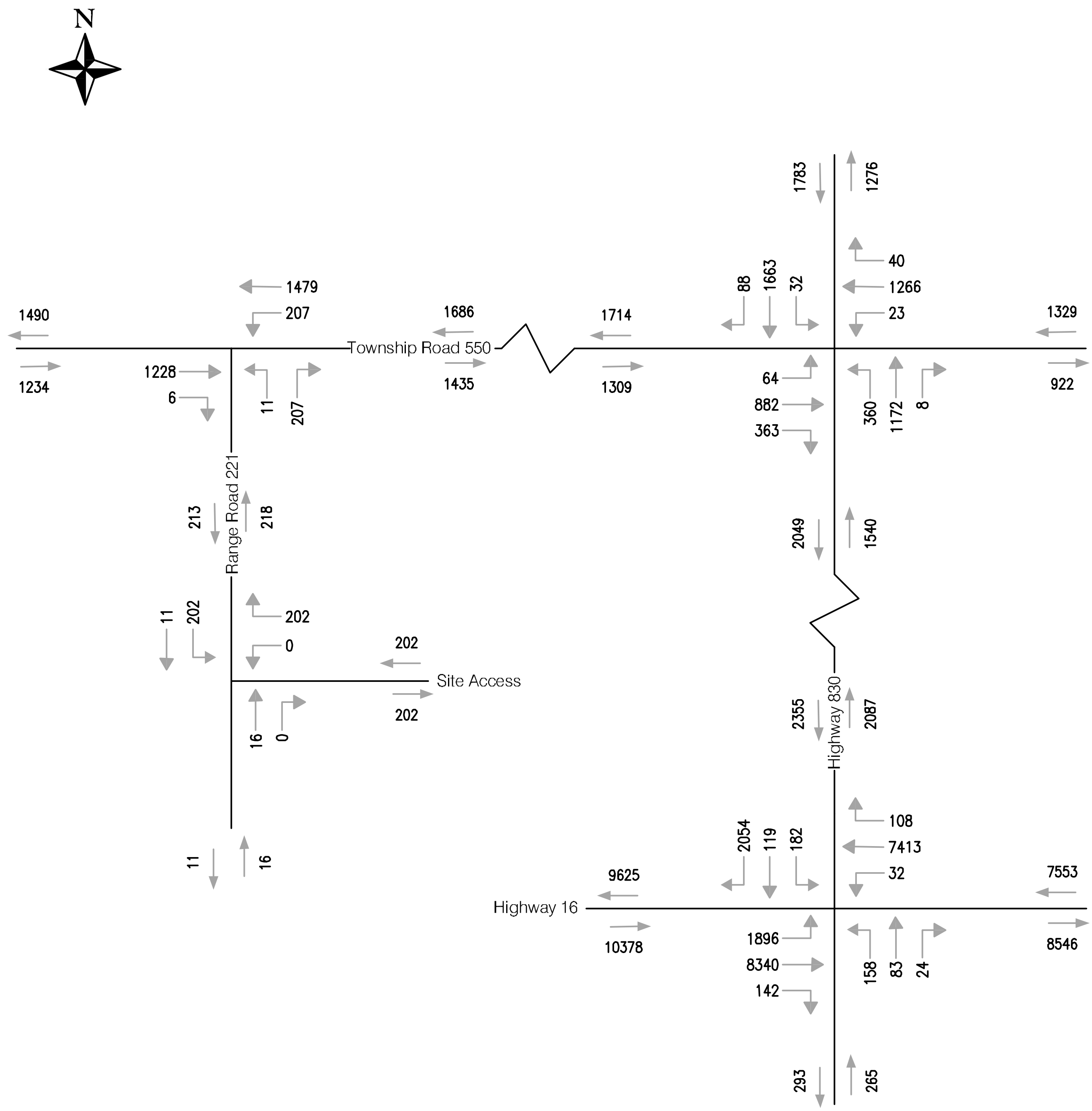


***Where (AM + PM) volume = 0 vpd**
**a minimum 5 vpd was assumed**
**for the movement**

**Exhibit 4-6**

Scale NTS

Project No. 3363.01

## 2031 Daily Total Traffic Volumes

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# 5. TRANSPORTATION ASSESSMENT

## 5.1 Analysis Methodology

The following transportation assessment follows Alberta Transportation guidelines and methodologies, and includes analyses of 2011 and 2031 background and total traffic scenarios. However, as the first phase of the proposed gravel extraction is only anticipated to be operational for 10 years, phase one site generated traffic volumes are not anticipated to be on the roadway network in 2031, and the 2031 total traffic volumes previously presented are not anticipated to be realized. Therefore, when an improvement was identified as being required in 2031, a 2021 total traffic scenario was also assessed to identify if the improvement was still warranted within the 10 years corresponding to the life of the first phase of the project. The 2021 AM/PM peak hour and daily total traffic volumes are summarized in **Appendix B**. It is anticipated that separate TIAs will be prepared with subsequent phases, which will provide additional opportunities to evaluate the roadway requirements over time.

The transportation assessment includes the following five components:

### 5.1.1 Alberta Transportation Highway Geometric Design Guide

An assessment was completed based on the procedure outlined in the Highway Geometric Design Guide to determine if any roadway geometric improvements are required to meet Alberta Transportation guidelines for the study area intersections.

### 5.1.2 Traffic Signal Warrants

Signal warrant analyses were conducted for the Highway 16/Highway 830, Township Road 550/Highway 830, and Township Road 550/Range Road 221 intersections for all horizon years using the methodology outlined in the Transportation Association of Canada's (TAC) "Canadian Traffic Signal Warrant Matrix Procedure 2005" and using the spreadsheets associated with the "Traffic Signal Warrant Handbook 2007". Signal warrant analyses were also conducted for the Site Access/Range Road 221 intersection under the 2011 and 2031 total traffic scenarios. The analyses identify whether traffic signals are anticipated to be required at the intersections in the future.

### 5.1.3 Capacity Analysis

To evaluate the traffic operating conditions during the peak periods of traffic activity, capacity assessments were completed based on the methods outlined in the Highway Capacity Manual 2000, using Synchro 7.0 analysis software. AM and PM peak hour intersection assessments were completed at following intersections for background and total traffic conditions:

- Highway 16 and Highway 830
- Township Road 550 and Highway 830

- Township Road 550 and Range Road 221

The future intersection of the Site Access/Range Road 221 was evaluated based on total traffic conditions only.

#### 5.1.4 Lighting Analysis

Assessments were completed using the TAC Guide for the Design of Roadway Lighting, 2006, to determine if illumination is required at the study area intersections.

#### 5.1.5 County Roadway Assessment

A review of the Strathcona County Rural Road Specifications was completed to identify any county roadway upgrades required based on existing and future traffic volumes.

## 5.2 Alberta Transportation's Highway Geometric Design Guide

Alberta Transportation's left and right turn warrants from the Highway Geometric Design Guide (1995) were reviewed to identify intersection improvements required. Figure D-7.4 in the Highway Geometric Design Guide (1995) was reviewed for left turn warrants along two-lane highways, while Figure D-8.6c was used to determine the requirement of left turn lanes along four-lane divided highways. Table D.7.6a was also used to determine any additional storage length required for trucks. The warrants were reviewed for all appropriate study area intersections, and detailed calculations are summarized in **Appendix C**.

#### 5.2.1 Highway 16 and Highway 830

Figure D-8.6c and Table D.7.6a from the Highway Geometric Design Guide were used to determine the requirement for left turn lanes along Highway 16 at the intersection of Highway 830. **Table 5-1** summarizes the storage length requirements for left turn lanes under the existing, 2011 and 2031 background and total traffic scenarios. An assessment of northbound and southbound left and right turn warrants at the intersection of Highway 16 and Highway 830 was not completed. The function and purpose of left and right turn warrants along highways is to maintain free-flow conditions and reduce potential interference caused by standing left or right turning vehicles. Because the intersection of Highway 16 and Highway 830 is stop controlled on the north and south approaches, free-flow conditions do not exist and left and right turn warrants are not anticipated to be applicable along Highway 830.

**Table 5-1: Warrant Analysis for Left Turn Lanes on Four-Lane Highways – Highway 16 & Highway 830**

| Horizon | Left Turn Storage Length EB | Left Turn Storage Length WB |
|---|---|---|
| Existing | 40m | No Left Turn Lane Required |
| 2011 Background | 40m | No Left Turn Lane Required |
| 2011 Total | 40m | No Left Turn Lane Required |
| 2031 Background | 70m | No Left Turn Lane Required |
| 2031 Total | 85m | No Left Turn Lane Required |

As shown in Table 5-1, an eastbound left turn lane is required at the Highway 16/Highway 830 intersection, while a westbound left turn lane is not anticipated to be required. Left turn lanes with approximately 85m of storage length are currently provided on both the east and west approaches of the Highway 16/Highway 830 intersection. Therefore, no additional parallel storage length is anticipated to be required to accommodate background or site generated traffic volumes.

**Table 5-2** summarizes the results of the right turn warrant analysis completed at the intersection of Highway 16 and Highway 830.

**Table 5-2: Warrant Analysis for Right Turn Lanes – Highway 16 & Highway 830**

| Horizon | Hwy 16/Hwy 830 EB | Hwy 16/Hwy 830 WB |
|---|---|---|
| Is a right turn bay required? | | |
| Existing | No | No |
| 2011 Background | No | No |
| 2011 Total | No | No |
| 2031 Background | No | No |
| 2031 Total | No | No |

The right turn warrant analysis indicated that eastbound and westbound right turn bays are not currently required at the Highway 16/Highway 830 intersection, and are not anticipated to be required in the future under background or total traffic conditions. Eastbound and westbound right turn bays are currently constructed at the Highway 16/Highway 830 intersection; therefore, no improvements to the existing right turn bays are anticipated to be required.

Based on the above information, no improvements to the left or right turn bays along Highway 16 at the intersection with Highway 830 are anticipated to be required to accommodate background or site generated traffic volumes in 2011 or 2031.

### 5.2.2 Township Road 550 and Highway 830

According to Figure D-7.4 from the Highway Geometric Design Guide, if the average annual daily traffic along the intersecting road is greater than the average annual daily traffic along the main road, the traffic control scheme at the intersection should be reviewed.

Highway 830 is stop controlled on the north and south approaches of the Township Road 550/Highway 830 intersection; therefore, Township Road 550 is considered the main road while Highway 830 is the intersecting road. Based on existing daily volumes of 855 vpd along Township Road 550 and 2,095 vpd along Highway 830, the traffic control scheme should be reviewed.

Due to the potential change in the direction of traffic control, left and right turn warrants were conducted along both Township Road 550 and Highway 830. However, it should be noted that the left and right turn warrants should only be applied to the major road as the function and purpose of left and right turn bypass lanes is to maintain free-flow conditions and reduce potential interference caused by standing left or right turning vehicles. For example, if the existing traffic control remains in place, left and right turn bypass lanes should only be applied to Township Road 550 and not to Highway 830.

***Scenario 1: Township Road 550 as Major Road (N/S Stop Control)***

Based on existing volumes, Figure D-7.4 indicates that the intersection in the study area should currently be designed as a Type II, III, IV, or V intersection. Figure D-7.4 also indicated that further analysis is required to determine the intersection treatment required, including warrant analysis for left and right turn lanes. The results of the left turn warrant analysis is summarized in **Table 5-3**, while the right turn warrant analysis is summarized in **Table 5-4**.

**Table 5-3: Scenario 1 Warrant Analysis for Left Turn Lanes**
**Township Road 550 & Highway 830 (N/S Stop Control)**

| Horizon | Twp Rd 550/Hwy 830 EB | Twp Rd 550/Hwy 830 WB |
|---|---|---|
| Existing | I | I |
| 2011 Background | I | I |
| 2011 Total | I | I |
| 2031 Background | II | II |
| 2031 Total | II | II |

Based on Table 5-3, a Type Ib intersection is required at the intersection of Township Road 550 and Highway 830 under existing, 2011 background, and 2011 total traffic scenarios, while a Type IIc intersection is required in 2031. Type I and Type II intersections do not include exclusive left turn lanes.

**Table 5-4: Scenario 1 Warrant Analysis for Right Turn Lanes Township Road 550 & Highway 830 (N/S Stop Control)**

| Horizon | Twp Rd 550/Hwy 830 EB | Twp Rd 550/Hwy 830 WB |
|---|---|---|
| Is a right turn bay required? | | |
| Existing | No | No |
| 2011 Background | No | No |
| 2011 Total | No | No |
| 2031 Background | No | No |
| 2031 Total | Yes | No |
| 2021 Total | Yes | No |

The right turn warrant analysis indicated that an eastbound right turn bay is anticipated to be required in 2031 with the addition of site generated traffic.

As the projected life span of the first phase is 10 years and site generated traffic is not anticipated at the intersection in 2031, a 10 year (2021) total traffic scenario was also reviewed to determine if an eastbound right turn bay is required during the life of the first phase of the gravel extraction project. The right turn warrant analysis indicated that the requirement for a right turn bay is 98% satisfied in 2021; therefore, it is anticipated that an eastbound right turn bay is an appropriate improvement to accommodate background and site generated traffic volumes.

Based on site observations, a Type IIc intersection is currently constructed at the intersection of Township Road 550 and Highway 830, and includes bypass lanes on the east and west approaches to allow vehicles to manoeuvre around standing left turning vehicles. As an exclusive left turn bay is not anticipated to be required under existing or future traffic conditions, it is anticipated that the existing intersection geometry can be modified through pavement markings to include a shared left/through lane and a right turn bay on the west approach as opposed to a bypass lane. A capacity analysis will be completed in **Section 5.4.2** to confirm that the intersection of Township Road 550 and Highway 830 operates at acceptable levels of service with the recommended intersection geometry.

The analysis of left and right turn warrants at the Township Road 550/Highway 830 intersection was based on the primary haul route; however, no further intersection improvements are anticipated to be required if, on occasion, a small portion of the haul truck traffic heads north along Highway 830 to Highway 15.

***Scenario 2: Highway 830 as Major Road (E/W Stop Control)***

The left and right turn warrant analyses were revised assuming the stop control is moved to the east and west approaches. The results of the left turn warrant analysis for Scenario 2 is summarized in **Table 5-5**, while the right turn warrant analysis for Scenario 2 is summarized in **Table 5-6**.

**Table 5-5: Scenario 2 Warrant Analysis for Left Turn Lanes**
**Township Road 550 & Highway 830 (E/W Stop Control)**

| Horizon | Twp Rd 550/Hwy 830 NB | Twp Rd 550/Hwy 830 SB |
|---|---|---|
| Existing | I | II |
| 2011 Background | I | II |
| 2011 Total | II | II |
| 2031 Background | I | II |
| 2031 Total | II | II |

Based on Table 5-5, a Type IIc intersection is required on both the north and south approaches of the Township Road 550/Highway 830 intersection with the addition of site generated traffic in the 2011 and 2031 horizons.

**Table 5-6: Scenario 2 Warrant Analysis for Right Turn Lanes**
**Township Road 550 & Highway 830 (E/W Stop Control)**

| Horizon | Twp Rd 550/Hwy 830 NB | Twp Rd 550/Hwy 830 SB |
|---|---|---|
| Is a right turn bay required? | | |
| Existing | No | No |
| 2011 Background | No | No |
| 2011 Total | No | No |
| 2031 Background | No | No |
| 2031 Total | No | No |

The right turn warrant analysis indicated that northbound and southbound right turn bays are not anticipated to be required under existing, background, or total traffic scenarios under Scenario 2.

Based on the above information, a Type IIc intersection treatment is required assuming east/west stop control at the intersection of Township Road 550 and Highway 830 with the addition of site generated traffic. Based on site observations, a Type IIc intersection is currently constructed; therefore, no further intersection improvements are anticipated to be required based on Alberta Transportation's Highway Geometric Design Guide.

It is anticipated that appropriate geometry is currently provided at the Township Road 550/Highway 830 intersection based on Alberta Transportation's Highway Geometric Design Guide (1995) for left and right turn warrants for both Scenario 1 and Scenario 2 regardless of the location of stop control.

#### 5.2.3 Township Road 550 and Range Road 221

A preliminary assessment based on Figure D-7.4 in the Highway Geometric Design Guide (1995) was completed for the east and west approaches at the Township Road 550/Range Road 221 intersection. **Table 5-7** summarizes the intersection treatment required based on Figure D-7.4.

**Table 5-7: Traffic Volume Warrant Intersection Treatments Township Road 550 & Range Road 221**

| Horizon | Range Road 221 AADT | Township Road 550 AADT | Figure D-7.4 Intersection Treatment |
|---|---|---|---|
| Existing | 27 | 958 | Type I |
| 2011 Background | 27 | 958 | Type I |
| 2011 Total | 431 | 1,355 | Type II |
| 2031 Background | 27 | 2,724 | Type I |
| 2031 Total | 431 | 3,121 | Detailed Analysis Required |

As shown in Table 5-7, a Type I intersection is anticipated to be appropriate to accommodate existing, 2011 background, and 2031 background traffic volumes. With the addition of site generated traffic volumes, a Type II intersection treatment is anticipated to be required in 2011.

Based on estimated 2031 total traffic volumes, Figure D-7.4 indicates that a Type II, III, IV, or V intersection is required and that further analysis is required to determine the intersection treatment, including warrant analysis for left and right turn lanes. The detailed analysis indicates that a Type II intersection treatment is anticipated to be required in 2031 with the addition of site generated traffic, which does not include an exclusive westbound left turn. The detailed analysis also indicated that an exclusive eastbound right turn lane is not warranted.

Based on the above information, a Type IIa intersection treatment is anticipated to be required to accommodate site generated traffic in both the 2011 and 2031 horizons. Based on site observations, the intersection of Township Road 550 and Range Road 221 is currently a Type Ia intersection.

## 5.3 Signal Warrant Analysis

Signal warrant analyses were conducted for all study area intersections using the Transportation Association of Canada's "Canadian Traffic Signal Warrant Matrix Procedure 2005" and spreadsheets from the "Traffic Signal Warrant Handbook 2007".

The TAC warrant matrix procedure uses 6 hours of traffic volume data, AM, midday, and PM data to determine the requirements for signalization. Existing traffic surveys completed at the intersections of Highway 16/Highway 830, Township Road 550/Highway 830, and Township Road 550/Range Road 221 were used in the existing analysis. For future traffic scenarios, the ratios of the existing AM and PM peak hour data to the full two hour counts were used to adjust the projected AM and PM peak hour volumes to two hour volumes. A ratio of noon traffic volumes to the AM and PM peak hours was also determined to calculate estimates of midday traffic volumes under future scenarios. Intersection improvements identified from Alberta Transportation's Highway Geometric Design Guide warrant analysis in Section 5.2 were used to in the 2011 and 2031 background and total traffic scenarios. **Appendix D** contains a summary of the warrant calculation sheets for reference.

The results of the signal warrant analyses are summarized in **Table 5-8**. When an analysis score is higher than 100, traffic signalization is warranted at the intersection. However, if the six-hour average side street traffic is below 75 vpd, traffic signalization should not typically be considered, even if an analysis score higher than 100 is achieved.

Based on the results of the signal warrant analyses, signalization was identified as being warranted at the intersection of Highway 16 and Highway 830 based on 2031 background traffic volumes. However, Highway 16 is a controlled access freeway facility and traffic signals are not anticipated to be an acceptable mitigation measure.

Alberta Transportation's Design Bulletin #68/2010, Roundabout Design Guidelines on Provincial Highways, states that roundabouts shall be considered as the first option for intersection designs, where, in the exclusive judgment of the department, a greater degree of traffic control other than a two-way stop is required on a paved roadway e.g. a signalization or four-way stop control. However, existing freeways are considered locations where Alberta Transportation would not wish to use roundabouts. Therefore, a roundabout was not considered at the intersection of Highway 16 and Highway 830. In addition, a Highway 16 Access Management study is currently underway for a portion of Highway 16 including the intersection with Highway 830. The study is anticipated to define long term access strategies along the Highway 16 corridor including intersection closures and interchange locations.

As the signal was warranted in 2031 based on background growth, a signal warrant analysis was also completed for the 2021 total traffic scenario to identify if a traffic signal is required during the 10 year life of the first phase of the gravel extraction project. As shown in Table 5-8, a traffic signal is not anticipated to be warranted by 2021 with the addition of phase one site generated traffic. Therefore, signalization is not recommended for the intersection of Highway 16 and Highway 830 to accommodate site generated traffic.

**Table 5-8: Summary of Signal Warrant Analysis**

| Intersection | Scenario | Warrant Analysis Score | Warranted? |
|---|---|---|---|
| **Highway 16 & Highway 830** | Existing | 45 | No |
| | 2011 Background | 54 | No |
| | 2011 Total | 60 | No |
| | 2031 Background | 107 | Yes |
| | 2031 Total | 116 | Yes |
| | 2021 Total | 84 | No |
| **Township Road 550 & Highway 830** | Existing | 6 | No |
| | 2011 Background | 7 | No |
| | 2011 Total | 10 | No |
| | 2031 Background | 29 | No |
| | 2031 Total | 36 | No |
| **Township Road 550 & Range Road 221** | Existing | 0 | No |
| | 2011 Background | 0 | No |
| | 2011 Total | 0 | No |
| | 2031 Background | 0 | No |
| | 2031 Total | 1 | No |
| **Site Access & Range Road 221** | 2011 Total | 0 | No |
| | 2031 Total | 0 | No |

Based on the results of the signal warrant analyses, traffic signalization is not anticipated to be required at the intersections of Township Road 550/Highway 830, Township Road 550/Range Road 221, and the Site Access/Range Road 221.

## 5.4 Capacity Assessment

The capacity analysis is based on the methods outlined in the Highway Capacity Manual 2000, using *SYNCHRO 7.0* analysis software. Detailed Synchro printouts are included in **Appendix E**.

Intersection operations are typically rated by two measures. The volume-to-capacity (V/C) ratio describes the extent to which the traffic volumes can be accommodated by the physical capacity of the road configuration and traffic control. A value (measured during the peak hour) less than 0.90 indicates that generally, there is sufficient capacity and projected traffic volumes can be accommodated at the intersection. A value between 0.90 and 1.0 suggests unstable operations may occur and volumes are nearing capacity conditions. A calculated value over 1.0 indicates that traffic volumes are theoretically exceeding capacity. The second measure of performance, Level of Service (LOS), is based on the estimated average delay per vehicle among all traffic passing through the intersection. A low average delay merits a LOS A rating. Average delays greater than 80 seconds per vehicle generally produce a LOS F rating for signalized intersections, while average delays greater than 50 seconds per vehicle generally produce a LOS F rating for unsignalized intersections.

The capacity analysis is based on the methods outlined in the Highway Capacity Manual 2000, using *SYNCHRO 7.0* analysis software.

The methodology includes a number of assumptions that relate to the operating conditions present at the intersections. The following assumptions were used in the analysis.

- Peak Hour Factor – As per existing count or 0.85 where unavailable
- % Heavy Vehicles – Existing % Heavy Vehicles, future increased to reflect site generated truck movements

Geometry at the intersections was based on the results of Alberta Transportation's left and right turn warrants from the Highway Geometric Design Guide. Where improvements were identified as being required to accommodate AM peak hour traffic, they were carried through the PM peak hour analyses for that traffic scenario. Traffic control at the study area intersections was based on the signal warrant analysis results.

### 5.4.1 Highway 16 and Highway 830

**Tables 5-9** through **5-13** present the results of the *Synchro* analysis completed for the Highway 16/Highway 830 intersection for the AM and PM peak hours. The tables include the analysis of existing, 2011 background and total, and 2031 background and total traffic volumes.

The intersection of Highway 16 and Highway 830 is currently unsignalized with stop control on the north and south approaches and includes the following geometry:

- *West Approach* – one left turn bay, two through lanes, one right turn bay
- *East Approach* – one left turn bay, two through lanes, one right turn bay
- *South Approach* – one shared left/through/right lane
- *North Approach* – one shared left/through/right lane

No improvements to the existing geometry were identified based on the results of the Alberta Transportation's left and right turn warrants from the Highway Geometric Design Guide; therefore, the existing intersection geometry was also used in future scenarios.

A traffic signal was identified as being warranted by 2031 based on background traffic volumes; however, as Highway 16 is a controlled access freeway facility a traffic signal is not recommended at this location. As well, according to Alberta Transportation, a roundabout is not a desirable intersection treatment along an existing freeway. Therefore, the intersection was assumed to continue to be unsignalized in the 2031 horizon.

**Table 5-9: Highway 16 and Highway 830 – AM Peak Hour**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2009 Existing – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 66 | 279 | 6 | 0 | 404 | 3 | 13 | 6 | 0 | 4 | 4 | 66 |
| **v/c** | 0.07 | 0.09 | 0.00 | 0.00 | 0.12 | 0.00 | 0.05 | | | 0.12 | | |
| **Delay (s)** | 8.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 13.7 | | | 11.2 | | |
| **LOS** | A | A | A | A | A | A | B | | | B | | |
| **95th Queue (m)** | 2 | 0 | 0 | 0 | 0 | 0 | 1 | | | 3 | | |
| **2011 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 69 | 312 | 6 | 0 | 453 | 3 | 14 | 6 | 0 | 4 | 4 | 69 |
| **v/c** | 0.07 | 0.10 | 0.00 | 0.00 | 0.14 | 0.00 | 0.05 | | | 0.13 | | |
| **Delay (s)** | 9.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.4 | | | 11.5 | | |
| **LOS** | A | A | A | A | A | A | B | | | B | | |
| **95th Queue (m)** | 2 | 0 | 0 | 0 | 0 | 0 | 1 | | | 4 | | |

**Table 5-10: Highway 16 and Highway 830 – AM Peak Hour Continued**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2011 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 84 | 312 | 6 | 0 | 453 | 3 | 14 | 6 | 0 | 4 | 4 | 84 |
| **v/c** | 0.10 | 0.10 | 0.00 | 0.00 | 0.14 | 0.00 | 0.06 | | | 0.16 | | |
| **Delay (s)** | 9.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.2 | | | 12.0 | | |
| **LOS** | A | A | A | A | A | A | C | | | B | | |
| **95th Queue (m)** | 3 | 0 | 0 | 0 | 0 | 0 | 1 | | | 4 | | |
| **2031 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 113 | 402 | 9 | 0 | 582 | 5 | 19 | 10 | 0 | 6 | 6 | 102 |
| **v/c** | 0.14 | 0.12 | 0.01 | 0.00 | 0.18 | 0.00 | 0.11 | | | 0.22 | | |
| **Delay (s)** | 9.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.6 | | | 13.4 | | |
| **LOS** | A | A | A | A | A | A | C | | | B | | |
| **95th Queue (m)** | 4 | 0 | 0 | 0 | 0 | 0 | 3 | | | 7 | | |
| **2031 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 128 | 402 | 9 | 0 | 582 | 5 | 19 | 10 | 0 | 6 | 6 | 117 |
| **v/c** | 0.17 | 0.12 | 0.01 | 0.00 | 0.18 | 0.00 | 0.12 | | | 0.25 | | |
| **Delay (s)** | 10.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.3 | | | 14.0 | | |
| **LOS** | B | A | A | A | A | A | C | | | B | | |
| **95th Queue (m)** | 5 | 0 | 0 | 0 | 0 | 0 | 3 | | | 8 | | |

As shown in Tables 5-9 and 5 -10, the intersection of Highway 16 and Highway 830 is anticipated to operate at acceptable levels of service as an unsignalized intersection with v/c ratios less than or equal to 0.25 during the AM peak hour based on existing, background, and total traffic volumes.

**Table 5-11: Highway 16 and Highway 830 – PM Peak Hour**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2009 Existing – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 138 | 774 | 12 | 4 | 532 | 10 | 7 | 4 | 3 | 19 | 11 | 167 |
| **v/c** | 0.16 | 0.24 | 0.01 | 0.01 | 0.16 | 0.01 | 0.07 | | | 0.38 | | |
| **Delay (s)** | 9.6 | 0.0 | 0.0 | 10.4 | 0.0 | 0.0 | 24.1 | | | 15.6 | | |
| **LOS** | A | A | A | B | A | A | C | | | C | | |
| **95th Queue (m)** | 4 | 0 | 0 | 0 | 0 | 0 | 2 | | | 14 | | |
| **2011 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 144 | 863 | 12 | 4 | 604 | 10 | 7 | 4 | 3 | 20 | 11 | 174 |
| **v/c** | 0.17 | 0.27 | 0.01 | 0.01 | 0.19 | 0.01 | 0.09 | | | 0.43 | | |
| **Delay (s)** | 10.0 | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 28.0 | | | 17.5 | | |
| **LOS** | B | A | A | B | A | A | D | | | C | | |
| **95th Queue (m)** | 5 | 0 | 0 | 0 | 0 | 0 | 2 | | | 17 | | |
| **2011 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 159 | 863 | 12 | 4 | 604 | 10 | 7 | 4 | 3 | 20 | 11 | 189 |
| **v/c** | 0.20 | 0.27 | 0.01 | 0.01 | 0.19 | 0.01 | 0.10 | | | 0.47 | | |
| **Delay (s)** | 10.5 | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 30.9 | | | 18.8 | | |
| **LOS** | B | A | A | B | A | A | D | | | C | | |
| **95th Queue (m)** | 6 | 0 | 0 | 0 | 0 | 0 | 3 | | | 20 | | |
| **2031 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 199 | 1115 | 17 | 6 | 766 | 14 | 10 | 6 | 4 | 27 | 16 | 248 |
| **v/c** | 0.28 | 0.35 | 0.01 | 0.01 | 0.24 | 0.01 | 1.34 | | | 0.82 | | |
| **Delay (s)** | 11.7 | 0.0 | 0.0 | 12.8 | 0.0 | 0.0 | >660 | | | 46.3 | | |
| **LOS** | B | A | A | B | A | A | F | | | E | | |
| **95th Queue (m)** | 9 | 0 | 0 | 0 | 0 | 0 | 25 | | | 59 | | |

**Table 5-12: Highway 16 and Highway 830 – PM Peak Hour Continued**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2031 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 214 | 1115 | 17 | 6 | 766 | 14 | 10 | 6 | 4 | 27 | 16 | 263 |
| **v/c** | 0.32 | 0.35 | 0.01 | 0.01 | 0.24 | 0.01 | 1.64 | | | 0.89 | | |
| **Delay (s)** | 12.4 | 0.0 | 0.0 | 12.8 | 0.0 | 0.0 | >900 | | | 58.7 | | |
| **LOS** | B | A | A | B | A | A | F | | | F | | |
| **95th Queue (m)** | 11 | 0 | 0 | 0 | 0 | 0 | 27 | | | 71 | | |

During the PM peak hour, northbound movements at the intersection of Highway 16 and Highway 830 are anticipated to operate poorly with excessive delays, v/c ratios greater than 1.0, and LOS F based on background and total traffic volumes in 2031; however, volumes on the south approach are anticipated to be very low. The southbound movements are also anticipated to operate at LOS F during the PM peak hour with the addition of site generated traffic, but the movements are anticipated to operate under capacity with a v/c ratio less than 0.90.

As phase one site generated traffic is only anticipated for a 10 year horizon, a capacity assessment was also completed for the 2021 horizon to identify intersection operations during the life of the gravel extraction project. Based on a signal warrant analysis at the intersection of Highway 16 and Highway 830, signalization is not anticipated to be required in 2021 with the addition of site generated traffic. **Table 5-13** summarizes the results of the capacity analysis during the AM and PM peak hours based on 2021 total traffic volumes.

As shown in Table 5-13, the intersection of Highway 16 and Highway 830 is anticipated to operate with v/c ratios less than 0.65 during the PM peak hour based on 2021 total traffic volumes. Although the northbound movements are anticipated to operate at LOS F, the volumes completing the movements are anticipated to be low and the v/c ratio is anticipated to be 0.20. Therefore, based on the capacity analyses completed for the 2021 horizon, no intersection improvements are anticipated to be required to accommodate the first phase of site generated traffic.

Table 5-13: Highway 16 and Highway 830 – 2021 Total

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **AM Peak Hour - 2021 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 115 | 346 | 7 | 0 | 501 | 5 | 16 | 9 | 0 | 5 | 5 | 104 |
| **v/c** | 0.14 | 0.11 | 0.00 | 0.00 | 0.15 | 0.00 | 0.09 | | | 0.20 | | |
| **Delay (s)** | 9.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.0 | | | 12.7 | | |
| **LOS** | A | A | A | A | A | A | C | | | B | | |
| **95th Queue (m)** | 4 | 0 | 0 | 0 | 0 | 0 | 2 | | | 6 | | |
| **PM Peak Hour - 2021 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | L/T/T/R | | | L/T/T/R | | | LTR | | | LTR | | |
| **Volume (vph)** | 186 | 960 | 15 | 5 | 660 | 12 | 9 | 5 | 3 | 24 | 14 | 228 |
| **v/c** | 0.25 | 0.30 | 0.01 | 0.01 | 0.20 | 0.01 | 0.20 | | | 0.64 | | |
| **Delay (s)** | 11.1 | 0.0 | 0.0 | 11.6 | 0.0 | 0.0 | 55.9 | | | 26.8 | | |
| **LOS** | B | A | A | B | A | A | F | | | D | | |
| **95th Queue (m)** | 8 | 0 | 0 | 0 | 0 | 0 | 6 | | | 35 | | |

### 5.4.2 Township Road 550 and Highway 830

Based on the Highway Geometric Design Guide, the traffic control scheme at the intersection should be reviewed; however, for the purpose of this assessment, the intersection of Township Road 550 and Highway 830 is assumed to continue to be stop controlled on the north and south approaches.

Although the intersection of Township Road 550 and Highway 830 is currently developed as a Type IIc intersection, which allows left turn traffic to be bypassed along Township Road 550 eastbound and westbound, the Synchro analysis has been completed assuming a single lane on the east and west approaches to be conservative. A shared left/through lane and a right turn bay are currently constructed on the north and south approaches.

With the addition of site generated traffic in 2031, an eastbound right turn bay is anticipated to be required based on the Alberta Transportation Highway Geometric Design Guide. Therefore, the intersection geometry for the 2031 total traffic scenario includes an eastbound right turn bay.

**Tables 5-14** through **5-17** summarize the results of the capacity analysis for the AM and PM peak hours.

**Table 5-14: Township Road 550 and Highway 830 – AM Peak Hour**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2009 Existing – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 1 | 6 | 1 | 1 | 43 | 4 | 9 | 110 | 0 | 1 | 14 | 2 |
| **v/c** | 0.00 | | | 0.00 | | | 0.17 | | 0.17 | 0.02 | | 0.02 |
| **Delay (s)** | 0.9 | | | 0.2 | | | 10.3 | | 10.3 | 9.6 | | 9.6 |
| **LOS** | A | | | A | | | B | | B | A | | A |
| **95th Queue (m)** | 0 | | | 0 | | | 5 | | 5 | 1 | | 1 |
| **2011 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 1 | 6 | 1 | 1 | 45 | 4 | 9 | 115 | 0 | 1 | 15 | 2 |
| **v/c** | 0.00 | | | 0.00 | | | 0.18 | | 0.18 | 0.03 | | 0.03 |
| **Delay (s)** | 0.9 | | | 0.1 | | | 10.4 | | 10.4 | 9.7 | | 9.7 |
| **LOS** | A | | | A | | | B | | B | A | | A |
| **95th Queue (m)** | 0 | | | 0 | | | 5 | | 5 | 1 | | 1 |
| **2011 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 1 | 6 | 16 | 1 | 45 | 4 | 24 | 115 | 0 | 1 | 15 | 2 |
| **v/c** | 0.00 | | | 0.00 | | | 0.21 | | 0.21 | 0.03 | | 0.03 |
| **Delay (s)** | 0.3 | | | 0.2 | | | 10.7 | | 10.7 | 9.8 | | 9.8 |
| **LOS** | A | | | A | | | B | | B | A | | A |
| **95th Queue (m)** | 0 | | | 0 | | | 6 | | 6 | 1 | | 1 |
| **2031 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 9 | 51 | 9 | 1 | 161 | 6 | 34 | 158 | 0 | 2 | 20 | 7 |
| **v/c** | 0.01 | | | 0.00 | | | 0.38 | | 0.38 | 0.05 | | 0.05 |
| **Delay (s)** | 1.0 | | | 0.1 | | | 14.4 | | 14.4 | 11.2 | | 11.2 |
| **LOS** | A | | | A | | | B | | B | B | | B |
| **95th Queue (m)** | 0 | | | 0 | | | 14 | | 14 | 1 | | 1 |

Table 5-15: Township Road 550 and Highway 830 – AM Peak Hour Continued

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2031 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | **LT/R** | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 9 | 51 | 24 | 1 | 161 | 6 | 49 | 158 | 0 | 2 | 20 | 7 |
| **v/c** | 0.01 | | 0.02 | 0.00 | | | 0.41 | | 0.41 | 0.05 | | 0.05 |
| **Delay (s)** | 1.2 | | 0.0 | 0.1 | | | 15.1 | | 15.1 | 11.3 | | 11.3 |
| **LOS** | A | | A | A | | | C | | C | B | | B |
| **95th Queue (m)** | 0 | | 0 | 0 | | | 16 | | 16 | 1 | | 1 |

Table 5-16: Township Road 550 and Highway 830 – PM Peak Hour

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2009 Existing – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 3 | 49 | 9 | 2 | 29 | 1 | 0 | 38 | 1 | 3 | 196 | 3 |
| **v/c** | 0.00 | | | 0.00 | | | 0.06 | | 0.06 | 0.30 | | 0.30 |
| **Delay (s)** | 0.4 | | | 0.5 | | | 10.0 | | 10.0 | 11.7 | | 11.7 |
| **LOS** | A | | | A | | | A | | A | B | | B |
| **95th Queue (m)** | 0 | | | 0 | | | 2 | | 2 | 10 | | 10 |
| **2011 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 3 | 51 | 9 | 2 | 30 | 1 | 0 | 40 | 1 | 3 | 204 | 3 |
| **v/c** | 0.00 | | | 0.00 | | | 0.06 | | 0.06 | 0.31 | | 0.31 |
| **Delay (s)** | 0.4 | | | 0.5 | | | 10.0 | | 10.0 | 11.9 | | 11.9 |
| **LOS** | A | | | A | | | B | | B | B | | B |
| **95th Queue (m)** | 0 | | | 0 | | | 2 | | 2 | 11 | | 11 |

**Table 5-17: Township Road 550 and Highway 830 – PM Peak Hour Continued**

| | Eastbound | | | Westbound | | | Northbound | | | Southbound | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Movement** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** | **L** | **T** | **R** |
| **2011 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 3 | 51 | 24 | 2 | 30 | 1 | 15 | 40 | 1 | 3 | 204 | 3 |
| **v/c** | 0.00 | | | 0.00 | | | 0.10 | | 0.10 | 0.32 | | 0.32 |
| **Delay (s)** | 0.3 | | | 0.5 | | | 11.0 | | 11.0 | 12.1 | | 12.1 |
| **LOS** | A | | | A | | | B | | B | B | | B |
| **$95^{th}$ Queue (m)** | 0 | | | 0 | | | 3 | | 3 | 11 | | 11 |
| **2031 Background – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | LTR | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 7 | 107 | 20 | 3 | 66 | 1 | 0 | 55 | 1 | 4 | 282 | 7 |
| **v/c** | 0.01 | | | 0.00 | | | 0.10 | | 0.10 | 0.52 | | 0.52 |
| **Delay (s)** | 0.4 | | | 0.3 | | | 11.1 | | 11.1 | 16.3 | | 16.3 |
| **LOS** | A | | | A | | | B | | B | C | | C |
| **$95^{th}$ Queue (m)** | 0 | | | 0 | | | 3 | | 3 | 24 | | 24 |
| **2031 Total – Unsignalized (N/S Stop Control)** | | | | | | | | | | | | |
| **Geometry** | **LT/R** | | | LTR | | | LT/R | | | LT/R | | |
| **Volume (vph)** | 7 | 107 | 35 | 3 | 66 | 1 | 15 | 55 | 1 | 4 | 282 | 7 |
| **v/c** | 0.01 | | 0.02 | 0.00 | | | 0.14 | | 0.14 | 0.53 | | 0.53 |
| **Delay (s)** | 0.5 | | 0.0 | 0.3 | | | 12.3 | | 12.3 | 16.9 | | 16.9 |
| **LOS** | A | | A | A | | | B | | B | C | | C |
| **$95^{th}$ Queue (m)** | 0 | | 0 | 0 | | | 4 | | 4 | 25 | | 25 |

As shown in Tables 5-14 to 5-17, the intersection of Township Road 550 and Highway 830 is anticipated to operate at acceptable levels of service during the AM and PM peak hours under existing, background, and total traffic conditions.

### 5.4.3 Township Road 550 and Range Road 221

**Tables 5-18** and **5-19** present the results of the Synchro analysis completed for the Township Road 550/Range Road 221 intersection for the AM and PM peak hours. The tables include the analysis of existing/2011 background, 2011 total, 2031 background, and 2031 total traffic volumes.

The intersection of Township Road 550 and Range Road 221 is currently unsignalized with stop control on the south approach and includes the following geometry:

- ***West Approach*** – one shared through/right lane
- ***East Approach*** – one shared left/through lane
- ***North Approach*** – one shared left/right lane

Although the intersection of Township Road 550 and Range Road 221 requires a Type IIb intersection treatment in 2011 and 2031 with the addition of site generated traffic, which allows left turning traffic to be bypassed along Township Road 550 westbound, the Synchro analysis has been completed assuming a single lane on the east approach to be conservative.

As shown in Tables 5-18 and 5-19, the intersection is anticipated to operate well in the AM and PM peak hours with the addition of site generated traffic in 2011 and 2031.

**Table 5-18: Township Road 550 and Range Road 221 – AM Peak Hour**

| | Eastbound | | Westbound | | Northbound | |
|---|---|---|---|---|---|---|
| **Movement** | **T** | **R** | **L** | **T** | **L** | **R** |
| **Existing/2011 Background – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 18 | 0 | 0 | 46 | 1 | 0 |
| **v/c** | 0.02 | | 0.00 | | 0.00 | |
| **Delay (s)** | 0.0 | | 0.0 | | 9.0 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 0 | | 0 | | 0 | |
| **2011 Total – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 18 | 0 | 15 | 46 | 1 | 15 |
| **v/c** | 0.02 | | 0.02 | | 0.03 | |
| **Delay (s)** | 0.0 | | 2.2 | | 9.5 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 0 | | 1 | | 1 | |
| **2031 Background – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 79 | 0 | 0 | 194 | 1 | 0 |
| **v/c** | 0.08 | | 0.00 | | 0.00 | |
| **Delay (s)** | 0.0 | | 0.0 | | 11.5 | |
| **LOS** | A | | A | | B | |
| **95th Queue (m)** | 0 | | 0 | | 0 | |
| **2031 Total – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 79 | 0 | 15 | 194 | 1 | 15 |
| **v/c** | 0.08 | | 0.03 | | 0.04 | |
| **Delay (s)** | 0.0 | | 0.9 | | 10.4 | |
| **LOS** | A | | A | | B | |
| **95th Queue (m)** | 0 | | 1 | | 1 | |

Table 5-19: Township Road 550 and Range Road 221 – PM Peak Hour

| | Eastbound | | Westbound | | Northbound | |
|---|---|---|---|---|---|---|
| **Movement** | **T** | **R** | **L** | **T** | **L** | **R** |
| **Existing/2011 Background – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 73 | 1 | 0 | 34 | 1 | 0 |
| **v/c** | 0.05 | | 0.00 | | 0.00 | |
| **Delay (s)** | 0.0 | | 0.0 | | 9.2 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 0 | | 0 | | 0 | |
| **2011 Total – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 73 | 1 | 15 | 34 | 1 | 15 |
| **v/c** | 0.05 | | 0.02 | | 0.03 | |
| **Delay (s)** | 0.0 | | 2.7 | | 9.9 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 0 | | 0 | | 1 | |
| **2031 Background – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 145 | 1 | 0 | 75 | 1 | 0 |
| **v/c** | 0.11 | | 0.00 | | 0.00 | |
| **Delay (s)** | 0.0 | | 0.0 | | 10.0 | |
| **LOS** | A | | A | | B | |
| **95th Queue (m)** | 0 | | 0 | | 0 | |
| **2031 Total – Unsignalized (NB Stop Control)** | | | | | | |
| **Geometry** | TR | | LT | | LR | |
| **Volume (vph)** | 145 | 1 | 15 | 75 | 1 | 15 |
| **v/c** | 0.11 | | 0.02 | | 0.03 | |
| **Delay (s)** | 0.0 | | 1.6 | | 10.6 | |
| **LOS** | A | | A | | B | |
| **95th Queue (m)** | 0 | | 1 | | 1 | |

### 5.4.4 Site Access and Range Road 221

The Site Access/Range Road 221 intersection is anticipated to be a future T-intersection providing access to the gravel extraction development and the intersection geometry is anticipated to include the following:

- ***East Approach*** – one shared left/right turn lane
- ***South Approach*** – one shared through/right lane
- ***North Approach*** – one shared left/through lane

**Tables 5-20** and **5-21** present the results of the Synchro analysis completed for the Site Access/Range Road 221 intersection for the AM and PM peak hours. The tables include the analysis of 2011 total and 2031 total traffic volumes only.

**Table 5-20: Site Access and Range Road 221 – AM Peak Hour**

| | Westbound | | Northbound | | Southbound | |
|---|---|---|---|---|---|---|
| **Movement** | **L** | **R** | **T** | **R** | **L** | **T** |
| **2011 Total – Unsignalized (WB Stop Control)** | | | | | | |
| **Geometry** | LR | | TR | | LT | |
| **Volume (vph)** | 0 | 15 | 1 | 0 | 15 | 0 |
| **v/c** | 0.02 | | 0.00 | | 0.02 | |
| **Delay (s)** | 9.3 | | 0.0 | | 0.1 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 1 | | 0 | | 0 | |
| **2031 Total – Unsignalized (WB Stop Control)** | | | | | | |
| **Geometry** | LR | | TR | | LT | |
| **Volume (vph)** | 0 | 15 | 1 | 0 | 15 | 0 |
| **v/c** | 0.02 | | 0.00 | | 0.02 | |
| **Delay (s)** | 9.3 | | 0.0 | | 0.1 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 1 | | 0 | | 0 | |

**Table 5-21: Site Access and Range Road 221 – PM Peak Hour**

| | Westbound | | Northbound | | Southbound | |
|---|---|---|---|---|---|---|
| **Movement** | **L** | **R** | **T** | **R** | **L** | **T** |
| **2011 Total – Unsignalized (WB Stop Control)** | | | | | | |
| **Geometry** | LR | | TR | | LT | |
| **Volume (vph)** | 0 | 15 | 1 | 0 | 15 | 1 |
| **v/c** | 0.02 | | 0.00 | | 0.02 | |
| **Delay (s)** | 9.3 | | 0.0 | | 7.6 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 1 | | 0 | | 0 | |
| **2031 Total – Unsignalized (WB Stop Control)** | | | | | | |
| **Geometry** | LR | | TR | | LT | |
| **Volume (vph)** | 0 | 15 | 1 | 0 | 15 | 1 |
| **v/c** | 0.02 | | 0.00 | | 0.02 | |
| **Delay (s)** | 9.3 | | 0.0 | | 7.6 | |
| **LOS** | A | | A | | A | |
| **95th Queue (m)** | 1 | | 0 | | 0 | |

As shown in Tables 5-20 and 5-21, the site access intersection with Range Road 221 is anticipated to operate very well in the AM and PM peak hours. Left and right turn bays along Range Road 221 are not anticipated to be required.

## 5.5 Lighting Assessment

A preliminary assessment based on Figure 10-2, Warrants for Intersection Lighting, from the TAC Guide for the Design of Roadway Lighting (2006) was completed to confirm if illumination is warranted at the study intersections. The detailed calculations for the illumination warrant analysis are summarized in **Appendix F**.

Partial lighting is currently provided at the intersection of Highway 16 and Highway 830. It is anticipated that the existing illumination will be sufficient to accommodate 2011 background and total traffic volumes; however, signalization was identified as being warranted based on 2031 background traffic volumes which will require full illumination if implemented.

Based on lighting assessments completed at the intersections of Township Road 550/Highway 830, Township Road 550/Range Road 221, and the Site Access/Range Road 221, illumination is not anticipated to be required to accommodate future background and total traffic scenarios.

## 5.6 County Roadway Assessment

Based on a review of the Strathcona County Rural Road Specifications, Class III roadways are gravel surface roads that carry less than 250 vehicles per day. Range Road 221 is currently a Class III gravel roadway with an estimated daily volume of approximately 27 vpd. With the addition of site generated traffic, daily volumes along Range Road 221 south of Township Road 550 are anticipated to increase to about 431 vpd. Therefore, Range Road 221 from the proposed site access north to Township Road 550 may need to be upgraded to a Class II, coldmix asphalt surface roadway, which can accommodate between 250 and 1,000 vpd. However, in discussion with Reperio Resources, it has been their experience that coldmix asphalt is hard to maintain when high volumes of heavy vehicles are present; therefore, Reperio Resources would prefer to enter into an agreement with Strathcona County to maintain the gravel road with dust prevention for the duration of the gravel extraction project.

Existing daily volumes along Township Road 550 are estimated to be in the order of 950 vpd near Range Road 221. Traffic volumes in the range of 250 to 1,000 vpd can be accommodated on a Class II roadway with a 7.5 metre wide coldmix asphalt surface. However, with the addition of site generated traffic in 2011, daily traffic volumes along Township Road 550 are anticipated to increase to about 1,355 vpd (70% background traffic/30% site traffic). Therefore, Township Road 550 would need to be upgraded to a Class I roadway with a 9.0 metre wide hotmix asphalt surface with 3.5 metre lanes and 1.0 metre shoulders.

Based on site observations and a review of County maps, Township Road 550 west of Highway 830 is designated as an unimproved Class I roadway that has been upgraded to include a hotmix asphalt surface and painted yellow centerline, but has not been widened to include two 3.5 metre lanes and 1.0 metre shoulders.

# 6. CONCLUSIONS AND RECOMMENDATIONS

This report documents the results of a comprehensive impact assessment report prepared for Reperio Resources regarding the proposed gravel extraction project near Josephburg, Alberta. Based on the analysis and assessment completed, it has been determined that the proposed development can be accommodated from a transportation perspective. The following summarizes the key conclusions and recommendations of the assessments completed.

## 6.1 Conclusions

- The existing intersection of Highway 16 and Highway 830 can accommodate the projected 2011 background and total site traffic; however, the intersection is anticipated to operate poorly in 2031 based on background and total traffic volumes.
- Although signalization was identified as being warranted at the intersection of Highway 16 and Highway 830 based on 2031 background traffic volumes, Highway 16 is an access controlled freeway facility and signalization is not anticipated to be an acceptable mitigation measure.
- Signalization is not anticipated to be warranted in 2021, which represents the anticipated 10 year life for the first phase of the gravel extraction.
- The intersection of Highway 16 and Highway 830 is anticipated to operate at acceptable levels of service in 2021 with the existing intersection geometry.
- The existing Type IIc intersection geometry at Township Road 550 and Highway 830 is anticipated to accommodate the projected 2011 and 2031 background and total site traffic with modifications to the pavement markings to include a shared left/through lane and a right turn bay (instead of a bypass lane) on the west approach.
- The Township Road 550/Range Road 221 intersection is currently a Type Ia intersection. It is anticipated that the intersection will need to be upgraded to a Type IIa intersection to accommodate site generated traffic volumes in both the 2011 and 2031 horizons.
- Range Road 221 is currently a Class III gravel roadway which is anticipated to accommodate less than 250 vehicles per day. With the addition of site generated traffic, daily volumes along Range Road 221 are anticipated to increase to about 431 vpd which is within the threshold for a Class II roadway.
- Township Road 550 is currently designated an unimproved Class I roadway with existing daily volumes in the order of 950 vpd near Range Road 221. With the addition of site generated traffic, daily volumes along Township Road 550 are anticipated to increase to about 1,355 vpd which is within the threshold for a Class I roadway.

## 6.2 Recommendations

Based on the transportation analysis completed, the following roadway improvements are recommended:

- Utilize the existing geometry but modify the pavement markings at the Township Road 550/Highway 830 intersection to include an eastbound shared left/through lane and an eastbound right turn bay to accommodate site generated traffic volumes.
- Upgrade the intersection of Township Road 550 and Range Road 221 from a Type Ia intersection treatment to a Type IIa intersection treatment.
- Widen Township Road 550 from Range Road 221 to west of Highway 830 to Strathcona County's Class I standard which includes a 9.0 metre wide surface with 3.5 metre lanes and 1.0 metre shoulders.
- Reconstruct Range Road 221 from the proposed site access to Township Road 550 to Class II roadway based on Strathcona County's rural road specifications or enter into an agreement with Strathcona County to maintain the Class III gravel roadway with dust control for the duration of the gravel extraction project.

# APPENDIX A

## Existing Roadway Network Photographs

Figure A-1: Range Road 221 Looking North

Figure A-2: Township Road 550 (Josephburg Road) Looking East at Range Road 221

**Figure A-3: Township Road 550/Highway 830 Intersection Looking East from West Approach**

**Figure A-4: Township Road 550/Highway 830 Intersection Looking North from South Approach**

**Figure A-5: Highway 830 Looking South At Township Road 550**

# APPENDIX B

## 2021 Total Traffic Volumes

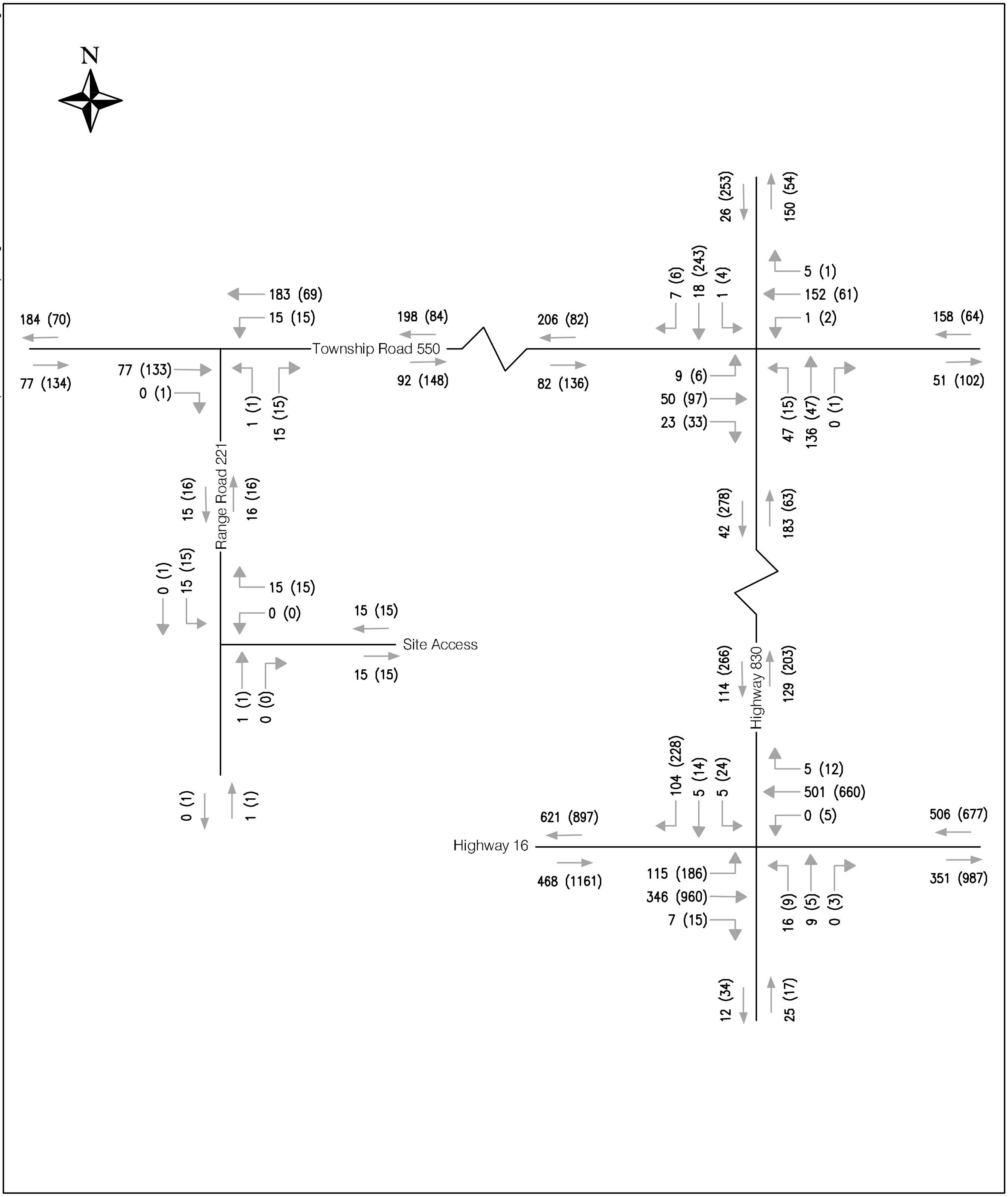



**Exhibit B-1**

Scale NTS

Project No. 3363.01

# 2021 Total Traffic Volumes
# AM (PM) Peak Hour

P:\3363.01 - Reperio Resources - Josephburg\CAD\Exhibits\Final Oct 20-11\Exhibit B-2.dwg

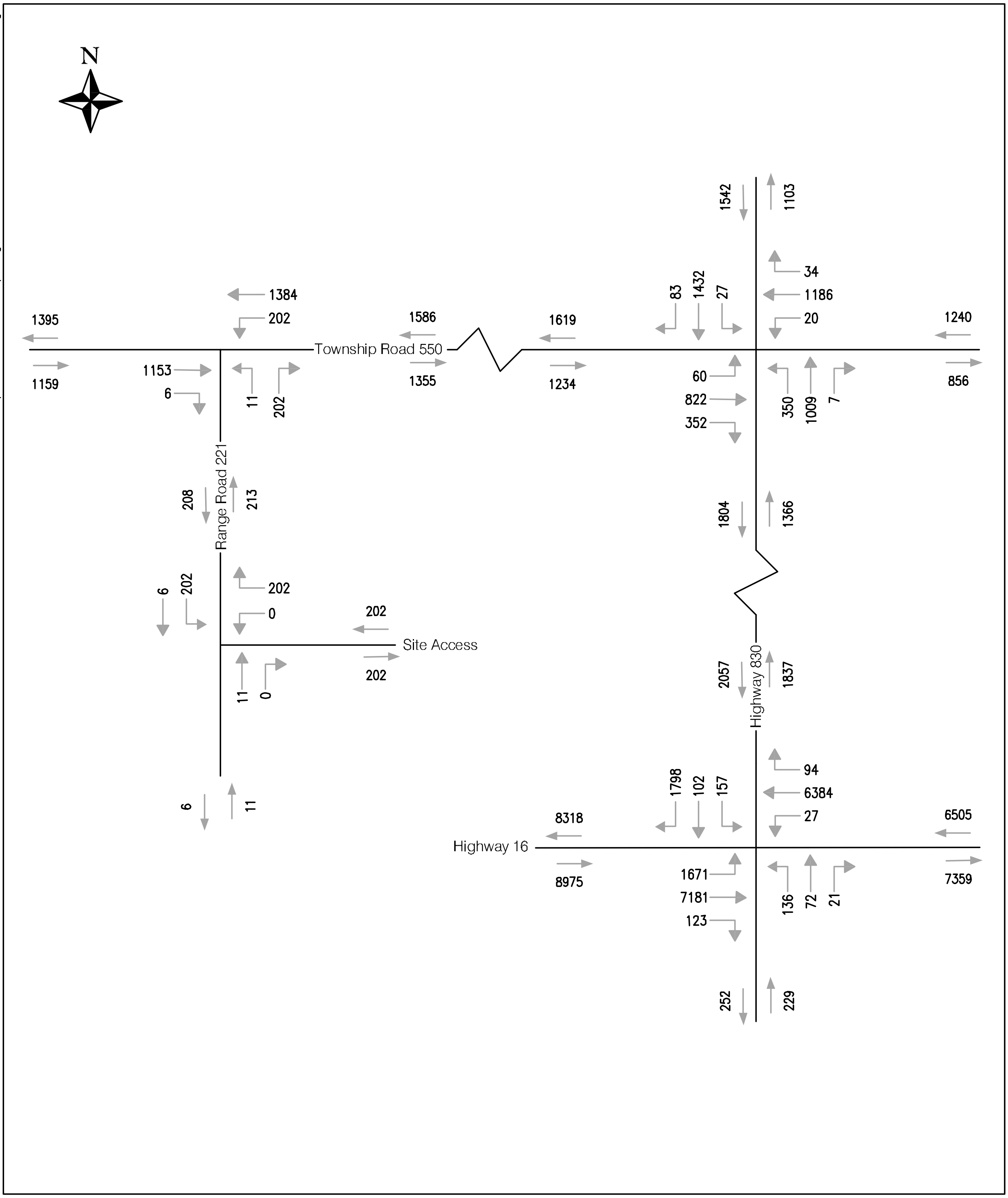



**Exhibit B-2**

Scale NTS

Project No. 3363.01

## 2021 Daily Total Traffic Volumes

# APPENDIX C

## AT Highway Geometric Design Guide Left and Right Turn Warrants

# Warrant Analysis for Left Turn Lanes - Highway 16 & Highway 830

| EXISTING TRAFFIC ANALYSIS | 2009 AM Peak Hour | | | | | | 2009 PM Peak Hour | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 0 | 0% | 351 | D-8.6c | no left turn lane required | no | 4 | 25% | 924 | D-8.6c | no left turn lane required | no |
| **West Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 66 | 18% | 407 | D-8.6c | 15m | 10m | 138 | 12% | 546 | D-8.6c | 30m | 10m |

| BACKGROUND TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | 2011 PM Peak Hour | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 0 | 0% | 387 | D-8.6c | no left turn lane required | no | 4 | 25% | 1019 | D-8.6c | no left turn lane required | no |
| **West Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 69 | 18% | 456 | D-8.6c | 15m | 10m | 144 | 12% | 618 | D-8.6c | 30m | 10m |

| TOTAL TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | 2011 PM Peak Hour | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 0 | 0% | 402 | D-8.6c | no left turn lane required | no | 4 | 25% | 1034 | D-8.6c | no left turn lane required | no |
| **West Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 84 | 32% | 456 | D-8.6c | 15m | 10m | 159 | 19% | 618 | D-8.6c | 30m | 10m |

| BACKGROUND TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | 2031 PM Peak Hour | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 0 | 0% | 524 | D-8.6c | no left turn lane required | no | 6 | 25% | 1331 | D-8.6c | no left turn lane required | no |
| **West Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 113 | 18% | 587 | D-8.6c | 25m | 10m | 199 | 12% | 786 | D-8.6c | 55m | 15m |

| TOTAL TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | 2031 PM Peak Hour | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Opposing Volume (V-o), vph | Chart Used | Left Turn Lane Storage Requirement | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 0 | 0% | 539 | D-8.6c | no left turn lane required | no | 6 | 25% | 1346 | D-8.6c | no left turn lane required | no |
| **West Approach** | | | | | | | | | | | | |
| Highway 16 & Highway 830 | 128 | 32% | 587 | D-8.6c | 25m | 15m | 214 | 19% | 786 | D-8.6c | 65m | 20m |

Notes:
1. Posted speed on Highway 16 is 110 km/h; it is assumed the design speed is 120 km/h
2. Where proportion of left turns is less than 3%, a Type I intersection was assumed to be adequate

## Warrant Analysis for Right Turn Lanes - Highway 16 & Highway 830

| EXISTING TRAFFIC ANALYSIS | 2009 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **East Approach** | | | | | | | |
| Highway 16 & Highway 830 | 11178 | yes | 2741 | yes | 72 | no | **NO** |
| **West Approach** | | | | | | | |
| Highway 16 & Highway 830 | 13553 | yes | 386 | no | 99 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **East Approach** | | | | | | | |
| Highway 16 & Highway 830 | 12470 | yes | 2851 | yes | 75 | no | **NO** |
| **West Approach** | | | | | | | |
| Highway 16 & Highway 830 | 14940 | yes | 401 | no | 103 | no | **NO** |

| TOTAL TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **East Approach** | | | | | | | |
| Highway 16 & Highway 830 | 12470 | yes | 3255 | yes | 75 | no | **NO** |
| **West Approach** | | | | | | | |
| Highway 16 & Highway 830 | 15344 | yes | 401 | no | 103 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **East Approach** | | | | | | | |
| Highway 16 & Highway 830 | 16099 | yes | 4038 | yes | 108 | no | **NO** |
| **West Approach** | | | | | | | |
| Highway 16 & Highway 830 | 19599 | yes | 558 | no | 142 | no | **NO** |

| TOTAL TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **East Approach** | | | | | | | |
| Highway 16 & Highway 830 | 16099 | yes | 4442 | yes | 108 | no | **NO** |
| **West Approach** | | | | | | | |
| Highway 16 & Highway 830 | 20003 | yes | 558 | no | 142 | no | **NO** |

Notes:
1. "Main Road AADT" is assumed to be the approach from which the right turns are leaving
2. "Intersecting Road Volume" assumed to be volume on leg that right-turning traffic is turning into

## Warrant Analysis for Left Turn Lanes - Township Road 550 & Highway 830 (N/S Stop Control)

| EXISTING TRAFFIC ANALYSIS | 2009 AM Peak Hour | | | | | | | | | 2009 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 48 | 2% | 8 | n/a | I | no | no | 2 | 0% | 32 | 6% | 61 | 5a (5%) | I | no | no |
| **West Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 8 | 13% | 48 | 5b (15%) | I | no | no | 3 | 0% | 61 | 5% | 32 | 5a (5%) | I | no | no |

| BACKGROUND TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | | | | 2011 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 50 | 2% | 8 | n/a | I | no | no | 2 | 0% | 33 | 6% | 63 | 5a (5%) | I | no | no |
| **West Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 8 | 13% | 50 | 5b (15%) | I | no | no | 3 | 0% | 63 | 5% | 33 | 5a (5%) | I | no | no |

| COMBINED TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | | | | 2011 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 50 | 2% | 23 | n/a | I | no | no | 2 | 0% | 33 | 6% | 78 | 5a (5%) | I | no | no |
| **West Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 23 | 4% | 50 | 5a (5%) | I | no | no | 3 | 0% | 78 | 4% | 33 | 5a (5%) | I | no | no |

| BACKGROUND TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | | | | 2031 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 168 | 1% | 69 | n/a | I | no | no | 3 | 0% | 70 | 4% | 134 | 5a (5%) | II | no | no |
| **West Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 9 | 0% | 69 | 13% | 168 | 5b (15%) | II | no | no | 7 | 0% | 134 | 5% | 70 | 5a (5%) | I | no | no |

| COMBINED TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | | | | 2031 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 168 | 1% | 84 | n/a | I | no | no | 3 | 0% | 70 | 4% | 149 | 5a (5%) | II | no | no |
| **West Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 9 | 0% | 84 | 11% | 168 | 5a (10%) | II | no | no | 7 | 0% | 149 | 5% | 70 | 5a (5%) | I | no | no |

Notes:
1. Posted speed on Township Road 550 is 80 km/h; it is assumed the design speed is 90 km/h
2. Where proportion of left turns is less than 3%, a Type I intersection was assumed to be adequate

## Warrant Analysis for Right Turn Lanes - Township Road 550 & Highway 830 (N/S Stop Control)

| EXISTING TRAFFIC ANALYSIS | 2009 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 772 | no | 2069 | yes | 28 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 854 | no | 2097 | yes | 55 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 803 | no | 2152 | yes | 29 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 888 | no | 2181 | yes | 57 | no | **NO** |

| COMBINED TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 803 | no | 2152 | yes | 29 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 1292 | no | 2585 | yes | 259 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2251 | yes | 3059 | yes | 40 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2619 | yes | 3185 | yes | 161 | no | **NO** |

| COMBINED TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2251 | yes | 3059 | yes | 40 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 3023 | yes | 3589 | yes | 363 | yes | **YES** |

| COMBINED TRAFFIC ANALYSIS | 2021 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted?** |
| **East Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2096 | yes | 2645 | yes | 34 | no | **NO** |
| **West Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2853 | yes | 3170 | yes | 352 | no | **NO** |

Notes:
1. "Main Road AADT" is assumed to be the approach from which the right turns are leaving
2. "Intersecting Road Volume" assumed to be volume on leg that right-turning traffic is turning into

# Warrant Analysis for Left Turn Lanes - Township Road 550 & Highway 830 (E/W Stop Control)

| EXISTING TRAFFIC ANALYSIS | 2009 AM Peak Hour | | | | | | | | | 2009 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **North Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 17 | 6% | 119 | 7a (5%) | II | no | no | 3 | 0% | 202 | 1% | 39 | n/a | I | no | no |
| **South Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 9 | 0% | 119 | 8% | 17 | 7a (10%) | I | no | no | 0 | 0% | 39 | 0% | 202 | n/a | I | no | no |

| BACKGROUND TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | | | | 2011 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **North Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 18 | 6% | 124 | 7a (5%) | II | no | no | 3 | 0% | 210 | 1% | 41 | n/a | I | no | no |
| **South Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 9 | 0% | 124 | 7% | 18 | 7a (5%) | I | no | no | 0 | 0% | 41 | 0% | 210 | n/a | I | no | no |

| COMBINED TRAFFIC ANALYSIS | 2011 AM Peak Hour | | | | | | | | | 2011 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **North Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 1 | 0% | 18 | 6% | 139 | 7a (5%) | II | no | no | 3 | 0% | 210 | 1% | 56 | n/a | I | no | no |
| **South Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 24 | 63% | 139 | 17% | 18 | 7b (15%) | I | no | no | 15 | 100% | 56 | 27% | 210 | 7c (25%) | II | no | no |

| BACKGROUND TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | | | | 2031 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **North Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 2 | 0% | 29 | 7% | 192 | 7a (5%) | II | no | no | 4 | 0% | 293 | 1% | 56 | n/a | I | no | no |
| **South Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 34 | 0% | 192 | 18% | 29 | 7b (20%) | I | no | no | 0 | 0% | 56 | 0% | 293 | n/a | I | no | no |

| COMBINED TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | | | | 2031 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage for Trucks? | Advancing Left Turn Volume, vph | Percent Trucks in ALTV, % | Advancing Volume (Va), vph | Proportion of Left Turns in Advancing Left Turn Volume (L), % | Opposing Volume (V-o), vph | Chart Used | Design Type? | Extra Storage Required? | Extra Storage Required for Trucks? |
| **North Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 2 | 0% | 29 | 7% | 207 | 7a (5%) | II | no | no | 4 | 0% | 293 | 1% | 71 | n/a | I | no | no |
| **South Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Highway 830 | 49 | 31% | 207 | 24% | 29 | 7c (25%) | I | no | no | 15 | 100% | 71 | 21% | 293 | 7b (20%) | II | no | no |

Notes:
1. Posted speed on Highway 830 is assumed to be 100 km/h for free-flow conditions; it is assumed the design speed is 110 km/h
2. Where proportion of left turns is less than 3%, a Type I intersection was assumed to be adequate

## Warrant Analysis for Right Turn Lanes - Township Road 550 & Highway 830 (E/W Stop Control)

| EXISTING TRAFFIC ANALYSIS | 2009 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **North Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2069 | yes | 854 | no | 28 | no | **NO** |
| **South Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2097 | yes | 772 | no | 6 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **North Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2152 | yes | 888 | no | 29 | no | **NO** |
| **South Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2181 | yes | 803 | no | 6 | no | **NO** |

| COMBINED TRAFFIC ANALYSIS | 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **North Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2152 | yes | 1292 | yes | 29 | no | **NO** |
| **South Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 2585 | yes | 803 | no | 6 | no | **NO** |

| BACKGROUND TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **North Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 3059 | yes | 2619 | yes | 88 | no | **NO** |
| **South Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 3185 | yes | 2251 | yes | 8 | no | **NO** |

| COMBINED TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Main Road AADT | Main Road AADT > 1800 vph? | Estimated Intersecting Road AADT | Intersecting Road AADT > 900 vpd? | Estimated AADT Right Turn Volume | Daily Right Turn Volume > 360? | Right Turn Lane Warranted? |
| **North Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 3059 | yes | 3023 | yes | 88 | no | **NO** |
| **South Approach** | | | | | | | |
| Township Road 550 & Highway 830 | 3589 | yes | 2251 | yes | 8 | no | **NO** |

Notes:
1. "Main Road AADT" is assumed to be the approach from which the right turns are leaving
2. "Intersecting Road Volume" assumed to be volume on leg that right-turning traffic is turning into

## Warrant Analysis for Left Turn Lanes - Township Road 550 & Range Road 221

| COMBINED TRAFFIC ANALYSIS | 2031 AM Peak Hour | | | | | | | | | 2031 PM Peak Hour | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Advancing Left Turn Volume, vph** | **Percent Trucks in ALTV, %** | **Advancing Volume (Va), vph** | **Proportion of Left Turns in Advancing Left Turn Volume (L), %** | **Opposing Volume (V-o), vph** | **Chart Used** | **Design Type?** | **Extra Storage Required?** | **Extra Storage for Trucks?** | **Advancing Left Turn Volume, vph** | **Percent Trucks in ALTV, %** | **Advancing Volume (Va), vph** | **Proportion of Left Turns in Advancing Left Turn Volume (L), %** | **Opposing Volume (V-o), vph** | **Chart Used** | **Design Type?** | **Extra Storage Required?** | **Extra Storage Required for Trucks?** |
| **East Approach** | | | | | | | | | | | | | | | | | | |
| Township Road 550 & Range Road 221 | 15 | 100% | 209 | 7% | 79 | 5a (5%) | I | no | no | 15 | 100% | 90 | 17% | 146 | 5b (15%) | II | no | no |

Notes:
1. Posted speed on Township Road 550 is 80 km/h; it is assumed the design speed is 90 km/h
2. Where proportion of left turns is less than 3%, a Type I intersection was assumed to be adequate

## Warrant Analysis for Right Turn Lanes - Township Road 550 & Range Road 221

| COMBINED TRAFFIC ANALYSIS | 2031 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Main Road AADT** | **Main Road AADT > 1800 vph?** | **Estimated Intersecting Road AADT** | **Intersecting Road AADT > 900 vpd?** | **Estimated AADT Right Turn Volume** | **Daily Right Turn Volume > 360?** | **Right Turn Lane Warranted ?** |
| **West Approach** | | | | | | | |
| Township Road 550 & Range Road 221 | 2724 | yes | 431 | no | 6 | no | **NO** |

Notes:
1. "Main Road AADT" is assumed to be the approach from which the right turns are leaving
2. "Intersecting Road Volume" assumed to be volume on leg that right-turning traffic is turning into

# APPENDIX D

## TAC Signal Warrants

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | |
|---|---|---|---|---|---|---|
| Main Street (name) | Highway 16 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2009 Existing Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) n
Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) n

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 21 | 7 | 0 | 8 | 6 | 130 | 1 | 751 | 9 | 111 | 631 | 12 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 17 | 1 | 3 | 12 | 5 | 83 | 5 | 964 | 9 | 91 | 935 | 14 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 12 | 4 | 3 | 31 | 19 | 254 | 7 | 1189 | 12 | 223 | 1550 | 22 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **50** | **12** | **6** | **51** | **30** | **467** | **13** | **2,904** | **30** | **425** | **3,116** | **48** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **8** | **2** | **1** | **9** | **5** | **78** | **2** | **484** | **5** | **71** | **519** | **8** | **0** | **0** | **0** | **0** |

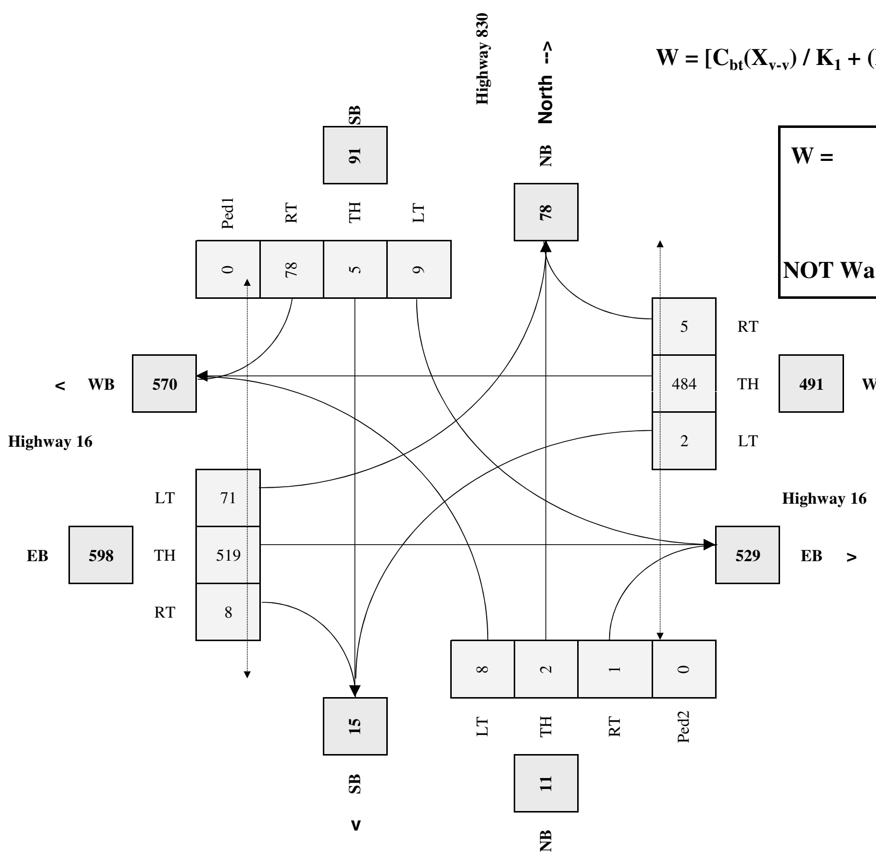
## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$

| | | | |
|---|---|---|---|
| **W =** | **45** | **45** | **0** |
| | | ***Veh*** | ***Ped*** |

**NOT Warranted**

RESET SHEET



# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | |
|---|---|---|---|---|---|---|
| Main Street (name) | Highway 16 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Background Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) n
Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) n

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 23 | 7 | 0 | 8 | 6 | 136 | 0 | 843 | 9 | 116 | 705 | 12 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 18 | 1 | 3 | 12 | 5 | 87 | 5 | 1089 | 9 | 96 | 1046 | 14 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 12 | 4 | 3 | 33 | 19 | 264 | 7 | 1347 | 12 | 233 | 1726 | 22 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **53** | **12** | **6** | **53** | **30** | **487** | **12** | **3,279** | **30** | **445** | **3,477** | **48** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **9** | **2** | **1** | **9** | **5** | **81** | **2** | **547** | **5** | **74** | **580** | **8** | **0** | **0** | **0** | **0** |

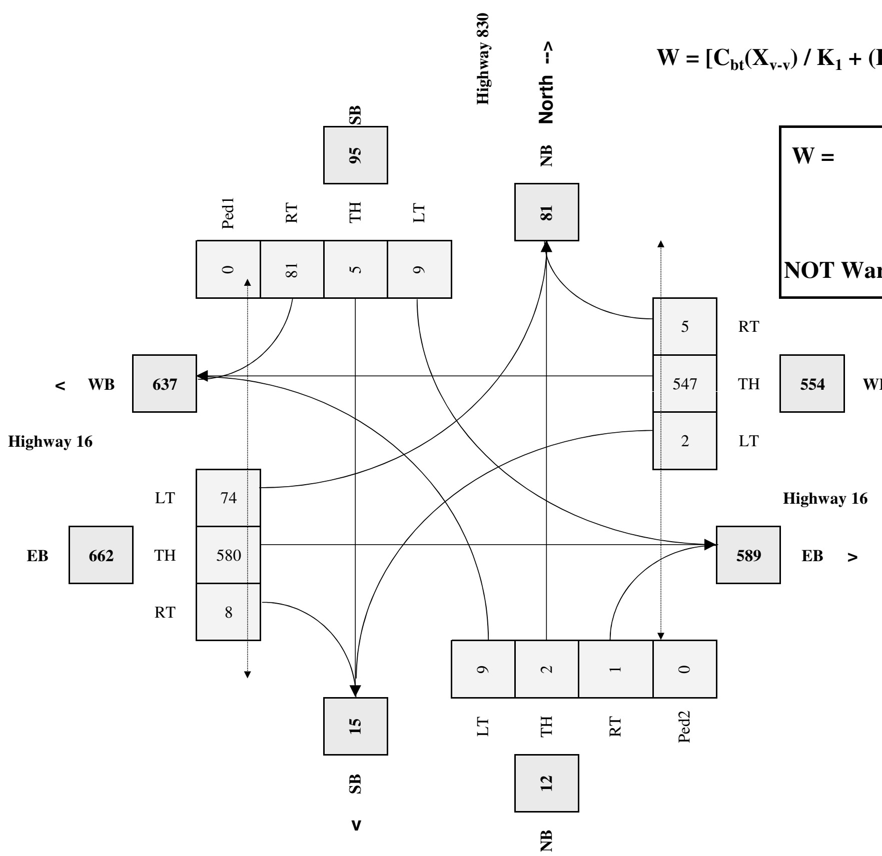
## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$

| W = | 54 | 54 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**NOT Warranted**

RESET SHEET



# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Highway 16 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Total Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) n
Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) n

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 23 | 7 | 0 | 8 | 6 | 165 | 0 | 843 | 9 | 141 | 705 | 12 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 18 | 1 | 3 | 12 | 5 | 98 | 5 | 1089 | 9 | 109 | 1046 | 14 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 12 | 4 | 3 | 33 | 19 | 287 | 7 | 1347 | 12 | 258 | 1726 | 22 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **53** | **12** | **6** | **53** | **30** | **550** | **12** | **3,279** | **30** | **508** | **3,477** | **48** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **9** | **2** | **1** | **9** | **5** | **92** | **2** | **547** | **5** | **85** | **580** | **8** | **0** | **0** | **0** | **0** |

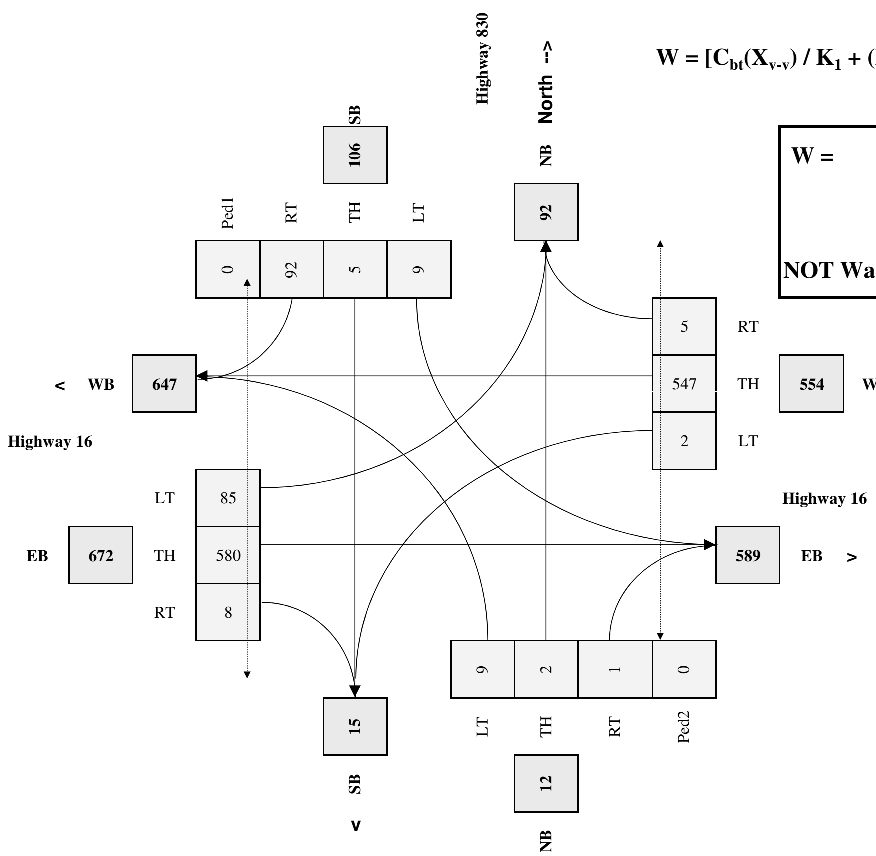
## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$

| W = | 60 | 60 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**NOT Warranted**

RESET SHEET




*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| **Main Street (name)** | **Highway 16** | **Direction (EW or NS)** | **EW** | **Road Authority:** | **Alberta Transportation** |
| **Side Street (name)** | **Highway 830** | **Direction (EW or NS)** | **NS** | **City:** | **Strathcona County** |
| **Quadrant / Int #** | | **Comments** | **2031 Background Traffic Volumes** | **Analysis Date:** | **2011 Jun 24, Fri** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | **Count Date:** | **2009 Aug 14, Fri** |
| | | | | **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) n

Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) n

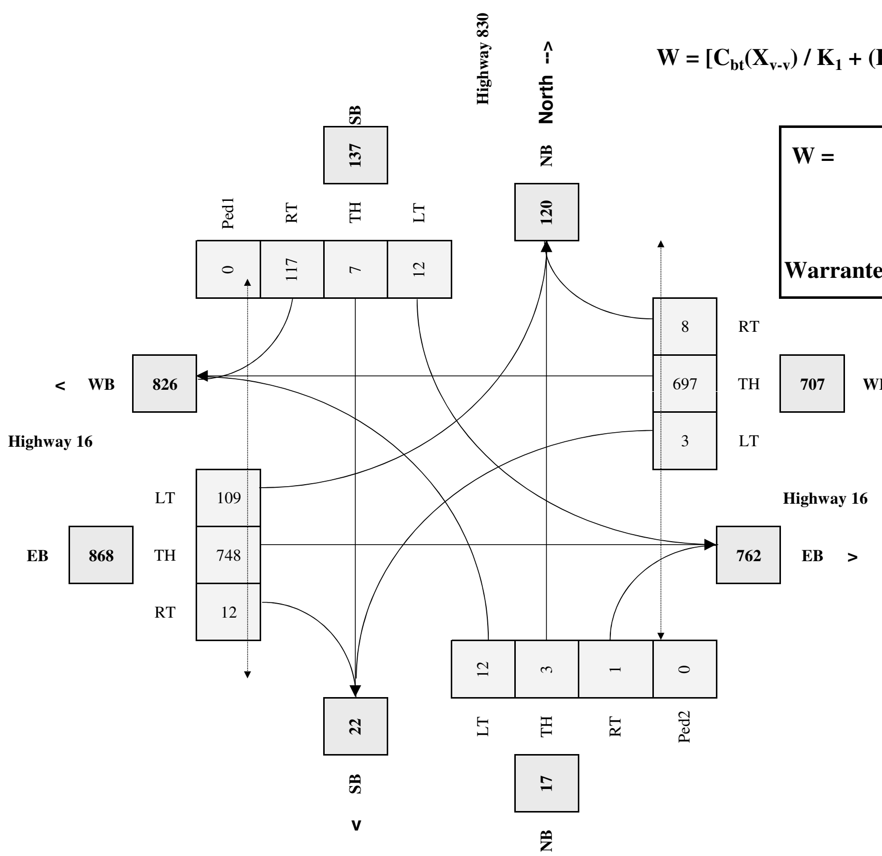
| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

Set Peak Hours

| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1 NS** | **Ped2 NS** | **Ped3 EW** | **Ped4 EW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 31 | 12 | 0 | 12 | 9 | 201 | 0 | 1083 | 15 | 190 | 909 | 18 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 25 | 2 | 4 | 17 | 7 | 126 | 8 | 1388 | 13 | 140 | 1350 | 20 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 17 | 6 | 4 | 44 | 28 | 377 | 11 | 1708 | 17 | 322 | 2230 | 31 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **73** | **20** | **8** | **73** | **44** | **704** | **19** | **4,179** | **45** | **652** | **4,489** | **69** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **12** | **3** | **1** | **12** | **7** | **117** | **3** | **697** | **8** | **109** | **748** | **12** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements




$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$

| | | | |
|---|---|---|---|
| **W =** | **107** | **107** | **0** |
| | | ***Veh*** | ***Ped*** |
| **Warranted** | | | |

RESET SHEET

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Main Street (name)** | **Highway 16** | **Direction (EW or NS)** | **EW** | | **Road Authority:** | **Alberta Transportation** |
| **Side Street (name)** | **Highway 830** | **Direction (EW or NS)** | **NS** | | **City:** | **Strathcona County** |
| **Quadrant / Int #** | | **Comments** | **2031 Total Traffic Volumes** | | **Analysis Date:** | **2011 Jun 24, Fri** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | | **Count Date:** | **2009 Aug 14, Fri** |
| | | | | | **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

| | |
|---|---|
| Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) | n |
| Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) | n |

| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

Set Peak Hours

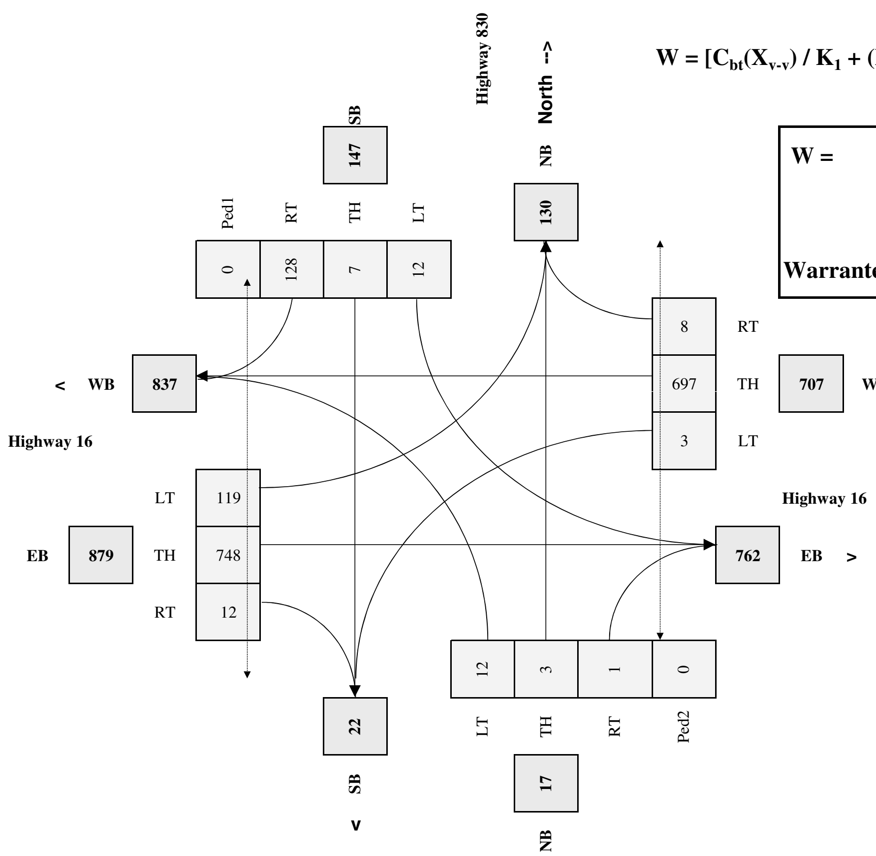
| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1 NS** | **Ped2 NS** | **Ped3 EW** | **Ped4 EW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 31 | 11 | 0 | 12 | 9 | 230 | 0 | 1083 | 15 | 215 | 909 | 18 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 25 | 2 | 4 | 17 | 7 | 137 | 8 | 1388 | 13 | 154 | 1350 | 20 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 17 | 6 | 4 | 44 | 28 | 400 | 11 | 1708 | 17 | 347 | 2230 | 31 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **73** | **19** | **8** | **73** | **44** | **767** | **19** | **4,179** | **45** | **716** | **4,489** | **69** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **12** | **3** | **1** | **12** | **7** | **128** | **3** | **697** | **8** | **119** | **748** | **12** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$

| | | | |
|---|---|---|---|
| **W =** | **116** | **116** | **0** |
| | | ***Veh*** | ***Ped*** |
| **Warranted** | | | |

RESET SHEET



# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| **Main Street (name)** | **Highway 16** | **Direction (EW or NS)** | **EW** | **Road Authority:** | **Alberta Transportation** |
| **Side Street (name)** | **Highway 830** | **Direction (EW or NS)** | **NS** | **City:** | **Strathcona County** |
| **Quadrant / Int #** | | **Comments** | **2021 Total Traffic Volumes** | **Analysis Date:** | **2011 Jun 29, Wed** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | **Count Date:** | **2009 Aug 14, Fri** |
| | | | | **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Highway 16 | WB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 16 | EB | 1 | | 2 | | | 1 | 2,500 | 2 |
| Highway 830 | NB | | | | 1 | | | | |
| Highway 830 | SB | | | | 1 | | | | |

Are the Highway 830 NB right turns significantly impeded by through movements? (y/n) n

Are the Highway 830 SB right turns significantly impeded by through movements? (y/n) n

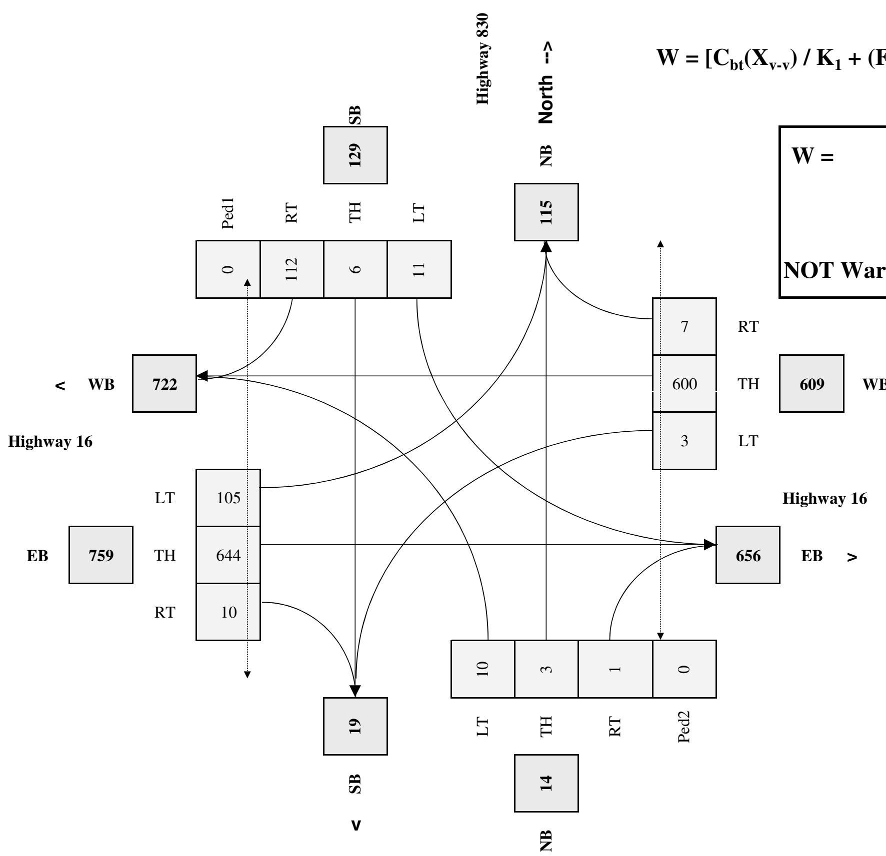
| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Highway 16 | EW | 110 | 14.0% | n | 22.0 |
| Highway 830 | NS | | 14.0% | n | |

**Set Peak Hours**

| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1 NS** | **Ped2 NS** | **Ped3 EW** | **Ped4 EW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 26 | 11 | 0 | 10 | 8 | 205 | 0 | 932 | 15 | 193 | 782 | 14 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 21 | 1 | 3 | 15 | 6 | 120 | 6 | 1196 | 12 | 135 | 1162 | 17 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 15 | 5 | 3 | 39 | 24 | 347 | 9 | 1472 | 14 | 301 | 1920 | 27 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **62** | **17** | **6** | **64** | **38** | **672** | **15** | **3,600** | **41** | **629** | **3,864** | **58** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **10** | **3** | **1** | **11** | **6** | **112** | **3** | **600** | **7** | **105** | **644** | **10** | **0** | **0** | **0** | **0** |

**Average 6-hour Peak Turning Movements**




$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F\ (X_{v\text{-}p})\ L) / K_2] \times C_i$$

| **W =** | **84** | **84** | **0** |
|---|---|---|---|
| | | ***Veh*** | ***Ped*** |

**NOT Warranted**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2009 Existing Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Highway 830 | NB | | 1 | | | | 1 | | |
| Highway 830 | SB | | 1 | | | | 1 | | |
| | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 5.0% | y | 0.0 |
| Highway 830 | NS | | 8.0% | y | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 13 | 149 | 1 | 1 | 75 | 3 | 2 | 74 | 4 | 5 | 18 | 4 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 4 | 36 | 3 | 3 | 67 | 7 | 2 | 42 | 4 | 3 | 27 | 7 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 3 | 83 | 1 | 7 | 338 | 3 | 2 | 51 | 1 | 4 | 101 | 20 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **20** | **268** | **5** | **11** | **480** | **13** | **6** | **167** | **9** | **12** | **146** | **31** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **3** | **45** | **1** | **2** | **80** | **2** | **1** | **28** | **2** | **2** | **24** | **5** | **0** | **0** | **0** | **0** |

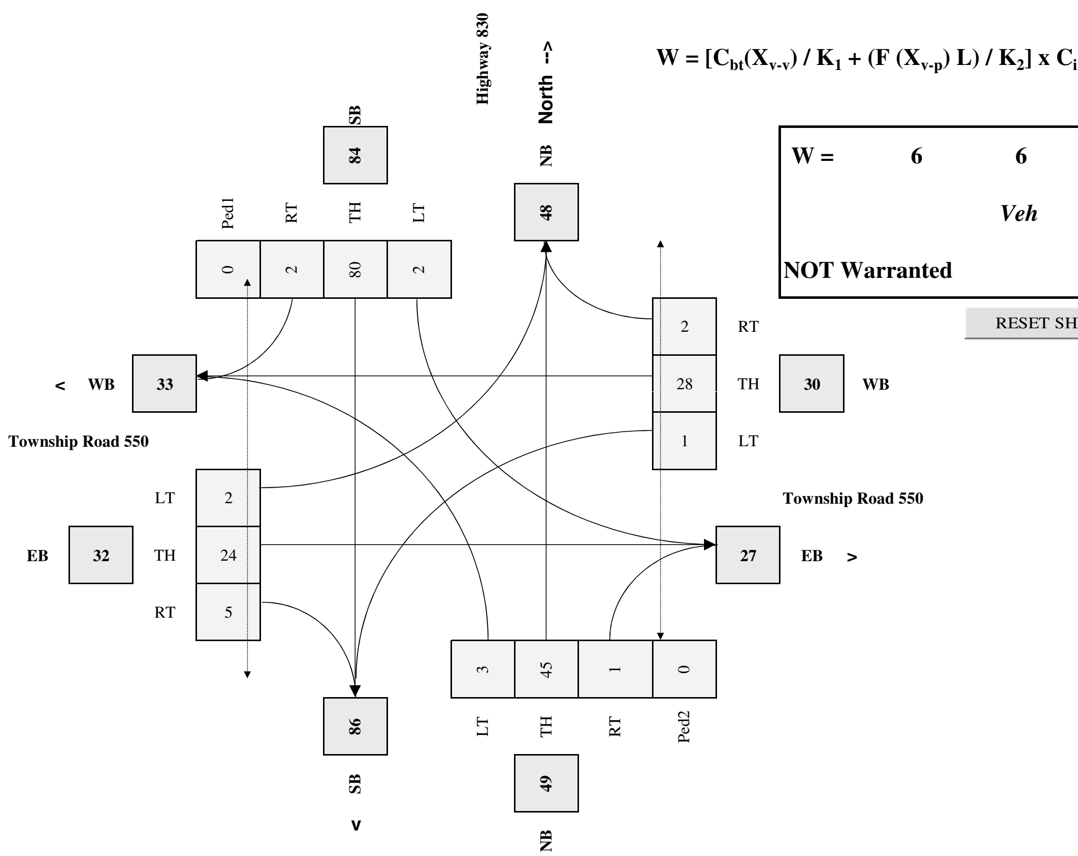
**Average 6-hour Peak Turning Movements**

$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$

| W = | 6 | 6 | 0 |
|---|---|---|---|
| | | Veh | Ped |

**NOT Warranted**

RESET SHEET




*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Background Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Highway 830 | NB | | 1 | | | | 1 | | |
| Highway 830 | SB | | 1 | | | | 1 | | |
| | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

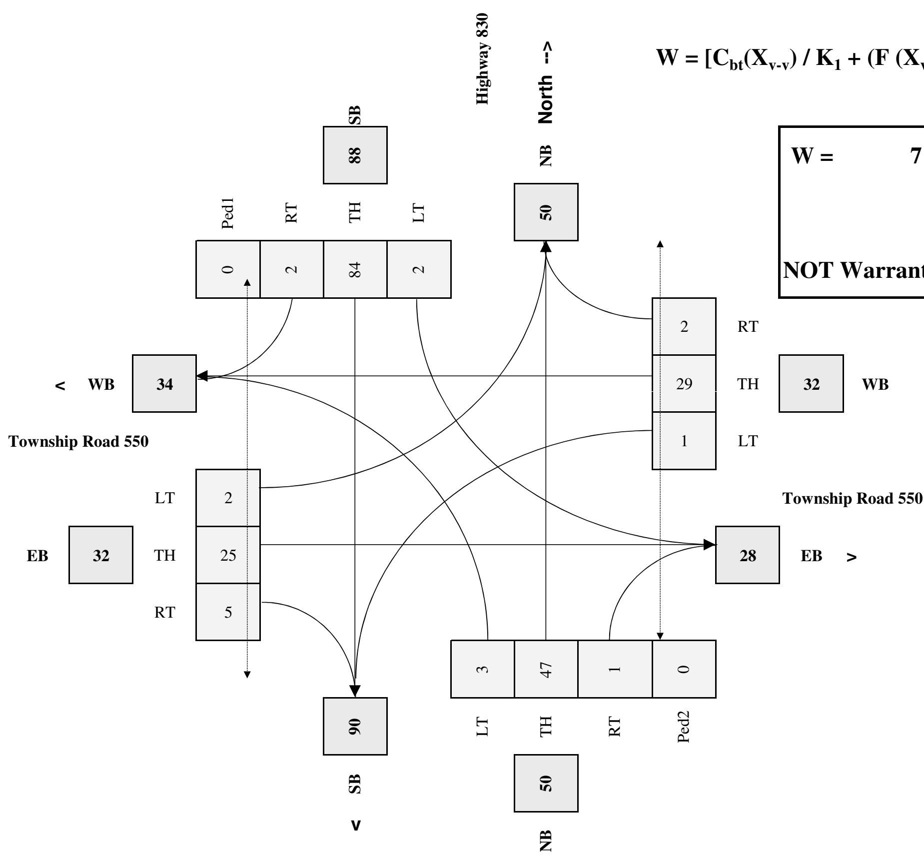
| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 5.0% | y | 0.0 |
| Highway 830 | NS | | 8.0% | y | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 13 | 155 | 0 | 1 | 80 | 3 | 2 | 77 | 4 | 5 | 18 | 4 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 4 | 37 | 3 | 3 | 70 | 7 | 2 | 44 | 4 | 3 | 28 | 7 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 0 | 87 | 1 | 7 | 351 | 3 | 2 | 53 | 1 | 4 | 105 | 20 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **17** | **279** | **4** | **11** | **501** | **13** | **6** | **174** | **9** | **12** | **151** | **31** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **3** | **47** | **1** | **2** | **84** | **2** | **1** | **29** | **2** | **2** | **25** | **5** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$




| W = | 7 | 7 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**NOT Warranted**

RESET SHEET

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | |
|---|---|---|---|---|---|---|
| **Main Street (name)** | **Township Road 550** | | **Direction (EW or NS)** | **EW** | **Road Authority:** | **Alberta Transportation** |
| **Side Street (name)** | **Highway 830** | | **Direction (EW or NS)** | **NS** | **City:** | **Strathcona County** |
| **Quadrant / Int #** | | **Comments** | **2011 Total Traffic Volumes** | | **Analysis Date:** | **2011 Jun 24, Fri** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | | **Count Date:** | **2009 Aug 14, Fri** |
| | | | | | **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Highway 830 | NB | | 1 | | | | 1 | | |
| Highway 830 | SB | | 1 | | | | 1 | | |
| | | | | | | | n | | |
| | | | | | | | n | | |

| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 16.0% | y | 0.0 |
| Highway 830 | NS | | 15.0% | y | |

**Set Peak Hours**

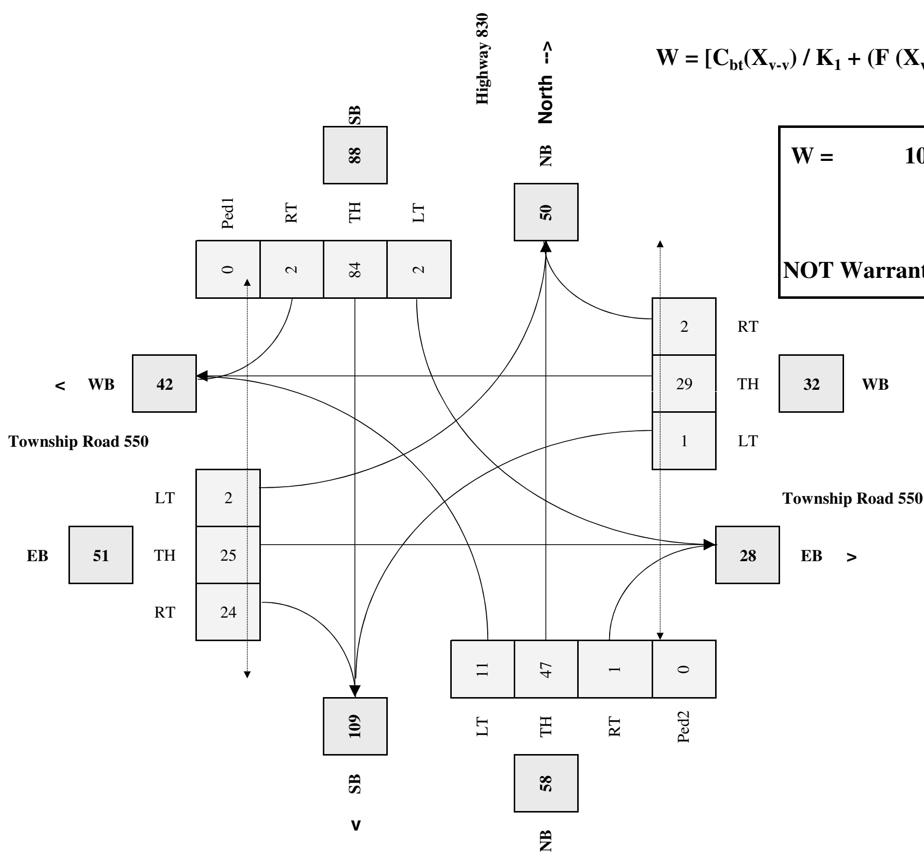
| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1** | **Ped2** | **Ped3** | **Ped4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | **NS** | **NS** | **EW** | **EW** |
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 35 | 155 | 0 | 1 | 80 | 3 | 2 | 77 | 4 | 5 | 18 | 64 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 17 | 37 | 3 | 3 | 70 | 7 | 2 | 44 | 4 | 3 | 28 | 28 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 15 | 87 | 1 | 7 | 351 | 3 | 2 | 53 | 1 | 4 | 105 | 53 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **67** | **279** | **4** | **11** | **501** | **13** | **6** | **174** | **9** | **12** | **151** | **145** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **11** | **47** | **1** | **2** | **84** | **2** | **1** | **29** | **2** | **2** | **25** | **24** | **0** | **0** | **0** | **0** |

**Average 6-hour Peak Turning Movements**

$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$

| | | | |
|---|---|---|---|
| **W =** | **10** | **10** | **0** |
| | | ***Veh*** | ***Ped*** |
| **NOT Warranted** | | | |

RESET SHEET




*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | |
|---|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2031 Background Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Highway 830 | NB | | 1 | | | | 1 | | |
| Highway 830 | SB | | 1 | | | | 1 | | |
| | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

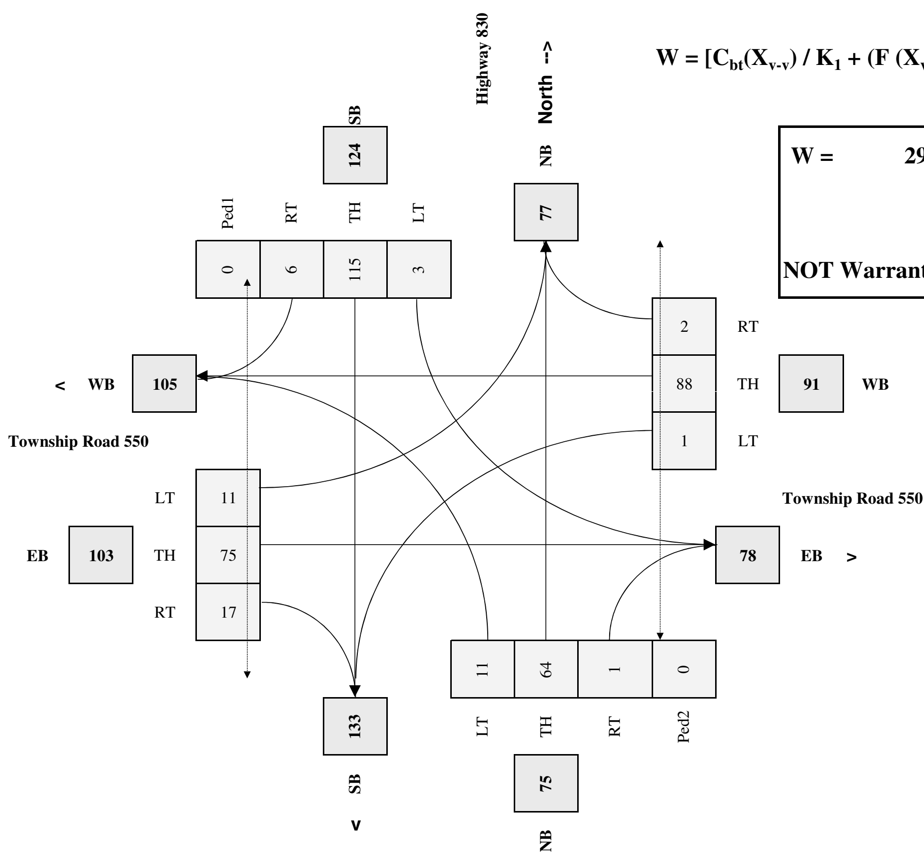
| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 5.0% | y | 0.0 |
| Highway 830 | NS | | 8.0% | y | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 49 | 213 | 0 | 2 | 107 | 11 | 2 | 277 | 6 | 45 | 153 | 36 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 15 | 51 | 3 | 5 | 97 | 20 | 3 | 132 | 6 | 12 | 77 | 20 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 0 | 120 | 1 | 9 | 485 | 7 | 3 | 116 | 1 | 9 | 220 | 44 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **64** | **384** | **4** | **16** | **689** | **38** | **8** | **525** | **13** | **66** | **450** | **100** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **11** | **64** | **1** | **3** | **115** | **6** | **1** | **88** | **2** | **11** | **75** | **17** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$




| W = | 29 | 29 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**NOT Warranted**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Highway 830 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2031 Total Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | 1 | | | | 1 | 2,500 | 1 |
| Highway 830 | NB | | 1 | | | | 1 | | |
| Highway 830 | SB | | 1 | | | | 1 | | |
| | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

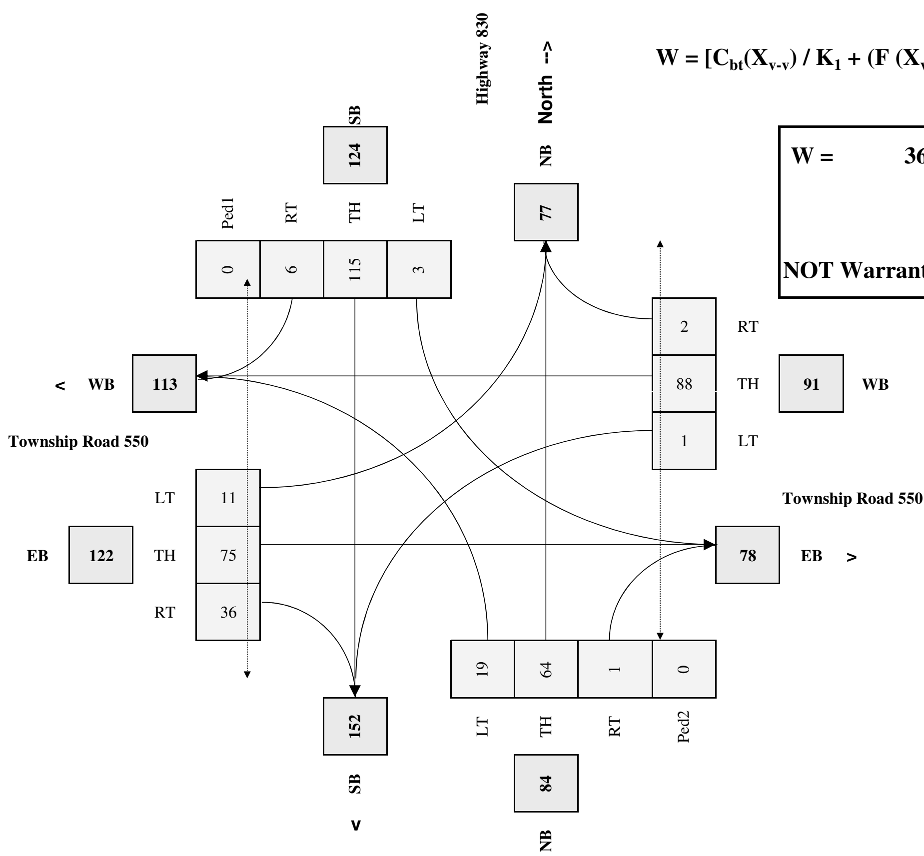
| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 16.0% | y | 0.0 |
| Highway 830 | NS | | 15.0% | y | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 71 | 213 | 0 | 2 | 107 | 11 | 2 | 277 | 6 | 45 | 153 | 96 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 28 | 51 | 3 | 5 | 97 | 20 | 3 | 132 | 6 | 12 | 77 | 41 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 15 | 120 | 1 | 9 | 485 | 7 | 3 | 116 | 1 | 9 | 220 | 78 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **114** | **384** | **4** | **16** | **689** | **38** | **8** | **525** | **13** | **66** | **450** | **215** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **19** | **64** | **1** | **3** | **115** | **6** | **1** | **88** | **2** | **11** | **75** | **36** | **0** | **0** | **0** | **0** |

**Average 6-hour Peak Turning Movements**

$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F\ (X_{v\text{-}p})\ L) / K_2] \times C_i$$




| | | | |
|---|---|---|---|
| **W =** | **36** | **36** | **0** |
| | | ***Veh*** | ***Ped*** |

**NOT Warranted**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Range Road 221 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Existing Traffic Volumes & 2011 Background Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | NB | | | | 1 | | | | |
| Range Road 221 | SB | | | | | | | | |

Are the Range Road 221 NB right turns significantly impeded by through movements? (y/n) n

n

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 8.0% | y | 0.0 |
| Range Road 221 | NS | | 0.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 82 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 72 | 0 | 0 | 82 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 62 | 0 | 0 | 134 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **6** | **0** | **2** | **0** | **0** | **0** | **0** | **216** | **0** | **0** | **246** | **2** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **36** | **0** | **0** | **41** | **0** | **0** | **0** | **0** | **0** |

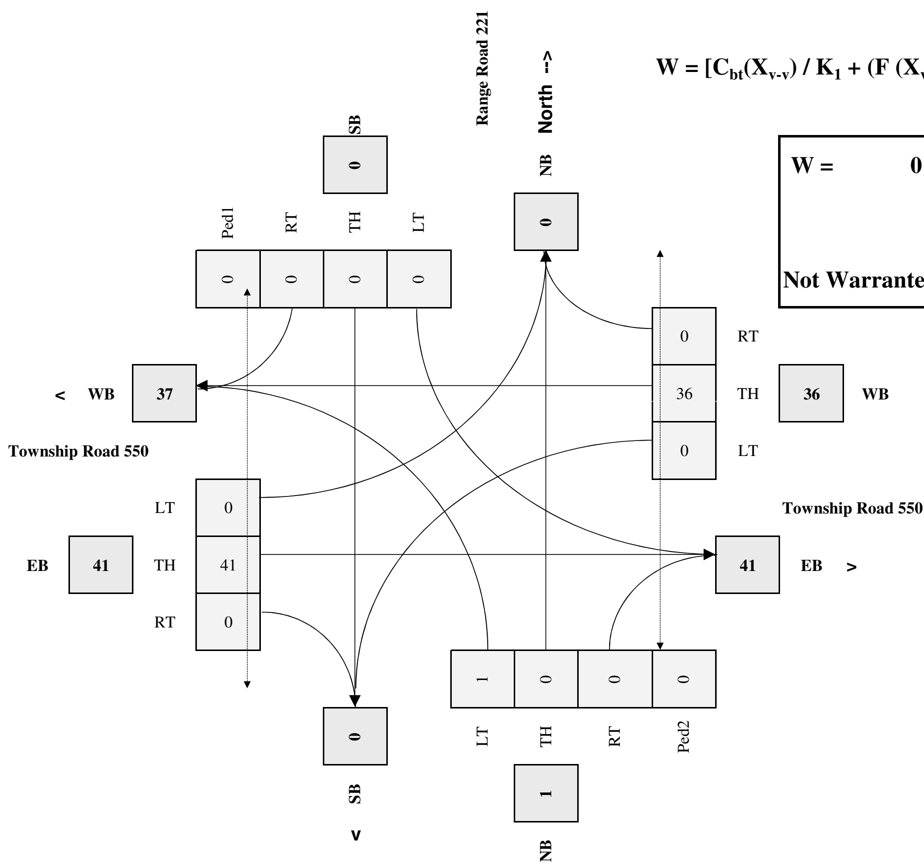
## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$

| W = | 0 | 0 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**Not Warranted - Vs<75**

RESET SHEET



# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | | |
|---|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | | Road Authority: | Alberta Transportation |
| Side Street (name) | Range Road 221 | Direction (EW or NS) | NS | | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Total Traffic Volumes | | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | | Count Date: | 2009 Aug 14, Fri |
| | | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | NB | | | | 1 | | | | |
| Range Road 221 | SB | | | | | | | | |
| Are the Range Road 221 NB right turns significantly impeded by through movements? (y/n) | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

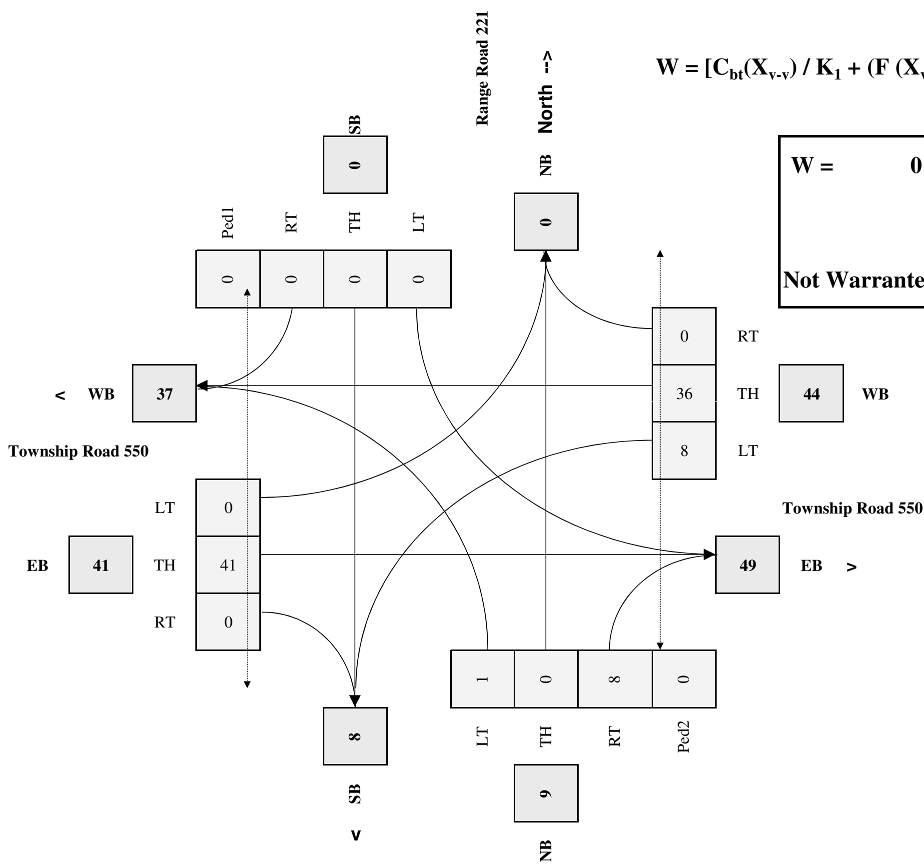
| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 16.0% | y | 0.0 |
| Range Road 221 | NS | | 86.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 3 | 0 | 15 | 0 | 0 | 0 | 15 | 82 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 2 | 0 | 15 | 0 | 0 | 0 | 15 | 72 | 0 | 0 | 82 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 1 | 0 | 15 | 0 | 0 | 0 | 15 | 62 | 0 | 0 | 134 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **6** | **0** | **45** | **0** | **0** | **0** | **45** | **216** | **0** | **0** | **246** | **2** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **1** | **0** | **8** | **0** | **0** | **0** | **8** | **36** | **0** | **0** | **41** | **0** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F\ (X_{v\text{-}p})\ L) / K_2] \times C_i$$




| W = | 0 | 0 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**Not Warranted - Vs<75**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| **Main Street (name)** | **Township Road 550** | **Direction (EW or NS)** | **EW** | **Road Authority:** | **Alberta Transportation** |
| **Side Street (name)** | **Range Road 221** | **Direction (EW or NS)** | **NS** | **City:** | **Strathcona County** |
| **Quadrant / Int #** | | **Comments** | **2031 Background Traffic Volumes** | **Analysis Date:** | **2011 Jun 24, Fri** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | **Count Date:** | **2009 Aug 14, Fri** |
| | | | | **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | NB | | | | 1 | | | | |
| Range Road 221 | SB | | | | | | | | |

Are the Range Road 221 NB right turns significantly impeded by through movements? (y/n) n

n

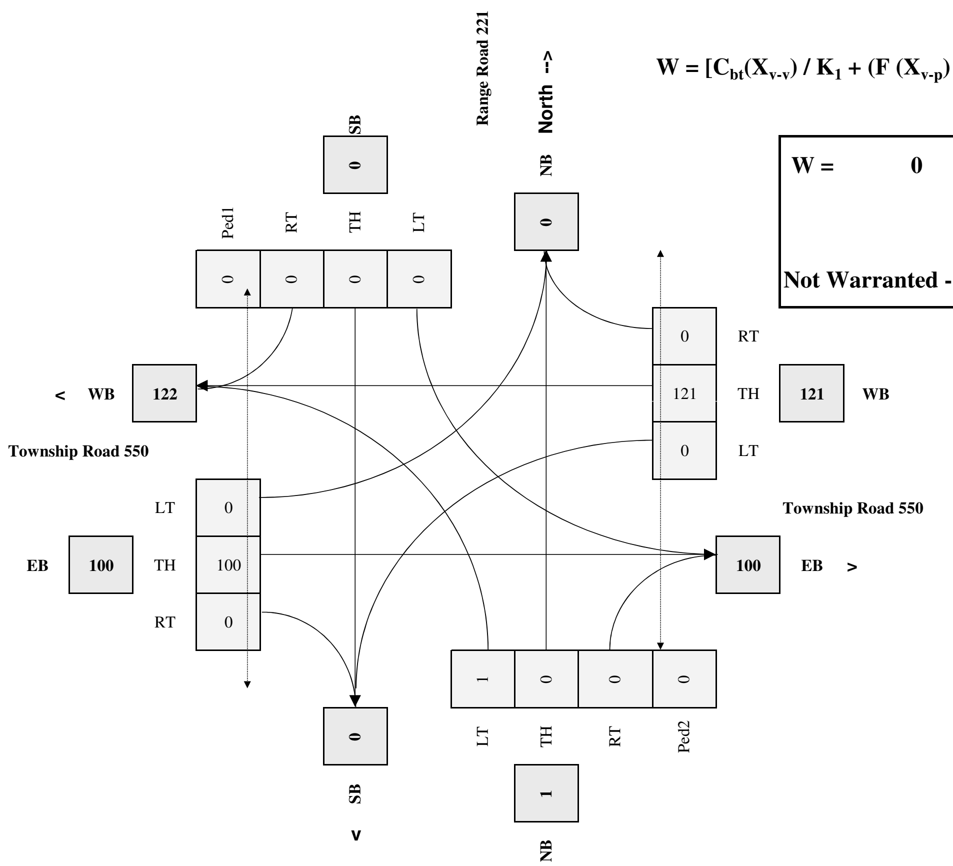
| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 8.0% | y | 0.0 |
| Range Road 221 | NS | | 0.0% | n | |

**Set Peak Hours**

| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1 NS** | **Ped2 NS** | **Ped3 EW** | **Ped4 EW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 345 | 0 | 0 | 132 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 241 | 0 | 0 | 200 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 137 | 0 | 0 | 267 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **6** | **0** | **0** | **0** | **0** | **0** | **0** | **723** | **0** | **0** | **599** | **2** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **121** | **0** | **0** | **100** | **0** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements




$$W = [C_{bt}(X_{v-v}) / K_1 + (F\ (X_{v-p})\ L) / K_2] \times C_i$$

| **W =** | **0** | **0** | **0** |
|---|---|---|---|
| | | ***Veh*** | ***Ped*** |

**Not Warranted - Vs<75**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Township Road 550 | Direction (EW or NS) | EW | Road Authority: | Alberta Transportation |
| Side Street (name) | Range Road 221 | Direction (EW or NS) | NS | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2031 Total Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Township Road 550 | WB | | | | 1 | | | 2,500 | 1 |
| Township Road 550 | EB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | NB | | | | 1 | | | | |
| Range Road 221 | SB | | | | | | | | |

Are the Range Road 221 NB right turns significantly impeded by through movements? (y/n) n

n

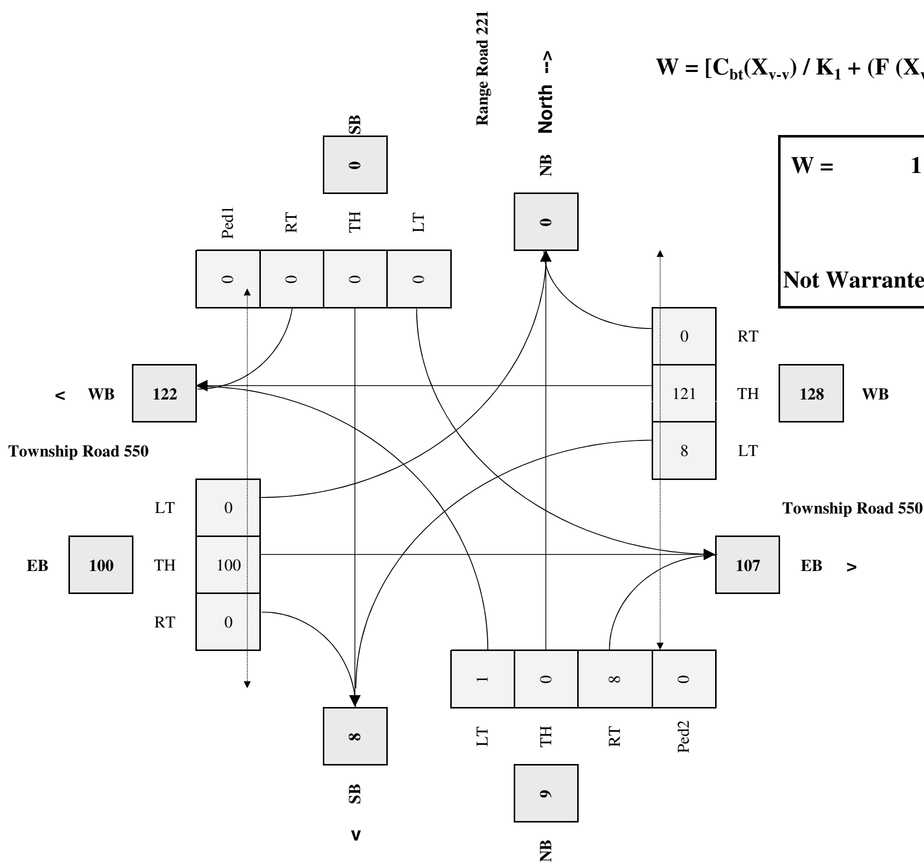
| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Township Road 550 | EW | 80 | 16.0% | y | 0.0 |
| Range Road 221 | NS | | 86.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 3 | 0 | 15 | 0 | 0 | 0 | 15 | 345 | 0 | 0 | 132 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 2 | 0 | 15 | 0 | 0 | 0 | 15 | 241 | 0 | 0 | 200 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 1 | 0 | 15 | 0 | 0 | 0 | 15 | 137 | 0 | 0 | 267 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **6** | **0** | **45** | **0** | **0** | **0** | **45** | **723** | **0** | **0** | **599** | **2** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **1** | **0** | **8** | **0** | **0** | **0** | **8** | **121** | **0** | **0** | **100** | **0** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements




$$W = [C_{bt}(X_{v-v}) / K_1 + (F (X_{v-p}) L) / K_2] \times C_i$$

| W = | 1 | 1 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**Not Warranted - Vs<75**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | | |
|---|---|---|---|---|---|
| Main Street (name) | Range Road 221 | Direction (EW or NS) | NS | Road Authority: | Alberta Transportation |
| Side Street (name) | Site Access | Direction (EW or NS) | EW | City: | Strathcona County |
| Quadrant / Int # | | Comments | 2011 Total Traffic Volumes | Analysis Date: | 2011 Jun 24, Fri |
| for Warrant Calculation Results, please hit 'Page Down' | CHECK SHEET | | | Count Date: | 2009 Aug 14, Fri |
| | | | | Date Entry Format: | (yyyy-mm-dd) |

| Lane Configuration | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Range Road 221 | NB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | SB | | | | 1 | | | 2,500 | 1 |
| Site Access | WB | | | | 1 | | | | |
| Site Access | EB | | | | | | | | |
| Are the Site Access WB right turns significantly impeded by through movements? (y/n) | | | | | | | n | | |
| | | | | | | | n | | |

| Demographics | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

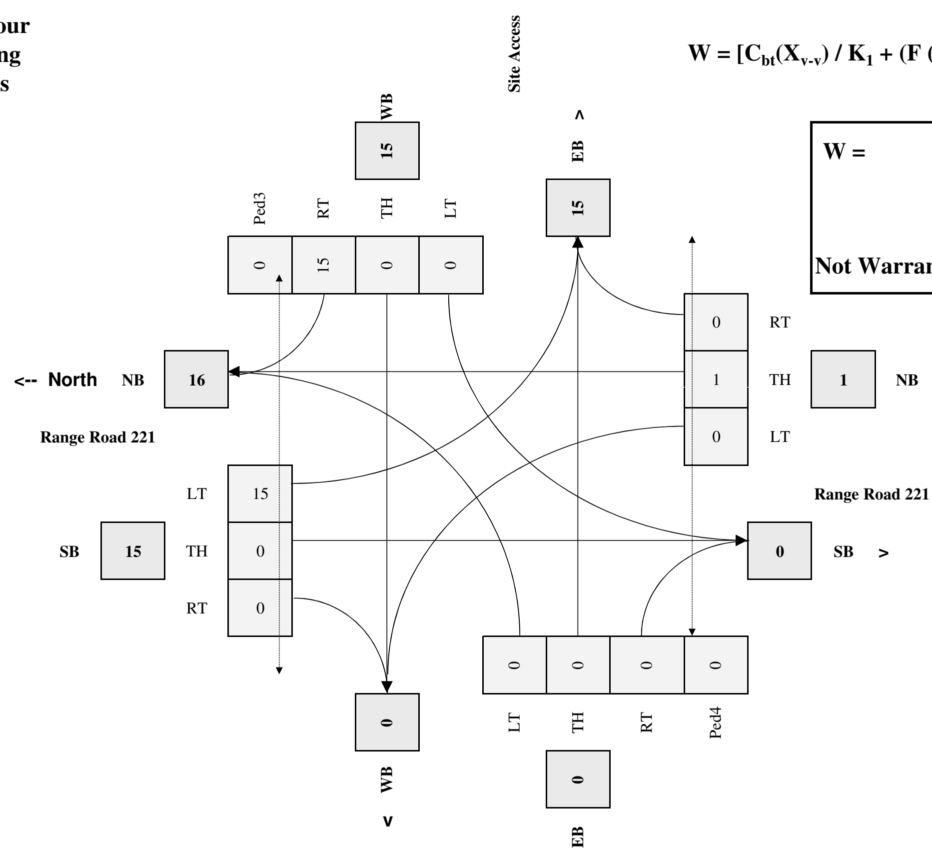
| Other input | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Range Road 221 | NS | 80 | 100.0% | n | 0.0 |
| Site Access | EW | | 100.0% | n | |

Set Peak Hours

| Traffic Input | NB | | | SB | | | WB | | | EB | | | Ped1 NS | Ped2 NS | Ped3 EW | Ped4 EW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | Th | RT | LT | Th | RT | LT | Th | RT | LT | Th | RT | W Side | E Side | N Side | S Side |
| 7:00 - 9:00 | 0 | 1 | 0 | 30 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 11:30 - 1:30 | 0 | 1 | 0 | 30 | 1 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 16:00 - 18:00 | 0 | 1 | 0 | 30 | 1 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **0** | **3** | **0** | **90** | **2** | **0** | **0** | **0** | **90** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **0** | **1** | **0** | **15** | **0** | **0** | **0** | **0** | **15** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F\ (X_{v\text{-}p})\ L) / K_2] \times C_i$$




| W = | 0 | 0 | 0 |
|---|---|---|---|
| | | *Veh* | *Ped* |

**Not Warranted - Vs<75**

RESET SHEET

*Traffic Signal Warrant Spreadsheet - v3H © 2007 Transportation Association of Canada*

# Alberta Transportation - Traffic Signal Warrant Analysis

| | | | | |
|---|---|---|---|---|
| **Main Street (name)** | **Range Road 221** | **Direction (EW or NS)** | **NS** | **Road Authority:** | 
| **Side Street (name)** | **Site Access** | **Direction (EW or NS)** | **EW** | **City:** |
| **Quadrant / Int #** | | **Comments** | **2031 Total Traffic Volumes** | **Analysis Date:** |
| **for Warrant Calculation Results, please hit 'Page Down'** | **CHECK SHEET** | | | **Count Date:** |
| | | | | **Date Entry Format:** |

| | |
|---|---|
| **Road Authority:** | **Alberta Transportation** |
| **City:** | **Strathcona County** |
| **Analysis Date:** | **2011 Jun 24, Fri** |
| **Count Date:** | **2009 Aug 14, Fri** |
| **Date Entry Format:** | (yyyy-mm-dd) |

| **Lane Configuration** | | Excl LT | Th & LT | Through | Th+RT+LT | Th & RT | Excl RT | UpStream Signal (m) | # of Thru Lanes |
|---|---|---|---|---|---|---|---|---|---|
| Range Road 221 | NB | | | | 1 | | | 2,500 | 1 |
| Range Road 221 | SB | | | | 1 | | | 2,500 | 1 |
| Site Access | WB | | | | 1 | | | | |
| Site Access | EB | | | | | | | | |
| Are the Site Access WB right turns significantly impeded by through movements? (y/n) | | | | | | | n | | |
| | | | | | | | n | | |

| **Demographics** | | |
|---|---|---|
| Elem. School/Mobility Challenged | (y/n) | n |
| Senior's Complex | (y/n) | n |
| Pathway to School | (y/n) | n |
| Metro Area Population | (#) | 100,000 |
| Central Business District | (y/n) | n |

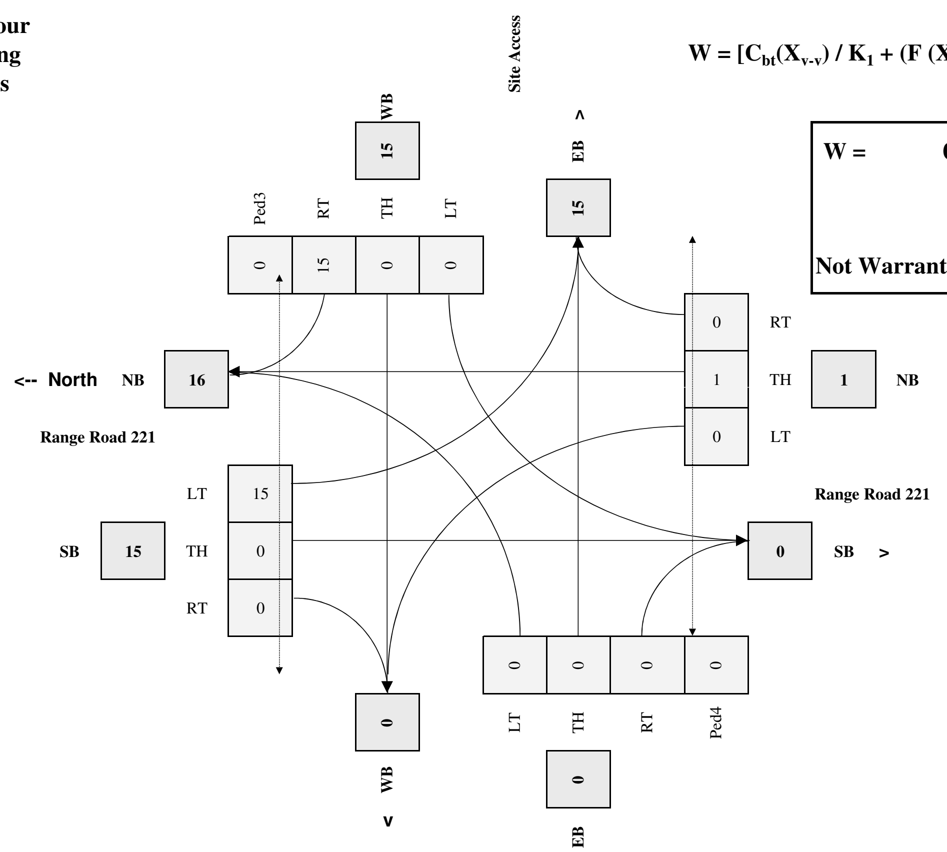
| **Other input** | | Speed (Km/h) | Truck % | Bus Rt (y/n) | Median (m) |
|---|---|---|---|---|---|
| Range Road 221 | NS | 80 | 100.0% | n | 0.0 |
| Site Access | EW | | 100.0% | n | |

**Set Peak Hours**

| **Traffic Input** | **NB** | | | **SB** | | | **WB** | | | **EB** | | | **Ped1 NS** | **Ped2 NS** | **Ped3 EW** | **Ped4 EW** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **LT** | **Th** | **RT** | **W Side** | **E Side** | **N Side** | **S Side** |
| **7:00 - 9:00** | 0 | 1 | 0 | 30 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **11:30 - 1:30** | 0 | 1 | 0 | 30 | 1 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **16:00 - 18:00** | 0 | 1 | 0 | 30 | 1 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| **Total (6-hour peak)** | **0** | **3** | **0** | **90** | **2** | **0** | **0** | **0** | **90** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Average (6-hour peak)** | **0** | **1** | **0** | **15** | **0** | **0** | **0** | **0** | **15** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

## Average 6-hour Peak Turning Movements

$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F\ (X_{v\text{-}p})\ L) / K_2] \times C_i$$




| **W =** | **0** | **0** | **0** |
|---|---|---|---|
| | | ***Veh*** | ***Ped*** |

**Not Warranted - Vs<75**

RESET SHEET

# APPENDIX E

## Synchro 7.0 Printouts

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 66 | 279 | 6 | 0 | 404 | 3 | 13 | 6 | 0 | 4 | 4 | 66 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 69 | 291 | 6 | 0 | 421 | 3 | 14 | 6 | 0 | 4 | 4 | 69 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 424 | | | 297 | | | 709 | 852 | 145 | 707 | 855 | 210 |
| vC1, stage 1 conf vol | | | | | | | 428 | 428 | | 421 | 421 | |
| vC2, stage 2 conf vol | | | | | | | 281 | 424 | | 286 | 434 | |
| vCu, unblocked vol | 424 | | | 297 | | | 709 | 852 | 145 | 707 | 855 | 210 |
| tC, single (s) | 4.5 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.6 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.4 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.6 |
| p0 queue free % | 93 | | | 100 | | | 97 | 98 | 100 | 99 | 99 | 90 |
| cM capacity (veh/h) | 1026 | | | 1276 | | | 449 | 403 | 882 | 444 | 409 | 708 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 69 | 145 | 145 | 6 | 0 | 210 | 210 | 3 | 20 | 77 |
| Volume Left | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 4 |
| Volume Right | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 69 |
| cSH | 1026 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 434 | 660 |
| Volume to Capacity | 0.07 | 0.09 | 0.09 | 0.00 | 0.00 | 0.12 | 0.12 | 0.00 | 0.05 | 0.12 |
| Queue Length 95th (m) | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 3.2 |
| Control Delay (s) | 8.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 13.7 | 11.2 |
| Lane LOS | A | | | | | | | | B | B |
| Approach Delay (s) | 1.6 | | | | 0.0 | | | | 13.7 | 11.2 |
| Approach LOS | | | | | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 31.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 1 | 6 | 1 | 1 | 43 | 4 | 9 | 110 | 1 | 1 | 14 | 2 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| Hourly flow rate (vph) | 1 | 7 | 1 | 1 | 52 | 5 | 11 | 133 | 1 | 1 | 17 | 2 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 57 | | | 8 | | | 77 | 69 | 8 | 134 | 67 | 54 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 57 | | | 8 | | | 77 | 69 | 8 | 134 | 67 | 54 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.8 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.3 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 99 | 84 | 100 | 100 | 98 | 100 |
| cM capacity (veh/h) | 1561 | | | 1625 | | | 899 | 816 | 1080 | 736 | 773 | 1019 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 10 | 58 | 145 | 20 |
| Volume Left | 1 | 1 | 11 | 1 |
| Volume Right | 1 | 5 | 1 | 2 |
| cSH | 1561 | 1625 | 829 | 873 |
| Volume to Capacity | 0.00 | 0.00 | 0.17 | 0.02 |
| Queue Length 95th (m) | 0.0 | 0.0 | 5.0 | 0.6 |
| Control Delay (s) | 0.9 | 0.2 | 10.3 | 9.6 |
| Lane LOS | A | A | B | A |
| Approach Delay (s) | 0.9 | 0.2 | 10.3 | 9.6 |
| Approach LOS | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.3 | | |
| Intersection Capacity Utilization | 23.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 18 | 0 | 0 | 46 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Hourly flow rate (vph) | 31 | 0 | 0 | 79 | 2 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 31 | | 110 | 31 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 31 | | 110 | 31 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1595 | | 892 | 1049 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 31 | 79 | 2 |
| Volume Left | 0 | 0 | 2 |
| Volume Right | 0 | 0 | 0 |
| cSH | 1700 | 1595 | 892 |
| Volume to Capacity | 0.02 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 9.0 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.0 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 13.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 138 | 774 | 12 | 4 | 532 | 10 | 7 | 4 | 3 | 19 | 11 | 167 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 145 | 815 | 13 | 4 | 560 | 11 | 7 | 4 | 3 | 20 | 12 | 176 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 571 | | | 827 | | | 1575 | 1684 | 407 | 1272 | 1686 | 280 |
| vC1, stage 1 conf vol | | | | | | | 1105 | 1105 | | 568 | 568 | |
| vC2, stage 2 conf vol | | | | | | | 470 | 579 | | 703 | 1118 | |
| vCu, unblocked vol | 571 | | | 827 | | | 1575 | 1684 | 407 | 1272 | 1686 | 280 |
| tC, single (s) | 4.3 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.0 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.3 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 84 | | | 99 | | | 95 | 98 | 99 | 93 | 94 | 75 |
| cM capacity (veh/h) | 932 | | | 668 | | | 156 | 209 | 599 | 271 | 203 | 702 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 145 | 407 | 407 | 13 | 4 | 280 | 280 | 11 | 15 | 207 |
| Volume Left | 145 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 7 | 20 |
| Volume Right | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 11 | 3 | 176 |
| cSH | 932 | 1700 | 1700 | 1700 | 668 | 1700 | 1700 | 1700 | 203 | 544 |
| Volume to Capacity | 0.16 | 0.24 | 0.24 | 0.01 | 0.01 | 0.16 | 0.16 | 0.01 | 0.07 | 0.38 |
| Queue Length 95th (m) | 4.4 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 1.9 | 14.2 |
| Control Delay (s) | 9.6 | 0.0 | 0.0 | 0.0 | 10.4 | 0.0 | 0.0 | 0.0 | 24.1 | 15.6 |
| Lane LOS | A | | | | B | | | | C | C |
| Approach Delay (s) | 1.4 | | | | 0.1 | | | | 24.1 | 15.6 |
| Approach LOS | | | | | | | | | C | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.8 | | |
| Intersection Capacity Utilization | 46.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 3 | 49 | 9 | 2 | 29 | 1 | 0 | 38 | 1 | 3 | 196 | 3 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Hourly flow rate (vph) | 3 | 56 | 10 | 2 | 33 | 1 | 0 | 44 | 1 | 3 | 225 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 34 | | | 67 | | | 221 | 107 | 61 | 129 | 112 | 34 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 34 | | | 67 | | | 221 | 107 | 61 | 129 | 112 | 34 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.6 | 6.2 | 7.1 | 6.6 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.1 | 3.3 | 3.5 | 4.1 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 100 | 94 | 100 | 100 | 70 | 100 |
| cM capacity (veh/h) | 1590 | | | 1548 | | | 566 | 763 | 1009 | 808 | 759 | 1045 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 70 | 37 | 45 | 232 |
| Volume Left | 3 | 2 | 0 | 3 |
| Volume Right | 10 | 1 | 1 | 3 |
| cSH | 1590 | 1548 | 783 | 771 |
| Volume to Capacity | 0.00 | 0.00 | 0.06 | 0.30 |
| Queue Length 95th (m) | 0.1 | 0.0 | 1.5 | 10.2 |
| Control Delay (s) | 0.4 | 0.5 | 10.0 | 11.7 |
| Lane LOS | A | A | A | B |
| Approach Delay (s) | 0.4 | 0.5 | 10.0 | 11.7 |
| Approach LOS | | | A | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.4 | | |
| Intersection Capacity Utilization | 27.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 73 | 1 | 0 | 34 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 91 | 1 | 0 | 42 | 1 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 92 | | 134 | 92 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 92 | | 134 | 92 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1515 | | 864 | 971 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 92 | 42 | 1 |
| Volume Left | 0 | 0 | 1 |
| Volume Right | 1 | 0 | 0 |
| cSH | 1700 | 1515 | 864 |
| Volume to Capacity | 0.05 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 9.2 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.2 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 13.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 69 | 312 | 6 | 0 | 453 | 3 | 14 | 6 | 0 | 4 | 4 | 69 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 72 | 325 | 6 | 0 | 472 | 3 | 15 | 6 | 0 | 4 | 4 | 72 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 475 | | | 331 | | | 779 | 944 | 162 | 781 | 947 | 236 |
| vC1, stage 1 conf vol | | | | | | | 469 | 469 | | 472 | 472 | |
| vC2, stage 2 conf vol | | | | | | | 310 | 475 | | 309 | 475 | |
| vCu, unblocked vol | 475 | | | 331 | | | 779 | 944 | 162 | 781 | 947 | 236 |
| tC, single (s) | 4.5 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.6 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.4 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.6 |
| p0 queue free % | 93 | | | 100 | | | 97 | 98 | 100 | 99 | 99 | 89 |
| cM capacity (veh/h) | 979 | | | 1240 | | | 417 | 373 | 860 | 412 | 381 | 679 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 72 | 162 | 162 | 6 | 0 | 236 | 236 | 3 | 21 | 80 |
| Volume Left | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 4 |
| Volume Right | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 72 |
| cSH | 979 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 403 | 632 |
| Volume to Capacity | 0.07 | 0.10 | 0.10 | 0.00 | 0.00 | 0.14 | 0.14 | 0.00 | 0.05 | 0.13 |
| Queue Length 95th (m) | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 3.5 |
| Control Delay (s) | 9.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.4 | 11.5 |
| Lane LOS | A | | | | | | | | B | B |
| Approach Delay (s) | 1.6 | | | | 0.0 | | | | 14.4 | 11.5 |
| Approach LOS | | | | | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 33.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 1 | 6 | 1 | 1 | 45 | 4 | 9 | 115 | 1 | 1 | 15 | 2 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| Hourly flow rate (vph) | 1 | 7 | 1 | 1 | 54 | 5 | 11 | 139 | 1 | 1 | 18 | 2 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 59 | | | 8 | | | 80 | 72 | 8 | 139 | 70 | 57 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 59 | | | 8 | | | 80 | 72 | 8 | 139 | 70 | 57 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.8 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.3 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 99 | 83 | 100 | 100 | 98 | 100 |
| cM capacity (veh/h) | 1558 | | | 1625 | | | 894 | 814 | 1080 | 725 | 770 | 1015 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 10 | 60 | 151 | 22 |
| Volume Left | 1 | 1 | 11 | 1 |
| Volume Right | 1 | 5 | 1 | 2 |
| cSH | 1558 | 1625 | 826 | 864 |
| Volume to Capacity | 0.00 | 0.00 | 0.18 | 0.03 |
| Queue Length 95th (m) | 0.0 | 0.0 | 5.3 | 0.6 |
| Control Delay (s) | 0.9 | 0.1 | 10.4 | 9.7 |
| Lane LOS | A | A | B | A |
| Approach Delay (s) | 0.9 | 0.1 | 10.4 | 9.7 |
| Approach LOS | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.4 | | |
| Intersection Capacity Utilization | 23.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 18 | 0 | 0 | 46 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Hourly flow rate (vph) | 31 | 0 | 0 | 79 | 2 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 31 | | 110 | 31 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 31 | | 110 | 31 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1595 | | 892 | 1049 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 31 | 79 | 2 |
| Volume Left | 0 | 0 | 2 |
| Volume Right | 0 | 0 | 0 |
| cSH | 1700 | 1595 | 892 |
| Volume to Capacity | 0.02 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 9.0 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.0 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 13.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 144 | 863 | 12 | 4 | 604 | 10 | 7 | 4 | 3 | 20 | 11 | 174 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 152 | 908 | 13 | 4 | 636 | 11 | 7 | 4 | 3 | 21 | 12 | 183 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 646 | | | 921 | | | 1727 | 1866 | 454 | 1407 | 1868 | 318 |
| vC1, stage 1 conf vol | | | | | | | 1212 | 1212 | | 644 | 644 | |
| vC2, stage 2 conf vol | | | | | | | 515 | 655 | | 763 | 1224 | |
| vCu, unblocked vol | 646 | | | 921 | | | 1727 | 1866 | 454 | 1407 | 1868 | 318 |
| tC, single (s) | 4.3 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.0 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.3 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 83 | | | 99 | | | 94 | 98 | 99 | 91 | 93 | 72 |
| cM capacity (veh/h) | 870 | | | 610 | | | 129 | 180 | 558 | 240 | 175 | 663 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 152 | 454 | 454 | 13 | 4 | 318 | 318 | 11 | 15 | 216 |
| Volume Left | 152 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 7 | 21 |
| Volume Right | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 11 | 3 | 183 |
| cSH | 870 | 1700 | 1700 | 1700 | 610 | 1700 | 1700 | 1700 | 171 | 502 |
| Volume to Capacity | 0.17 | 0.27 | 0.27 | 0.01 | 0.01 | 0.19 | 0.19 | 0.01 | 0.09 | 0.43 |
| Queue Length 95th (m) | 5.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 2.2 | 17.1 |
| Control Delay (s) | 10.0 | 0.0 | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 0.0 | 28.0 | 17.5 |
| Lane LOS | B | | | | B | | | | D | C |
| Approach Delay (s) | 1.4 | | | | 0.1 | | | | 28.0 | 17.5 |
| Approach LOS | | | | | | | | | D | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.9 | | |
| Intersection Capacity Utilization | 49.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 3 | 51 | 9 | 2 | 30 | 1 | 0 | 40 | 1 | 3 | 204 | 3 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Hourly flow rate (vph) | 3 | 59 | 10 | 2 | 34 | 1 | 0 | 46 | 1 | 3 | 234 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 36 | | | 69 | | | 229 | 111 | 64 | 134 | 116 | 35 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 36 | | | 69 | | | 229 | 111 | 64 | 134 | 116 | 35 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.6 | 6.2 | 7.1 | 6.6 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.1 | 3.3 | 3.5 | 4.1 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 100 | 94 | 100 | 100 | 69 | 100 |
| cM capacity (veh/h) | 1588 | | | 1545 | | | 551 | 760 | 1006 | 800 | 755 | 1044 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 72 | 38 | 47 | 241 |
| Volume Left | 3 | 2 | 0 | 3 |
| Volume Right | 10 | 1 | 1 | 3 |
| cSH | 1588 | 1545 | 779 | 767 |
| Volume to Capacity | 0.00 | 0.00 | 0.06 | 0.31 |
| Queue Length 95th (m) | 0.1 | 0.0 | 1.5 | 10.8 |
| Control Delay (s) | 0.4 | 0.5 | 10.0 | 11.9 |
| Lane LOS | A | A | B | B |
| Approach Delay (s) | 0.4 | 0.5 | 10.0 | 11.9 |
| Approach LOS | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.5 | | |
| Intersection Capacity Utilization | 27.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 73 | 1 | 0 | 34 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 91 | 1 | 0 | 42 | 1 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 92 | | 134 | 92 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 92 | | 134 | 92 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1515 | | 864 | 971 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 92 | 42 | 1 |
| Volume Left | 0 | 0 | 1 |
| Volume Right | 1 | 0 | 0 |
| cSH | 1700 | 1515 | 864 |
| Volume to Capacity | 0.05 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 9.2 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.2 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 13.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 84 | 312 | 6 | 0 | 453 | 3 | 14 | 6 | 0 | 4 | 4 | 84 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 88 | 325 | 6 | 0 | 472 | 3 | 15 | 6 | 0 | 4 | 4 | 88 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 475 | | | 331 | | | 826 | 975 | 162 | 812 | 978 | 236 |
| vC1, stage 1 conf vol | | | | | | | 500 | 500 | | 472 | 472 | |
| vC2, stage 2 conf vol | | | | | | | 326 | 475 | | 341 | 506 | |
| vCu, unblocked vol | 475 | | | 331 | | | 826 | 975 | 162 | 812 | 978 | 236 |
| tC, single (s) | 4.8 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.8 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.5 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.8 |
| p0 queue free % | 90 | | | 100 | | | 96 | 98 | 100 | 99 | 99 | 86 |
| cM capacity (veh/h) | 893 | | | 1240 | | | 381 | 355 | 860 | 397 | 365 | 647 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 88 | 162 | 162 | 6 | 0 | 236 | 236 | 3 | 21 | 96 |
| Volume Left | 88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 4 |
| Volume Right | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 88 |
| cSH | 893 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 373 | 610 |
| Volume to Capacity | 0.10 | 0.10 | 0.10 | 0.00 | 0.00 | 0.14 | 0.14 | 0.00 | 0.06 | 0.16 |
| Queue Length 95th (m) | 2.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 4.4 |
| Control Delay (s) | 9.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.2 | 12.0 |
| Lane LOS | A | | | | | | | | C | B |
| Approach Delay (s) | 2.0 | | | | 0.0 | | | | 15.2 | 12.0 |
| Approach LOS | | | | | | | | | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.3 | | |
| Intersection Capacity Utilization | 34.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 1 | 6 | 16 | 1 | 45 | 4 | 24 | 115 | 1 | 1 | 15 | 2 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| Hourly flow rate (vph) | 1 | 7 | 19 | 1 | 54 | 5 | 29 | 139 | 1 | 1 | 18 | 2 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 59 | | | 27 | | | 89 | 81 | 17 | 148 | 88 | 57 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 59 | | | 27 | | | 89 | 81 | 17 | 148 | 88 | 57 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.7 | 6.5 | 6.2 | 7.1 | 6.8 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 4.1 | 4.0 | 3.3 | 3.5 | 4.3 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 96 | 83 | 100 | 100 | 98 | 100 |
| cM capacity (veh/h) | 1558 | | | 1601 | | | 752 | 804 | 1068 | 714 | 752 | 1015 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 28 | 60 | 169 | 22 |
| Volume Left | 1 | 1 | 29 | 1 |
| Volume Right | 19 | 5 | 1 | 2 |
| cSH | 1558 | 1601 | 801 | 844 |
| Volume to Capacity | 0.00 | 0.00 | 0.21 | 0.03 |
| Queue Length 95th (m) | 0.0 | 0.0 | 6.3 | 0.6 |
| Control Delay (s) | 0.3 | 0.2 | 10.7 | 9.8 |
| Lane LOS | A | A | B | A |
| Approach Delay (s) | 0.3 | 0.2 | 10.7 | 9.8 |
| Approach LOS | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.3 | | |
| Intersection Capacity Utilization | 24.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 18 | 0 | 15 | 46 | 1 | 15 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Hourly flow rate (vph) | 31 | 0 | 26 | 79 | 2 | 26 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 31 | | 162 | 31 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 31 | | 162 | 31 |
| tC, single (s) | | | 5.1 | | 6.4 | 7.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 3.1 | | 3.5 | 4.2 |
| p0 queue free % | | | 98 | | 100 | 97 |
| cM capacity (veh/h) | | | 1126 | | 814 | 820 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 31 | 105 | 28 |
| Volume Left | 0 | 26 | 2 |
| Volume Right | 0 | 0 | 26 |
| cSH | 1700 | 1126 | 820 |
| Volume to Capacity | 0.02 | 0.02 | 0.03 |
| Queue Length 95th (m) | 0.0 | 0.6 | 0.8 |
| Control Delay (s) | 0.0 | 2.2 | 9.5 |
| Lane LOS | | A | A |
| Approach Delay (s) | 0.0 | 2.2 | 9.5 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.0 | | |
| Intersection Capacity Utilization | 19.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 15 | 1 | 0 | 15 | 0 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Hourly flow rate (vph) | 0 | 18 | 1 | 0 | 18 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 36 | 1 | | | 1 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 36 | 1 | | | 1 | |
| tC, single (s) | 6.4 | 7.2 | | | 5.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 4.2 | | | 3.1 | |
| p0 queue free % | 100 | 98 | | | 98 | |
| cM capacity (veh/h) | 966 | 856 | | | 1160 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 18 | 1 | 18 |
| Volume Left | 0 | 0 | 18 |
| Volume Right | 18 | 0 | 0 |
| cSH | 856 | 1700 | 1160 |
| Volume to Capacity | 0.02 | 0.00 | 0.02 |
| Queue Length 95th (m) | 0.5 | 0.0 | 0.4 |
| Control Delay (s) | 9.3 | 0.0 | 8.2 |
| Lane LOS | A | | A |
| Approach Delay (s) | 9.3 | 0.0 | 8.2 |
| Approach LOS | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.4 | | |
| Intersection Capacity Utilization | 17.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 159 | 863 | 12 | 4 | 604 | 10 | 7 | 4 | 3 | 20 | 11 | 189 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 167 | 908 | 13 | 4 | 636 | 11 | 7 | 4 | 3 | 21 | 12 | 199 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 646 | | | 921 | | | 1774 | 1898 | 454 | 1438 | 1900 | 318 |
| vC1, stage 1 conf vol | | | | | | | 1243 | 1243 | | 644 | 644 | |
| vC2, stage 2 conf vol | | | | | | | 531 | 655 | | 794 | 1256 | |
| vCu, unblocked vol | 646 | | | 921 | | | 1774 | 1898 | 454 | 1438 | 1900 | 318 |
| tC, single (s) | 4.5 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.2 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.4 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 80 | | | 99 | | | 93 | 97 | 99 | 91 | 93 | 69 |
| cM capacity (veh/h) | 823 | | | 610 | | | 113 | 168 | 558 | 225 | 164 | 644 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 167 | 454 | 454 | 13 | 4 | 318 | 318 | 11 | 15 | 232 |
| Volume Left | 167 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 7 | 21 |
| Volume Right | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 11 | 3 | 199 |
| cSH | 823 | 1700 | 1700 | 1700 | 610 | 1700 | 1700 | 1700 | 154 | 489 |
| Volume to Capacity | 0.20 | 0.27 | 0.27 | 0.01 | 0.01 | 0.19 | 0.19 | 0.01 | 0.10 | 0.47 |
| Queue Length 95th (m) | 6.1 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 2.5 | 20.0 |
| Control Delay (s) | 10.5 | 0.0 | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 0.0 | 30.9 | 18.8 |
| Lane LOS | B | | | | B | | | | D | C |
| Approach Delay (s) | 1.6 | | | | 0.1 | | | | 30.9 | 18.8 |
| Approach LOS | | | | | | | | | D | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.3 | | |
| Intersection Capacity Utilization | 50.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 3 | 51 | 24 | 2 | 30 | 1 | 15 | 40 | 1 | 3 | 204 | 3 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Hourly flow rate (vph) | 3 | 59 | 28 | 2 | 34 | 1 | 17 | 46 | 1 | 3 | 234 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 36 | | | 86 | | | 238 | 120 | 72 | 143 | 133 | 35 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 36 | | | 86 | | | 238 | 120 | 72 | 143 | 133 | 35 |
| tC, single (s) | 4.1 | | | 4.1 | | | 8.1 | 6.6 | 6.2 | 7.1 | 6.6 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 4.4 | 4.1 | 3.3 | 3.5 | 4.1 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 96 | 94 | 100 | 100 | 68 | 100 |
| cM capacity (veh/h) | 1588 | | | 1523 | | | 414 | 751 | 995 | 790 | 739 | 1044 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 90 | 38 | 64 | 241 |
| Volume Left | 3 | 2 | 17 | 3 |
| Volume Right | 28 | 1 | 1 | 3 |
| cSH | 1588 | 1523 | 671 | 750 |
| Volume to Capacity | 0.00 | 0.00 | 0.10 | 0.32 |
| Queue Length 95th (m) | 0.1 | 0.0 | 2.5 | 11.1 |
| Control Delay (s) | 0.3 | 0.5 | 11.0 | 12.1 |
| Lane LOS | A | A | B | B |
| Approach Delay (s) | 0.3 | 0.5 | 11.0 | 12.1 |
| Approach LOS | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.5 | | |
| Intersection Capacity Utilization | 28.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 73 | 1 | 15 | 34 | 1 | 15 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 91 | 1 | 19 | 42 | 1 | 19 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 92 | | 172 | 92 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 92 | | 172 | 92 |
| tC, single (s) | | | 5.1 | | 6.4 | 7.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 3.1 | | 3.5 | 4.2 |
| p0 queue free % | | | 98 | | 100 | 98 |
| cM capacity (veh/h) | | | 1060 | | 808 | 752 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 92 | 61 | 20 |
| Volume Left | 0 | 19 | 1 |
| Volume Right | 1 | 0 | 19 |
| cSH | 1700 | 1060 | 755 |
| Volume to Capacity | 0.05 | 0.02 | 0.03 |
| Queue Length 95th (m) | 0.0 | 0.4 | 0.7 |
| Control Delay (s) | 0.0 | 2.7 | 9.9 |
| Lane LOS | | A | A |
| Approach Delay (s) | 0.0 | 2.7 | 9.9 |
| Approach LOS | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.1 | | |
| Intersection Capacity Utilization | 19.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 15 | 1 | 0 | 15 | 1 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Hourly flow rate (vph) | 0 | 18 | 1 | 0 | 18 | 1 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 38 | 1 | | | 1 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 38 | 1 | | | 1 | |
| tC, single (s) | 6.4 | 7.2 | | | 5.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 4.2 | | | 3.1 | |
| p0 queue free % | 100 | 98 | | | 98 | |
| cM capacity (veh/h) | 965 | 856 | | | 1160 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 18 | 1 | 19 |
| Volume Left | 0 | 0 | 18 |
| Volume Right | 18 | 0 | 0 |
| cSH | 856 | 1700 | 1160 |
| Volume to Capacity | 0.02 | 0.00 | 0.02 |
| Queue Length 95th (m) | 0.5 | 0.0 | 0.4 |
| Control Delay (s) | 9.3 | 0.0 | 7.6 |
| Lane LOS | A | | A |
| Approach Delay (s) | 9.3 | 0.0 | 7.6 |
| Approach LOS | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.2 | | |
| Intersection Capacity Utilization | 17.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 113 | 402 | 9 | 0 | 582 | 5 | 19 | 10 | 0 | 6 | 6 | 102 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 118 | 419 | 9 | 0 | 606 | 5 | 20 | 10 | 0 | 6 | 6 | 106 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 611 | | | 428 | | | 1067 | 1266 | 209 | 1056 | 1270 | 303 |
| vC1, stage 1 conf vol | | | | | | | 654 | 654 | | 606 | 606 | |
| vC2, stage 2 conf vol | | | | | | | 412 | 611 | | 450 | 664 | |
| vCu, unblocked vol | 611 | | | 428 | | | 1067 | 1266 | 209 | 1056 | 1270 | 303 |
| tC, single (s) | 4.5 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.6 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.4 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.6 |
| p0 queue free % | 86 | | | 100 | | | 93 | 96 | 100 | 98 | 98 | 83 |
| cM capacity (veh/h) | 862 | | | 1142 | | | 281 | 267 | 803 | 309 | 288 | 609 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 118 | 209 | 209 | 9 | 0 | 303 | 303 | 5 | 30 | 119 |
| Volume Left | 118 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 6 |
| Volume Right | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 5 | 0 | 106 |
| cSH | 862 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 276 | 549 |
| Volume to Capacity | 0.14 | 0.12 | 0.12 | 0.01 | 0.00 | 0.18 | 0.18 | 0.00 | 0.11 | 0.22 |
| Queue Length 95th (m) | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 6.5 |
| Control Delay (s) | 9.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.6 | 13.4 |
| Lane LOS | A | | | | | | | | C | B |
| Approach Delay (s) | 2.1 | | | | 0.0 | | | | 19.6 | 13.4 |
| Approach LOS | | | | | | | | | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.6 | | |
| Intersection Capacity Utilization | 40.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 9 | 51 | 9 | 1 | 161 | 6 | 34 | 158 | 1 | 2 | 20 | 7 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| Hourly flow rate (vph) | 11 | 61 | 11 | 1 | 194 | 7 | 41 | 190 | 1 | 2 | 24 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 201 | | | 72 | | | 305 | 292 | 67 | 384 | 294 | 198 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 201 | | | 72 | | | 305 | 292 | 67 | 384 | 294 | 198 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.8 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.3 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 93 | 69 | 100 | 99 | 96 | 99 |
| cM capacity (veh/h) | 1383 | | | 1541 | | | 620 | 610 | 1002 | 435 | 570 | 849 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 83 | 202 | 233 | 35 |
| Volume Left | 11 | 1 | 41 | 2 |
| Volume Right | 11 | 7 | 1 | 8 |
| cSH | 1383 | 1541 | 615 | 735 |
| Volume to Capacity | 0.01 | 0.00 | 0.38 | 0.05 |
| Queue Length 95th (m) | 0.2 | 0.0 | 14.1 | 1.2 |
| Control Delay (s) | 1.0 | 0.1 | 14.4 | 11.2 |
| Lane LOS | A | A | B | B |
| Approach Delay (s) | 1.0 | 0.1 | 14.4 | 11.2 |
| Approach LOS | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 6.9 | | |
| Intersection Capacity Utilization | 33.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 79 | 0 | 0 | 194 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Hourly flow rate (vph) | 136 | 0 | 0 | 334 | 2 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 136 | | 471 | 136 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 136 | | 471 | 136 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1460 | | 555 | 918 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 136 | 334 | 2 |
| Volume Left | 0 | 0 | 2 |
| Volume Right | 0 | 0 | 0 |
| cSH | 1700 | 1460 | 555 |
| Volume to Capacity | 0.08 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.1 |
| Control Delay (s) | 0.0 | 0.0 | 11.5 |
| Lane LOS | | | B |
| Approach Delay (s) | 0.0 | 0.0 | 11.5 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 20.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | ↰ | ↑↑ | ↱ | ↰ | ↑↑ | ↱ | | ✣ | | | ✣ | |
| Volume (veh/h) | 199 | 1115 | 17 | 6 | 766 | 14 | 10 | 6 | 4 | 27 | 16 | 248 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 209 | 1174 | 18 | 6 | 806 | 15 | 11 | 6 | 4 | 28 | 17 | 261 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 821 | | | 1192 | | | 2278 | 2426 | 587 | 1832 | 2429 | 403 |
| vC1, stage 1 conf vol | | | | | | | 1593 | 1593 | | 819 | 819 | |
| vC2, stage 2 conf vol | | | | | | | 685 | 834 | | 1013 | 1611 | |
| vCu, unblocked vol | 821 | | | 1192 | | | 2278 | 2426 | 587 | 1832 | 2429 | 403 |
| tC, single (s) | 4.3 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.0 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.3 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 72 | | | 99 | | | 0 | 94 | 99 | 80 | 83 | 55 |
| cM capacity (veh/h) | 743 | | | 468 | | | 8 | 98 | 458 | 144 | 96 | 583 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 209 | 587 | 587 | 18 | 6 | 403 | 403 | 15 | 21 | 306 |
| Volume Left | 209 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 11 | 28 |
| Volume Right | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 15 | 4 | 261 |
| cSH | 743 | 1700 | 1700 | 1700 | 468 | 1700 | 1700 | 1700 | 16 | 373 |
| Volume to Capacity | 0.28 | 0.35 | 0.35 | 0.01 | 0.01 | 0.24 | 0.24 | 0.01 | 1.34 | 0.82 |
| Queue Length 95th (m) | 9.3 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 25.3 | 58.6 |
| Control Delay (s) | 11.7 | 0.0 | 0.0 | 0.0 | 12.8 | 0.0 | 0.0 | 0.0 | 692.6 | 46.3 |
| Lane LOS | B | | | | B | | | | F | E |
| Approach Delay (s) | 1.8 | | | | 0.1 | | | | 692.6 | 46.3 |
| Approach LOS | | | | | | | | | F | E |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 12.3 | | |
| Intersection Capacity Utilization | 61.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 7 | 107 | 20 | 3 | 66 | 1 | 0 | 55 | 1 | 4 | 282 | 7 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Hourly flow rate (vph) | 8 | 123 | 23 | 3 | 76 | 1 | 0 | 63 | 1 | 5 | 324 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 77 | | | 146 | | | 400 | 234 | 134 | 266 | 245 | 76 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 77 | | | 146 | | | 400 | 234 | 134 | 266 | 245 | 76 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.6 | 6.2 | 7.1 | 6.6 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.1 | 3.3 | 3.5 | 4.1 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 100 | 90 | 100 | 99 | 49 | 99 |
| cM capacity (veh/h) | 1535 | | | 1448 | | | 333 | 646 | 920 | 634 | 637 | 990 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 154 | 80 | 64 | 337 |
| Volume Left | 8 | 3 | 0 | 5 |
| Volume Right | 23 | 1 | 1 | 8 |
| cSH | 1535 | 1448 | 657 | 652 |
| Volume to Capacity | 0.01 | 0.00 | 0.10 | 0.52 |
| Queue Length 95th (m) | 0.1 | 0.1 | 2.6 | 23.8 |
| Control Delay (s) | 0.4 | 0.3 | 11.1 | 16.3 |
| Lane LOS | A | A | B | C |
| Approach Delay (s) | 0.4 | 0.3 | 11.1 | 16.3 |
| Approach LOS | | | B | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 9.9 | | |
| Intersection Capacity Utilization | 35.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 145 | 1 | 0 | 75 | 1 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 181 | 1 | 0 | 94 | 1 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 182 | | 276 | 182 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 182 | | 276 | 182 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 100 | 100 |
| cM capacity (veh/h) | | | 1405 | | 718 | 866 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 182 | 94 | 1 |
| Volume Left | 0 | 0 | 1 |
| Volume Right | 1 | 0 | 0 |
| cSH | 1700 | 1405 | 718 |
| Volume to Capacity | 0.11 | 0.00 | 0.00 |
| Queue Length 95th (m) | 0.0 | 0.0 | 0.0 |
| Control Delay (s) | 0.0 | 0.0 | 10.0 |
| Lane LOS | | | B |
| Approach Delay (s) | 0.0 | 0.0 | 10.0 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 17.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 128 | 402 | 9 | 0 | 582 | 5 | 19 | 10 | 0 | 6 | 6 | 117 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 133 | 419 | 9 | 0 | 606 | 5 | 20 | 10 | 0 | 6 | 6 | 122 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 611 | | | 428 | | | 1114 | 1297 | 209 | 1088 | 1301 | 303 |
| vC1, stage 1 conf vol | | | | | | | 685 | 685 | | 606 | 606 | |
| vC2, stage 2 conf vol | | | | | | | 428 | 611 | | 481 | 695 | |
| vCu, unblocked vol | 611 | | | 428 | | | 1114 | 1297 | 209 | 1088 | 1301 | 303 |
| tC, single (s) | 4.7 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.7 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.5 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.7 |
| p0 queue free % | 83 | | | 100 | | | 92 | 96 | 100 | 98 | 98 | 79 |
| cM capacity (veh/h) | 806 | | | 1142 | | | 251 | 251 | 803 | 295 | 273 | 587 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 133 | 209 | 209 | 9 | 0 | 303 | 303 | 5 | 30 | 134 |
| Volume Left | 133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 6 |
| Volume Right | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 5 | 0 | 122 |
| cSH | 806 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 251 | 534 |
| Volume to Capacity | 0.17 | 0.12 | 0.12 | 0.01 | 0.00 | 0.18 | 0.18 | 0.00 | 0.12 | 0.25 |
| Queue Length 95th (m) | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | 7.9 |
| Control Delay (s) | 10.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.3 | 14.0 |
| Lane LOS | B | | | | | | | | C | B |
| Approach Delay (s) | 2.5 | | | | 0.0 | | | | 21.3 | 14.0 |
| Approach LOS | | | | | | | | | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.9 | | |
| Intersection Capacity Utilization | 42.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 9 | 51 | 24 | 1 | 161 | 6 | 49 | 158 | 1 | 2 | 20 | 7 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| Hourly flow rate (vph) | 11 | 61 | 29 | 1 | 194 | 7 | 59 | 190 | 1 | 2 | 24 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 201 | | | 90 | | | 299 | 287 | 61 | 379 | 312 | 198 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 201 | | | 90 | | | 299 | 287 | 61 | 379 | 312 | 198 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.4 | 6.5 | 6.2 | 7.1 | 6.8 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.8 | 4.0 | 3.3 | 3.5 | 4.3 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 90 | 69 | 100 | 99 | 96 | 99 |
| cM capacity (veh/h) | 1383 | | | 1517 | | | 570 | 614 | 1009 | 439 | 556 | 849 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total | 72 | 29 | 202 | 251 | 35 |
| Volume Left | 11 | 0 | 1 | 59 | 2 |
| Volume Right | 0 | 29 | 7 | 1 | 8 |
| cSH | 1383 | 1700 | 1517 | 607 | 719 |
| Volume to Capacity | 0.01 | 0.02 | 0.00 | 0.41 | 0.05 |
| Queue Length 95th (m) | 0.2 | 0.0 | 0.0 | 16.2 | 1.2 |
| Control Delay (s) | 1.2 | 0.0 | 0.1 | 15.1 | 11.3 |
| Lane LOS | A | | A | C | B |
| Approach Delay (s) | 0.9 | | 0.1 | 15.1 | 11.3 |
| Approach LOS | | | | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.2 | | |
| Intersection Capacity Utilization | 34.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 79 | 0 | 15 | 194 | 1 | 15 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| Hourly flow rate (vph) | 136 | 0 | 26 | 334 | 2 | 26 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 136 | | 522 | 136 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 136 | | 522 | 136 |
| tC, single (s) | | | 5.1 | | 6.4 | 7.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 3.1 | | 3.5 | 4.2 |
| p0 queue free % | | | 97 | | 100 | 96 |
| cM capacity (veh/h) | | | 1015 | | 505 | 706 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 136 | 360 | 28 |
| Volume Left | 0 | 26 | 2 |
| Volume Right | 0 | 0 | 26 |
| cSH | 1700 | 1015 | 689 |
| Volume to Capacity | 0.08 | 0.03 | 0.04 |
| Queue Length 95th (m) | 0.0 | 0.6 | 1.0 |
| Control Delay (s) | 0.0 | 0.9 | 10.4 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 0.9 | 10.4 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 27.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 15 | 1 | 0 | 15 | 0 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Hourly flow rate (vph) | 0 | 18 | 1 | 0 | 18 | 0 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 36 | 1 | | | 1 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 36 | 1 | | | 1 | |
| tC, single (s) | 6.4 | 7.2 | | | 5.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 4.2 | | | 3.1 | |
| p0 queue free % | 100 | 98 | | | 98 | |
| cM capacity (veh/h) | 966 | 856 | | | 1160 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 18 | 1 | 18 |
| Volume Left | 0 | 0 | 18 |
| Volume Right | 18 | 0 | 0 |
| cSH | 856 | 1700 | 1160 |
| Volume to Capacity | 0.02 | 0.00 | 0.02 |
| Queue Length 95th (m) | 0.5 | 0.0 | 0.4 |
| Control Delay (s) | 9.3 | 0.0 | 8.2 |
| Lane LOS | A | | A |
| Approach Delay (s) | 9.3 | 0.0 | 8.2 |
| Approach LOS | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.4 | | |
| Intersection Capacity Utilization | 17.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 214 | 1115 | 17 | 6 | 766 | 14 | 10 | 6 | 4 | 27 | 16 | 263 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 225 | 1174 | 18 | 6 | 806 | 15 | 11 | 6 | 4 | 28 | 17 | 277 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 821 | | | 1192 | | | 2325 | 2458 | 587 | 1864 | 2461 | 403 |
| vC1, stage 1 conf vol | | | | | | | 1624 | 1624 | | 819 | 819 | |
| vC2, stage 2 conf vol | | | | | | | 701 | 834 | | 1045 | 1642 | |
| vCu, unblocked vol | 821 | | | 1192 | | | 2325 | 2458 | 587 | 1864 | 2461 | 403 |
| tC, single (s) | 4.5 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.1 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.4 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 68 | | | 99 | | | 0 | 93 | 99 | 78 | 81 | 51 |
| cM capacity (veh/h) | 709 | | | 468 | | | 7 | 90 | 458 | 131 | 88 | 570 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 225 | 587 | 587 | 18 | 6 | 403 | 403 | 15 | 21 | 322 |
| Volume Left | 225 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 11 | 28 |
| Volume Right | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 15 | 4 | 277 |
| cSH | 709 | 1700 | 1700 | 1700 | 468 | 1700 | 1700 | 1700 | 13 | 361 |
| Volume to Capacity | 0.32 | 0.35 | 0.35 | 0.01 | 0.01 | 0.24 | 0.24 | 0.01 | 1.64 | 0.89 |
| Queue Length 95th (m) | 10.9 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 26.9 | 70.8 |
| Control Delay (s) | 12.4 | 0.0 | 0.0 | 0.0 | 12.8 | 0.0 | 0.0 | 0.0 | 905.3 | 58.7 |
| Lane LOS | B | | | | B | | | | F | F |
| Approach Delay (s) | 2.0 | | | | 0.1 | | | | 905.3 | 58.7 |
| Approach LOS | | | | | | | | | F | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 15.8 | | |
| Intersection Capacity Utilization | 62.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 7 | 107 | 35 | 3 | 66 | 1 | 15 | 55 | 1 | 4 | 282 | 7 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| Hourly flow rate (vph) | 8 | 123 | 40 | 3 | 76 | 1 | 17 | 63 | 1 | 5 | 324 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | 12 | | | 12 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 77 | | | 163 | | | 389 | 223 | 123 | 255 | 263 | 76 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 77 | | | 163 | | | 389 | 223 | 123 | 255 | 263 | 76 |
| tC, single (s) | 4.1 | | | 4.1 | | | 8.1 | 6.6 | 6.2 | 7.1 | 6.6 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 4.4 | 4.1 | 3.3 | 3.5 | 4.1 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 93 | 90 | 100 | 99 | 48 | 99 |
| cM capacity (veh/h) | 1535 | | | 1428 | | | 249 | 655 | 933 | 646 | 623 | 990 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|---|
| Volume Total | 131 | 40 | 80 | 82 | 337 |
| Volume Left | 8 | 0 | 3 | 17 | 5 |
| Volume Right | 0 | 40 | 1 | 1 | 8 |
| cSH | 1535 | 1700 | 1428 | 576 | 638 |
| Volume to Capacity | 0.01 | 0.02 | 0.00 | 0.14 | 0.53 |
| Queue Length 95th (m) | 0.1 | 0.0 | 0.1 | 3.9 | 24.8 |
| Control Delay (s) | 0.5 | 0.0 | 0.3 | 12.3 | 16.9 |
| Lane LOS | A | | A | B | C |
| Approach Delay (s) | 0.4 | | 0.3 | 12.3 | 16.9 |
| Approach LOS | | | | B | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 10.1 | | |
| Intersection Capacity Utilization | 34.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 145 | 1 | 15 | 75 | 1 | 15 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Hourly flow rate (vph) | 181 | 1 | 19 | 94 | 1 | 19 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 182 | | 313 | 182 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 182 | | 313 | 182 |
| tC, single (s) | | | 5.1 | | 6.4 | 7.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 3.1 | | 3.5 | 4.2 |
| p0 queue free % | | | 98 | | 100 | 97 |
| cM capacity (veh/h) | | | 969 | | 671 | 661 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 182 | 112 | 20 |
| Volume Left | 0 | 19 | 1 |
| Volume Right | 1 | 0 | 19 |
| cSH | 1700 | 969 | 662 |
| Volume to Capacity | 0.11 | 0.02 | 0.03 |
| Queue Length 95th (m) | 0.0 | 0.5 | 0.7 |
| Control Delay (s) | 0.0 | 1.6 | 10.6 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 1.6 | 10.6 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.3 | | |
| Intersection Capacity Utilization | 25.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 15 | 1 | 0 | 15 | 1 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Hourly flow rate (vph) | 0 | 18 | 1 | 0 | 18 | 1 |
| Pedestrians | | | | | | |
| Lane Width (m) | | | | | | |
| Walking Speed (m/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (m) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 38 | 1 | | | 1 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 38 | 1 | | | 1 | |
| tC, single (s) | 6.4 | 7.2 | | | 5.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 4.2 | | | 3.1 | |
| p0 queue free % | 100 | 98 | | | 98 | |
| cM capacity (veh/h) | 965 | 856 | | | 1160 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 18 | 1 | 19 |
| Volume Left | 0 | 0 | 18 |
| Volume Right | 18 | 0 | 0 |
| cSH | 856 | 1700 | 1160 |
| Volume to Capacity | 0.02 | 0.00 | 0.02 |
| Queue Length 95th (m) | 0.5 | 0.0 | 0.4 |
| Control Delay (s) | 9.3 | 0.0 | 7.6 |
| Lane LOS | A | | A |
| Approach Delay (s) | 9.3 | 0.0 | 7.6 |
| Approach LOS | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.2 | | |
| Intersection Capacity Utilization | 17.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 115 | 346 | 7 | 0 | 501 | 5 | 16 | 9 | 0 | 5 | 5 | 104 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Hourly flow rate (vph) | 120 | 360 | 7 | 0 | 522 | 5 | 17 | 9 | 0 | 5 | 5 | 108 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 527 | | | 368 | | | 972 | 1127 | 180 | 946 | 1129 | 261 |
| vC1, stage 1 conf vol | | | | | | | 600 | 600 | | 522 | 522 | |
| vC2, stage 2 conf vol | | | | | | | 372 | 527 | | 424 | 607 | |
| vCu, unblocked vol | 527 | | | 368 | | | 972 | 1127 | 180 | 946 | 1129 | 261 |
| tC, single (s) | 4.7 | | | 4.1 | | | 7.5 | 6.8 | 6.9 | 8.0 | 7.0 | 7.7 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.8 | | 7.0 | 6.0 | |
| tF (s) | 2.5 | | | 2.2 | | | 3.5 | 4.2 | 3.3 | 3.8 | 4.2 | 3.7 |
| p0 queue free % | 86 | | | 100 | | | 95 | 97 | 100 | 98 | 98 | 83 |
| cM capacity (veh/h) | 875 | | | 1202 | | | 307 | 298 | 838 | 342 | 316 | 630 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 120 | 180 | 180 | 7 | 0 | 261 | 261 | 5 | 26 | 119 |
| Volume Left | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 5 |
| Volume Right | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 108 |
| cSH | 875 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | 304 | 583 |
| Volume to Capacity | 0.14 | 0.11 | 0.11 | 0.00 | 0.00 | 0.15 | 0.15 | 0.00 | 0.09 | 0.20 |
| Queue Length 95th (m) | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.2 | 6.1 |
| Control Delay (s) | 9.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.0 | 12.7 |
| Lane LOS | A | | | | | | | | C | B |
| Approach Delay (s) | 2.4 | | | | 0.0 | | | | 18.0 | 12.7 |
| Approach LOS | | | | | | | | | C | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.7 | | |
| Intersection Capacity Utilization | 38.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 186 | 960 | 15 | 5 | 660 | 12 | 9 | 5 | 3 | 24 | 14 | 228 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Hourly flow rate (vph) | 196 | 1011 | 16 | 5 | 695 | 13 | 9 | 5 | 3 | 25 | 15 | 240 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | Raised | | | Raised | | | | | | | |
| Median storage veh) | | 2 | | | 2 | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 707 | | | 1026 | | | 2007 | 2120 | 505 | 1608 | 2123 | 347 |
| vC1, stage 1 conf vol | | | | | | | 1402 | 1402 | | 705 | 705 | |
| vC2, stage 2 conf vol | | | | | | | 605 | 718 | | 903 | 1418 | |
| vCu, unblocked vol | 707 | | | 1026 | | | 2007 | 2120 | 505 | 1608 | 2123 | 347 |
| tC, single (s) | 4.5 | | | 4.6 | | | 7.5 | 6.5 | 6.9 | 7.6 | 6.7 | 7.1 |
| tC, 2 stage (s) | | | | | | | 6.5 | 5.5 | | 6.6 | 5.7 | |
| tF (s) | 2.4 | | | 2.5 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.1 | 3.4 |
| p0 queue free % | 75 | | | 99 | | | 84 | 96 | 99 | 86 | 89 | 61 |
| cM capacity (veh/h) | 788 | | | 550 | | | 60 | 132 | 517 | 182 | 128 | 621 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | EB 4 | WB 1 | WB 2 | WB 3 | WB 4 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume Total | 196 | 505 | 505 | 16 | 5 | 347 | 347 | 13 | 18 | 280 |
| Volume Left | 196 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 9 | 25 |
| Volume Right | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 13 | 3 | 240 |
| cSH | 788 | 1700 | 1700 | 1700 | 550 | 1700 | 1700 | 1700 | 88 | 437 |
| Volume to Capacity | 0.25 | 0.30 | 0.30 | 0.01 | 0.01 | 0.20 | 0.20 | 0.01 | 0.20 | 0.64 |
| Queue Length 95th (m) | 7.8 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 5.7 | 35.0 |
| Control Delay (s) | 11.1 | 0.0 | 0.0 | 0.0 | 11.6 | 0.0 | 0.0 | 0.0 | 55.9 | 26.8 |
| Lane LOS | B | | | | B | | | | F | D |
| Approach Delay (s) | 1.8 | | | | 0.1 | | | | 55.9 | 26.8 |
| Approach LOS | | | | | | | | | F | D |

| Intersection Summary | | | | |
|---|---|---|---|---|
| Average Delay | 4.8 | | | |
| Intersection Capacity Utilization | 56.0% | ICU Level of Service | | B |
| Analysis Period (min) | 15 | | | |

# APPENDIX F

## TAC Illumination Warrants

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | Existing Traffic |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 2 | 30 | | OK | 60 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **115** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## ILLUMINATION WARRANTED

**REVIEW SITE AND COLLISIONS TO DETERMINE LIGHTING TYPE ( PARTIAL OR DELINEATION )**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 115 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **136** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING
## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | Existing |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 1 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 5 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **11** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 1 | 5 | Refer to Table 1(B) for ratings. | OK | 5 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 70 | 2 | 5 | Refer to Table 1(B), note #3 | OK | 10 |
| | | | | | **Operational Factors Subtotal** | **30** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 11 |
| Operational Factor Subtotal | 30 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **41** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Range Road 221 | Minor Road | **Other** | Existing/2011 Background |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 958 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 27 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **30** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## LIGHTING IS NOT WARRANTED

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 30 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **33** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2011 Background |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 2 | 30 | | OK | 60 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **115** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**ILLUMINATION WARRANTED**
**REVIEW SITE AND COLLISIONS TO DETERMINE LIGHTING TYPE ( PARTIAL OR DELINEATION )**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 115 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **136** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2011 Background |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 1 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 5 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **11** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 1 | 5 | Refer to Table 1(B) for ratings. | OK | 5 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 70 | 2 | 5 | Refer to Table 1(B), note #3 | OK | 10 |
| | | | | | **Operational Factors Subtotal** | **30** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## LIGHTING IS NOT WARRANTED

### SUMMARY

| | |
|---|---|
| Geometric Factors Subtotal | 11 |
| Operational Factor Subtotal | 30 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **41** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

| **INTERSECTION CHARACTERISTICS** | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2011 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 3 | 30 | | OK | 90 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **145** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**ILLUMINATION WARRANTED**
**DELINEATION LIGHTING TO ILLUMINATE PEDESTRIANS OR CROSS STREET TRAFFIC**

| **SUMMARY** | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 145 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **166** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2011 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 1 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 5 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **11** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 1 | 5 | Refer to Table 1(B) for ratings. | OK | 5 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 70 | 2 | 5 | Refer to Table 1(B), note #3 | OK | 10 |
| | | | | | **Operational Factors Subtotal** | **30** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 11 |
| Operational Factor Subtotal | 30 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **41** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Range Road 221 | Minor Road | **Other** | 2011 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 1355 | 1 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 10 |
| AADT on Minor Road (2-way) | 431 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **40** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## LIGHTING IS NOT WARRANTED

### SUMMARY

| | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 40 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **43** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Range Road 221 | Main Road | **Date** | June 28, 2011 |
| Site Access | Minor Road | **Other** | 2011 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 431 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 404 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 50 | 0 | 5 | Refer to Table 1(B), note #3 | OK | 0 |
| | | | | | **Operational Factors Subtotal** | **15** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

**SUMMARY**

| | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 15 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **18** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2031 Background |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | y | | | Illumination is Warranted | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **55** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is Signalized**

**FULL ILLUMINATION WARRANTED**

| **SUMMARY** | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 55 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **76** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2031 Background |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 1 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 5 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **11** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 1 | 30 | | OK | 30 |
| | | | | | OK | |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 1 | 5 | Refer to Table 1(B) for ratings. | OK | 5 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 70 | 2 | 5 | Refer to Table 1(B), note #3 | OK | 10 |
| | | | | | **Operational Factors Subtotal** | **60** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | OK | |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 11 |
| Operational Factor Subtotal | 60 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **71** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Range Road 221 | Minor Road | **Other** | 2031 Background |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 2724 | 2 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 20 |
| AADT on Minor Road (2-way) | 27 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **50** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## LIGHTING IS NOT WARRANTED

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 50 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **53** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2031 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | y | | | Illumination is Warranted | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **55** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is Signalized**

**FULL ILLUMINATION WARRANTED**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 55 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **76** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2031 Total |
| Strathcona County | City/Town | | |

### GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 1 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 5 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **11** |

### OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 1 | 30 | | OK | 30 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 1 | 5 | Refer to Table 1(B) for ratings. | OK | 5 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 70 | 2 | 5 | Refer to Table 1(B), note #3 | OK | 10 |
| | | | | | **Operational Factors Subtotal** | **60** |

### ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

### COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 11 |
| Operational Factor Subtotal | 60 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **71** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING
## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Township Road 550 | Main Road | **Date** | June 28, 2011 |
| Range Road 221 | Minor Road | **Other** | 2031 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 3121 | 3 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 30 |
| AADT on Minor Road (2-way) | 431 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | OK | |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **60** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | OK | |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

## LIGHTING IS NOT WARRANTED

### SUMMARY

| | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 60 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **63** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Range Road 221 | Main Road | **Date** | June 28, 2011 |
| Site Access | Minor Road | **Other** | 2031 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 0 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 0 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 80 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | C | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 3 | 1 | 3 | Number of legs = 3 or more | OK | 3 |
| | | | | | **Geometric Factors Subtotal** | **3** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 431 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 404 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 0 | 30 | | OK | 0 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 0 | 5 | Refer to Table 1(B) for ratings. | OK | 0 |
| Operating Speed or Posted Speed on Major Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| Operating Speed on Minor Road (km/h) | 50 | 0 | 5 | Refer to Table 1(B), note #3 | OK | 0 |
| | | | | | **Operational Factors Subtotal** | **15** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**LIGHTING IS NOT WARRANTED**

| **SUMMARY** | |
|---|---|
| Geometric Factors Subtotal | 3 |
| Operational Factor Subtotal | 15 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **18** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING

## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | June 28, 2011 |
| Highway 830 | Minor Road | **Other** | 2021 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 4 | 30 | | OK | 120 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **175** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**ILLUMINATION WARRANTED**
**DELINEATION LIGHTING TO ILLUMINATE PEDESTRIANS OR CROSS STREET TRAFFIC**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 175 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **196** |

bunt & associates

# MEMO

DATE: June 5, 2012
PROJECT NO: 3363.01
**PROJECT:** **Josephburg Area Gravel Extraction Operation**
**SUBJECT:** **Response to May 2, 2012 TIA Comments**

TO: Gerard Marrinier
Alberta Transportation, North Central Region
FROM: Janelle Willis

Thank-you for the comments you provided May 2, 2012 regarding the October 21, 2011 TIA - Josephburg Area Gravel Extraction Operation. The following information is provided in response to your comments.

***Page 5, Section 2.2.2, Existing Traffic Characteristics: It is mentioned that a traffic count at the Highway 830/Twp. Rd. 550 intersection was conducted in June of 2011. Can you include a copy of the factored count results/turning movement diagram in the appendix (Also advise times, day, and month of year) This section also discusses various percentages of truck traffic along Highway 830 (6-24%)? Is this above average? What are the ESALs for this highway? Are they above average?***

As mentioned in Section 2.2.2, the only 2011 traffic count was conducted by Bunt & Associates at the intersection of Twp. Rd. 550 and RR 221. The count was completed June 16, 2011 between the hours of 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM. Exhibit 2-2 in the TIA illustrates the existing traffic volumes counted at the intersection of Twp. Rd. 550 and RR 221. The measured volumes are not factored, and are assumed to represent typical turning movements at the intersection during the AM and PM peak hours. Attached is a summary of the traffic count completed at the intersection of Twp. Rd. 550 and RR 221.

The various percentages of truck traffic along Highway 830 are dependent on the location along Highway 830 as well as the time of day. Although I am not aware of a provincial average for percent heavy vehicles, the existing heavy vehicles along Highway 830 seem appropriate for the industrial nature of the area. **Table 1** on the following page illustrates the percentage and number of heavy vehicles along Highway 830 during the peak hours, as well as heavy vehicle activity along Highway 16 for comparison purposes.

**Table 1: Heavy Vehicle Summary**

| Location | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|
| | %HV | # of HV | %HV | # of HV |
| Highway 830 *N of Twp. Rd. 550* | 8% | 10 | 11% | 27 |
| Highway 830 *S of Twp. Rd. 550* | 7% | 9 | 11% | 27 |
| Highway 830 *N of Highway 16* | 26% | 38 | 9% | 30 |
| Highway 16 *E of Highway 830* | 13% | 87 | 11% | 151 |
| Highway 16 *W of Highway 830* | 14% | 120 | 11% | 176 |

ESAL reports are prepared by Alberta Transportation for the use of consultants undertaking pavement designs for Alberta Transportation. The TIA does not address pavement design, and the traffic analyses use percent heavy vehicles not ESALs.

***Page 31, Section 5.2.2. Township Road 550 and Highway 830: The warrant analysis indicated that an eastbound right turn lane is needed. However, the report further suggests the existing (Type II) intersection can be modified to include a right turn lane by re-painting. We do not understand how this can be achieved and meet standards and in this regard we would require a drawing. We would also recommend that the page number for reviewing the right turn analysis be included in the report (as well as the left turn analysis).***

As outlined on page 31 of the TIA, a Type IIc intersection is currently constructed at the intersection of Township Road 550 and Highway 830, and includes bypass lanes on the east and west approaches to allow vehicles to manoeuvre around standing left turning vehicles. As an exclusive left turn bay is not required under existing or future traffic conditions, it is anticipated that the existing intersection can be modified with pavement markings indicating a shared left/through lane and a right turn bay on the west approach as opposed to a bypass lane. Attached is an illustration of the proposed lane markings on the west approach of the Township Road 550/Highway 830 intersection.

It is noted that the proposed pavement markings are not the standard of a Type IIc intersection; however a standard Type IIc intersection treatment is not anticipated to be warranted on the west approach. It should also be noted that Township Road 550 is not a highway, and the background and total traffic volumes can be accommodated at the intersection with a shared left/through lane and right turn bay on the west approach. With the exception of pavement markings, no further intersection modifications are anticipated to be required.

The warrant for a left turn lane is based on page D-139 of the Alberta Transportation Highway Geometric Design Guide, and the charts used in the analysis are identified in Appendix C of the TIA. The right turn analysis is based on page D-171 of the Alberta Transportation Highway Geometric Design Guide.

***Page 34 – Section 5.3 Signal Warrant Analysis: We note the traffic count (TMD) is not included in the appendix.***

A summary of the traffic count completed by Bunt & Associates at the intersection of Twp. Rd. 550 and RR 221 is attached.

***Why isn't the intersection of Highway 830 & Township Road 544 included or impacted. This should be discussed in the report in (new) Section 5.2.4 on Page 34?***

The intersection of Township Road 544 and Highway 830 was not included as part of the TIA because only northbound and southbound through movements are anticipated to be added to the intersection with the addition of site generated traffic. There is no traffic control along Highway 830 at this location, and the northbound and southbound traffic movements are free flow.

***Page 36 to Page 41, Capacity Analysis (Highway 16/830 intersection): We note the analysis indicated that the intersection will fail by 2021 and since Highway 16 is a freeway—installing signals (or a round-about) would not be an acceptable solution. Therefore what would be recommended as an acceptable solution? E.g. would a dedicated s/b turning w/b right turn lane resolve any issues? Would channelization of the north and south legs resolve any issues? In Conclusion, Section 6.1, Page 51; we note that it does not concur with the issues raised here.***

The northbound movements at the intersection of Highway 16 and Highway 830 are anticipated to operate at Level of Service (LOS) F during the PM peak hour based on 2021 total traffic volumes; however, this does not mean that the intersection fails. The volume to capacity (v/c) ratio for the northbound movements is anticipated to be 0.20 during the PM peak hour, indicating that there is sufficient capacity and projected traffic volumes can be accommodated at the intersection. In addition, only 17 northbound vehicles are projected at the intersection during the PM peak hour. No geometric improvements are recommended to accommodate total traffic volumes in 2021.

The phase one site generated traffic is only anticipated for a 10 year horizon, and is not anticipated to be present in 2031. The 2031 horizon is not a realistic scenario, and was only included to satisfy Alberta Transportation's TIA requirements for a 20 year horizon. No intersection improvements are recommended for a scenario that is not anticipated to be realised. If additional phases of the gravel operation are added in the future, subsequent TIAs will be required to identify any improvements.

***Page 49, Section 5.5 Lighting Assessment: We note it states that full illumination would be required at the Highway 16/830 intersection. We also note the following statement…"however signalization is warranted'. Please clarify this statement and revise accordingly. i.e. Are they not two separate issues? Also why is the 20-year warrant score (76 points) lower then both the existing score (136 points) and year 1 development score (166 points)?***

According to TAC's Guide for the Design of Roadway Lighting, 2006 Edition, full illumination is always warranted if the intersection is signalized. As noted on page 49 of the TIA, partial lighting is currently provided at the intersection of Highway 16 and Highway 830, and the existing illumination will be sufficient to accommodate 2011 background and total traffic volumes. However, signalization was identified as being warranted based on 2031 background traffic volumes; therefore, full illumination is required if a traffic signal is implemented.

The illumination warrant spreadsheets provided in Appendix F of the TIA assumed the intersection would be signalized by 2031 based on background traffic volumes. However, as we did not ultimately recommend signalization at the Highway 16/Highway 830 intersection, we should have included an illumination warrant analysis assuming the signalization warrant was greater than 80% satisfied. The updated illumination warrant spreadsheets are attached for the 2031 background and total traffic scenarios.

As shown on the attached illumination warrant worksheets, delineation lighting is warranted based on 2031 background and 2031 total traffic volumes. According to TAC's Guide for the Design of Roadway Lighting, delineation lighting refers to "beacon" lighting that marks an intersection location for approaching traffic, for the illumination of vehicles on a cross street or median crossing, or for the illumination of pedestrians. The existing intersection lighting provides illumination for the median crossing as well as for cross street vehicles along Highway 830; therefore, the existing illumination is anticipated to be sufficient to accommodate 2031 background and total traffic volumes.

***With respect to the Highway 830/Twp. Rd 550 intersection the report advised that illumination is not warranted. However we note that the AADT on both roads is entered as zero. Is this an error? Please advise.***

Points are calculated on the basis of either the AADT or the Signalization Warrant Factor. Since signalization warrants analyses were completed in Section 5.3 of the TIA, the Signalization Warrant Factors were used in the warrants for intersection lighting.

A rating factor of zero is inputted when the intersection is not signalized and the volume-based signal warrant is less than 20% satisfied; therefore, the zero value within the lighting warrant spreadsheet is not an error.

***Page 51, Section 6.1, Conclusions:  Please revise the conclusion as noted above.***

***For example the 1st and 4th bullets, do not concur with issues raised in the Capacity Analysis Section where it is indicates certain movements will fail on Highway 830 in 2021 & 2031.***

***The 5th bullet would need to be reviewed in conjunction with a drawing.***

***As well a bullet on illumination is not included.***

***Page 52, Section 6.2, Recommendations:  Similar comments as above.  For example regarding the 1st bullet, there is not drawing included to show what this proposed change would look like.  This would be required if Alberta Transportation is to support the improvement.***

We continue to stand behind the conclusions and recommendations outlined in the October 2011 Josephburg Area Gravel Extraction Operation TIA.

- The Highway 16/Highway 830 intersection in 2021 is not anticipated to fail with v/c ratios less than 1.0.  No improvements are justified; therefore the 1st and 4th bullet of Section 6.1 continues to be appropriate.
- A drawing is attached for review in conjunction with the 5th bullet.
- The existing illumination at the Highway 16/Highway 830 intersection is anticipated to be appropriate for existing and future traffic conditions; however, full illumination will be required if signalization is implemented.

It is anticipated that the above information appropriately responds to your questions and comments.  The conclusions and recommendations provided in the October 21, 2011 Josephburg Area Gravel Extraction Operation TIA continue to be appropriate, and it is not anticipated that an updated TIA is required.

Please contact me at 780-732-5373 or jwillis@bunteng.com if you have any further questions or comments.

C.C. David Yue, Sameng Inc. (via e-mail)

Project No. 3363.01
Location RR 221 & TWP RD 550
Date 16-Jun-11
Weather overcast / rain
Surveyor A.B.

**TWP RD 550 (AM)**

| Street | TWP RD 550 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | Eastbound | | | | | | | | | Westbound | | | | | | | | |
| Movement | Left | | | Thru | | | Right | | | Left | | | Thru | | | Right | | |
| start time | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS |
| 7:00 AM | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| 7:15 AM | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 |
| 7:30 AM | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 |
| 7:45 AM | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 1 | 2 | 0 | 0 | 0 |
| 8:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| 8:15 AM | 0 | 0 | 0 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 2 | 1 | 0 | 0 | 0 |
| 8:30 AM | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 |
| 8:45 AM | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 26 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 3 | 3 | 0 | 0 | 0 |
| EPCU Total | 0 | | | 34 | | | 0 | | | 0 | | | 88 | | | 0 | | |
| Peak hour | 7:30 - 8:30 AM | | | | | | | | | | | | | | | | | |
| Peak Hour Total | **0** | | | **18** | | | **0** | | | **0** | | | **46** | | | **0** | | |
| % HV | **#DIV/0!** | | | **22%** | | | **#DIV/0!** | | | **#DIV/0!** | | | **13%** | | | **#DIV/0!** | | |
| 2 hr multiplier | **1.78** | | | **1.67** | | | **1.78** | | | **1.78** | | | **1.78** | | | **1.78** | | |

**RR 221 (AM)**

| Street | RR 221 | | | | | | | | | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | Northbound | | | | | | | | | Southbound | | | | | | | | | | Hourly Totals |
| Movement | Left | | | Thru | | | Right | | | Left | | | Thru | | | Right | | | | |
| start time | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | | |
| 7:00 AM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |
| 7:15 AM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | |
| 7:30 AM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | |
| 7:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 62 |
| 8:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 51 |
| 8:15 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 65 |
| 8:30 AM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 62 |
| 8:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 54 |
| Total | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 116 | 65 |
| EPCU Total | 3 | | | 0 | | | 1 | | | 0 | | | 0 | | | 0 | | | | |
| Peak hour | | | | | | | | | | | | | | | | | | | | |
| Peak Hour Total | **1** | | | **0** | | | **0** | | | **0** | | | **0** | | | **0** | | | **65** | |
| % HV | **0%** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **15%** | |
| 2 hr multiplier | **3.00** | | | **1.78** | | | **1.78** | | | **1.78** | | | **1.78** | | | **1.78** | | | **1.78** | |

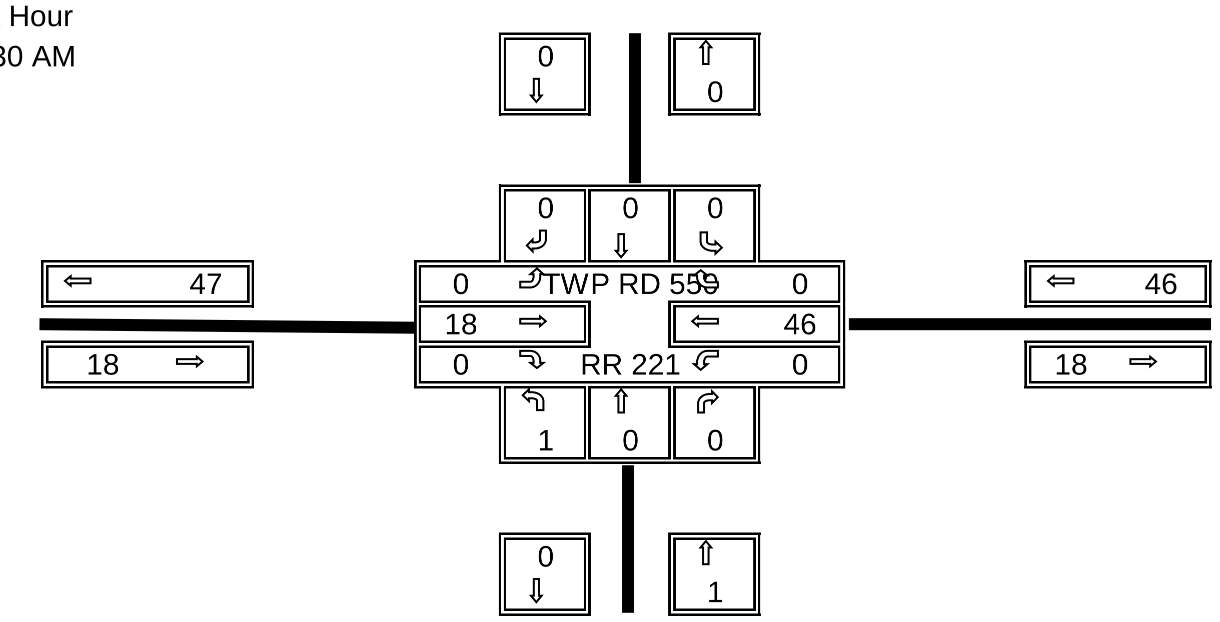
**TWP RD 550 (PM)**

| Street | TWP RD 550 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | Eastbound | | | | | | | | | Westbound | | | | | | | | |
| Movement | Left | | | Thru | | | Right | | | Left | | | Thru | | | Right | | |
| start time | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS |
| 4:00 PM | 0 | 0 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 |
| 4:15 PM | 0 | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| 4:30 PM | 0 | 0 | 0 | 17 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 2 | 0 | 0 | 0 | 0 |
| 4:45 PM | 0 | 0 | 0 | 17 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 0 |
| 5:00 PM | 0 | 0 | 0 | 22 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 5:15 PM | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| 5:30 PM | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| 5:45 PM | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 127 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 57 | 5 | 0 | 0 | 0 | 0 |
| EPCU Total | 0 | | | 141 | | | 1 | | | 0 | | | 67 | | | 0 | | |
| Peak hour | 4:15 - 5:15 PM | | | | | | | | | | | | | | | | | |
| Peak Hour Total | **0** | | | **73** | | | **1** | | | **0** | | | **34** | | | **0** | | |
| % HV | **#DIV/0!** | | | **7%** | | | **0%** | | | **#DIV/0!** | | | **12%** | | | **#DIV/0!** | | |
| 2 hr multiplier | **1.82** | | | **1.84** | | | **1.00** | | | **1.82** | | | **1.82** | | | **1.82** | | |

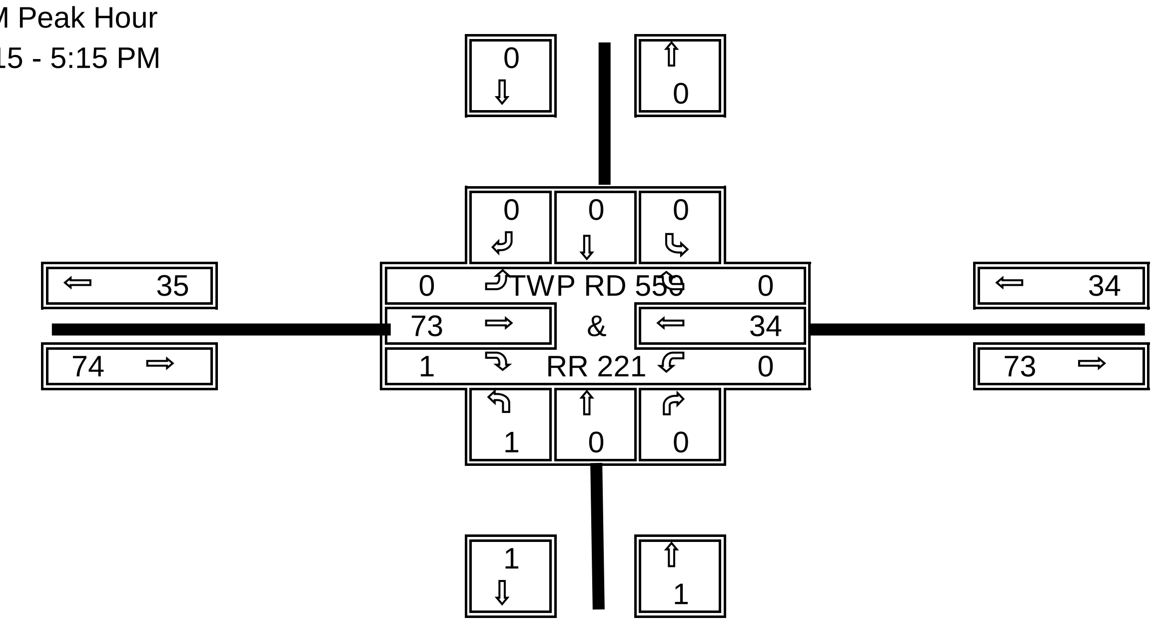
**RR 221 (PM)**

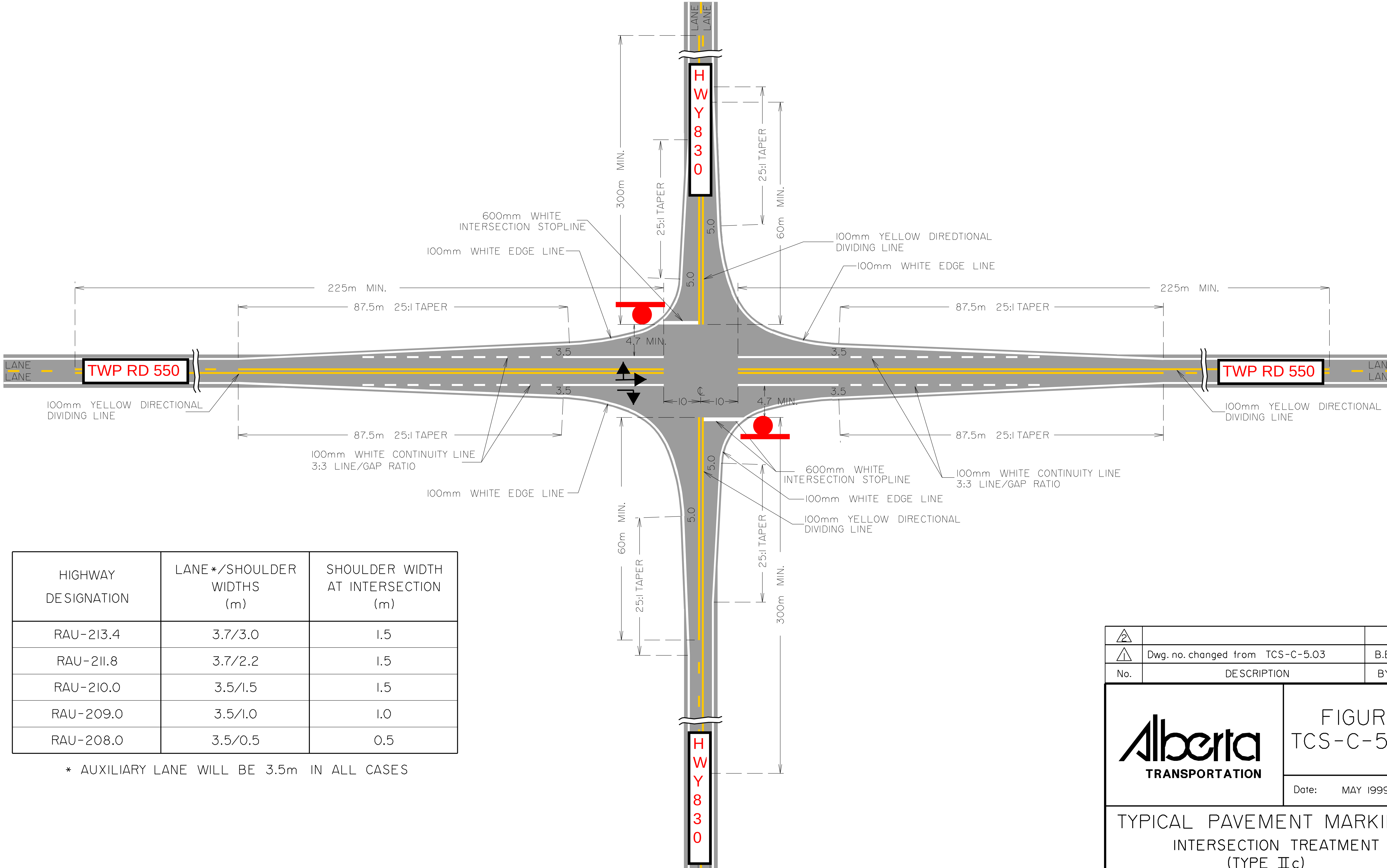
| Street | RR 221 | | | | | | | | | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | Northbound | | | | | | | | | Southbound | | | | | | | | | | Hourly Totals |
| Movement | Left | | | Thru | | | Right | | | Left | | | Thru | | | Right | | | | |
| start time | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | Car | HV | YBUS | | |
| 4:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | |
| 4:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | |
| 4:30 PM | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | |
| 4:45 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 103 |
| 5:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 109 |
| 5:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 107 |
| 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 99 |
| 5:45 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 95 |
| Total | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 198 | 109 |
| EPCU Total | 1 | | | 0 | | | 0 | | | 0 | | | 0 | | | 0 | | | | |
| Peak hour | | | | | | | | | | | | | | | | | | | | |
| Peak Hour Total | **1** | | | **0** | | | **0** | | | **0** | | | **0** | | | **0** | | | **109** | |
| % HV | **0%** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **#DIV/0!** | | | **8%** | |
| 2 hr multiplier | **1.00** | | | **1.82** | | | **1.82** | | | **1.82** | | | **1.82** | | | **1.82** | | | 1.82 | |

AM Peak Hour
7:30 - 8:30 AM




PM Peak Hour
4:15 - 5:15 PM






| HIGHWAY DESIGNATION | LANE*/SHOULDER WIDTHS (m) | SHOULDER WIDTH AT INTERSECTION (m) |
|---|---|---|
| RAU-213.4 | 3.7/3.0 | 1.5 |
| RAU-211.8 | 3.7/2.2 | 1.5 |
| RAU-210.0 | 3.5/1.5 | 1.5 |
| RAU-209.0 | 3.5/1.0 | 1.0 |
| RAU-208.0 | 3.5/0.5 | 0.5 |

* AUXILIARY LANE WILL BE 3.5m IN ALL CASES

| No. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| 2 | | | |
| 1 | Dwg. no. changed from TCS-C-5.03 | B.B. | Mar/03 |

Alberta TRANSPORTATION

FIGURE TCS-C-501.4

Date: MAY 1999

# TYPICAL PAVEMENT MARKINGS
## INTERSECTION TREATMENT (TYPE IIc) (TWO-LANE HIGHWAY)

Prepared By: P.G. | Checked By: S.J.M. | Scale: N.T.S. | Section C5

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING
## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

| INTERSECTION CHARACTERISTICS | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | May 23, 2012 |
| Highway 830 | Minor Road | **Other** | 2031 Background |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 4 | 30 | | OK | 120 |
| | | | | | OK | |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **175** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | OK | |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**ILLUMINATION WARRANTED**
**DELINEATION LIGHTING TO ILLUMINATE PEDESTRIANS OR CROSS STREET TRAFFIC**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 175 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **196** |

# GUIDE FOR THE DESIGN OF ROADWAY LIGHTING
## LIGHTING WARRANT SPREADSHEET

**This spreadsheet is to be used in conjunction with *Guide for the Design of Roadway Lighting*, Transportation Association of Canada, 2006 Edition.**

**Please enter information in the cells with yellow background**

**INTERSECTION CHARACTERISTICS**

| | | | |
|---|---|---|---|
| Highway 16 | Main Road | **Date** | May 23, 2012 |
| Highway 830 | Minor Road | **Other** | 2031 Total |
| Strathcona County | City/Town | | |

## GEOMETRIC FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Channelization Rating | Descriptive | 3 | | Refer to Table 1(A) to determine rating value | OK | |
| Presence of raised channelization? ( Y / N ) | n | | | | OK | |
| Highest operating speed on raised, channelized approach (km/h) | | | 5 | | OK | |
| Channelization Factor | | | | | OK | 15 |
| Approach Sight Distance on most constrained approach (%) | 100 | 0 | 10 | Relative to the recommended minimum sight distance | OK | 0 |
| Posted Speed limit (in 10's of km/h) | 110 | | | | OK | |
| Radius of Horizontal Curve (m) | T | | | Enter "T" for tangent (no horizontal curve at the intersection) | OK | |
| Posted Speed Category = | A | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Posted Speed Category = | | 0 | | | | |
| Horizontal Curvature Factor | | 0 | 5 | | OK | 0 |
| Angle of Intersection (10's of Degrees) | 90 | 0 | 5 | | OK | 0 |
| Downhill Approach Grade (x.x%) | 0.0 | 0 | 3 | Rounded to nearest tenth of a percent | OK | 0 |
| Number of Intersection Legs | 4 | 2 | 3 | Number of legs = 3 or more | OK | 6 |
| | | | | | **Geometric Factors Subtotal** | **21** |

## OPERATIONAL FACTORS

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Is the intersection signalized ? ( Y/ N ) | n | | | Calculate the Signalization Warrant Factor | | |
| AADT on Major Road (2-way) | 0 | 0 | 10 | Either Use the two AADT inputs **OR** the Descriptive Signalization Warrant (Unused values should be set to Zero) Refer to Table 1(B) for description and rating values for signalization warrant. | OK | 0 |
| AADT on Minor Road (2-way) | 0 | 0 | 20 | | OK | 0 |
| Signalization Warrant | Descriptive | 4 | 30 | | OK | 120 |
| | | | | | | OK |
| Night-Time Hourly Pedestrian Volume | 0 | 0 | 10 | Refer to Table 1(B), note #2, to account for children and seniors | OK | 0 |
| Intersecting Roadway Classification | Descriptive | 4 | 5 | Refer to Table 1(B) for ratings. | OK | 20 |
| Operating Speed or Posted Speed on Major Road (km/h) | 110 | 4 | 5 | Refer to Table 1(B), note #3 | OK | 20 |
| Operating Speed on Minor Road (km/h) | 80 | 3 | 5 | Refer to Table 1(B), note #3 | OK | 15 |
| | | | | | **Operational Factors Subtotal** | **175** |

## ENVIRONMENTAL FACTOR

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Lighted Developments within 150 m radius of intersection | 0 | 0 | 5 | Maximum of 4 quadrants | OK | 0 |
| | | | | | **Environmental Factor Subtotal** | **0** |

## COLLISION HISTORY

| | Value | Rating | Weight | Comments | Check | Score |
|---|---|---|---|---|---|---|
| Average Annual night-time collision frequency due to inadequate lighting (collisions/yr, rounded to nearest whole # ) | | 0 | 0 | Enter **either** the annual frequency (See Table 1(C), note #4) | OK | 0 |
| **OR** | | | | **OR** the number of collisions / MEV | | |
| Collision Rate over last 3 years, due to inadequate lighting (/MEV) | | 0 | 0 | (Unused values should be set to Zero) | OK | 0 |
| Is the average ratio of **all** night to day collisions >= 1.5 (Y/N) | | 0 | | | Use Y or N | |
| | | | | | | OK |
| | | | | | **Collision History Subtotal** | **Check Entry** |

**Check Intersection Signalization:**
**Intersection is not Signalized**

**ILLUMINATION WARRANTED**
**DELINEATION LIGHTING TO ILLUMINATE PEDESTRIANS OR CROSS STREET TRAFFIC**

| SUMMARY | |
|---|---|
| Geometric Factors Subtotal | 21 |
| Operational Factor Subtotal | 175 |
| Environmental Factor Subtotal | 0 |
| Collision History Subtotal | Check Entry |
| **TOTAL POINTS** | **196** |

March 4, 2015
3363.02

Jordan Hoffart, P.Eng.
Sameng Inc.
1500 Baker Centre
10025 – 106 Street
Edmonton, AB T5J 1G3

Dear Mr. Hoffart:

**Re: Josephburg Area Gravel Extraction Operation**
**Background Traffic Review**

# INTRODUCTION

## Background

A Traffic Impact Assessment (TIA) for the Josephburg Area Gravel Extraction Operation was completed in October 2011 (2011 TIA) by Bunt & Associates. The study evaluated the traffic characteristics associated with the first phase of the proposed gravel extraction operation beginning in late 2011/early 2012. Therefore, the TIA included a 2011 horizon corresponding to the start date for the project, a 2021 horizon corresponding to the 10 year life span of the project, and a 2031 horizon to ensure that any improvements identified were appropriate for 20 years, or the expected life of the improvements, as per Alberta Transportation's requirements.

## Study Purpose

Four years has passed since the completion of the 2011 TIA, and as of January 2015, pit development for the Josephburg area gravel extraction operation has yet to begin. Strathcona County recently raised concerns that the potential increase in background traffic volumes between 2011 and 2015 could change the roadway improvements required to support the gravel extraction operation. Bunt & Associates was retained to determine if the change in background traffic volumes are significant enough to warrant additional roadway upgrades.

### Study Methodology

It is assumed that the gravel operation characteristics outlined in the 2011 TIA remain unchanged and that the site generated traffic volumes are still appropriate; therefore, the only change to total traffic volumes will be as a result of increased background traffic. To determine if the change in background traffic volumes are significant enough to warrant additional roadway upgrades, 2021 background traffic volumes used in the completion of the 2011 TIA will be compared to 2025 background traffic estimates. Where significant volume increases are identified, a high level review of improvement warrants will be completed to determine if additional improvements are anticipated to be required.

## BACKGROUND TRAFFIC VOLUMES

### 2021 Background Traffic Volumes

**Exhibits 1** and **2** illustrate the 2021 AM and PM peak hour background traffic volumes and 2021 daily background traffic volumes used within the 2011 TIA.

Based on a review of historical growth rates provided by Alberta Transportation for the 2011 TIA, the long term linear traffic growth rate as a percentage of 2010 AADT is 1.921% along Highway 830 and 1.870% along Highway 16. The 10 year linear traffic growth rate as a percentage of 2010 AADT is 2.288% along Highway 830 and 3.117% along Highway 16.

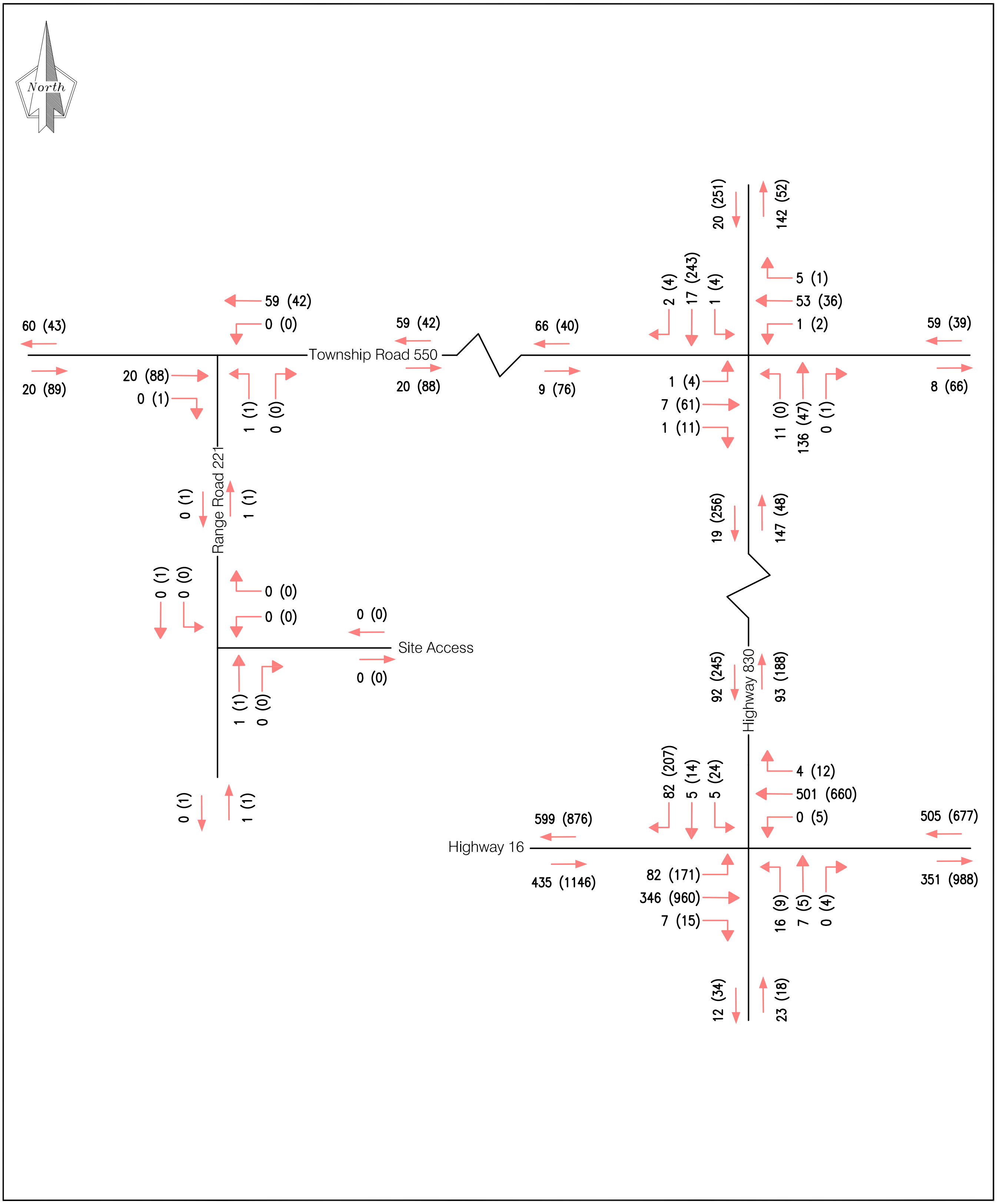
### 2025 Background Traffic Volumes

Since completion of the 2011 TIA, more current information has become available regarding historical growth rates along Highway 16 and Highway 830. Based on a review of Alberta Transportation's historical 2013 AADT traffic volumes, the long term growth rate has decreased since 2010, while the 10 year linear growth rate has increased. In addition, a new traffic count was completed by Alberta Transportation in April 2014 at the Highway 16/Highway 830 intersection.

Based on a review of Alberta Transportation's historical AADT traffic volumes, the long term linear growth rate as a percentage of 2013 AADT is 1.835% along Highway 830 and 1.774% along Highway 16. The 10 year linear growth rate as a percentage of 2013 AADT is 2.742% along Highway 830 and 3.274% along Highway 16. The provincial average for linear highway growth is 2.0% per year.

The 2014 traffic volumes at the Highway 16/Highway 830 intersection were used to determine 2025 background traffic volume estimates as opposed to the 2009 traffic volumes used in the completion of the 2011 TIA. Updated traffic counts were not completed at the Township Road 550/Highway 830 intersection; therefore, 2009 volumes used in the completion of the 2011 TIA were also used to determine 2025 background traffic volumes.

P:\3363.02 - Josephburg Gravel Bkdg Traffic Review\CAD\Exhibit 1.dwg

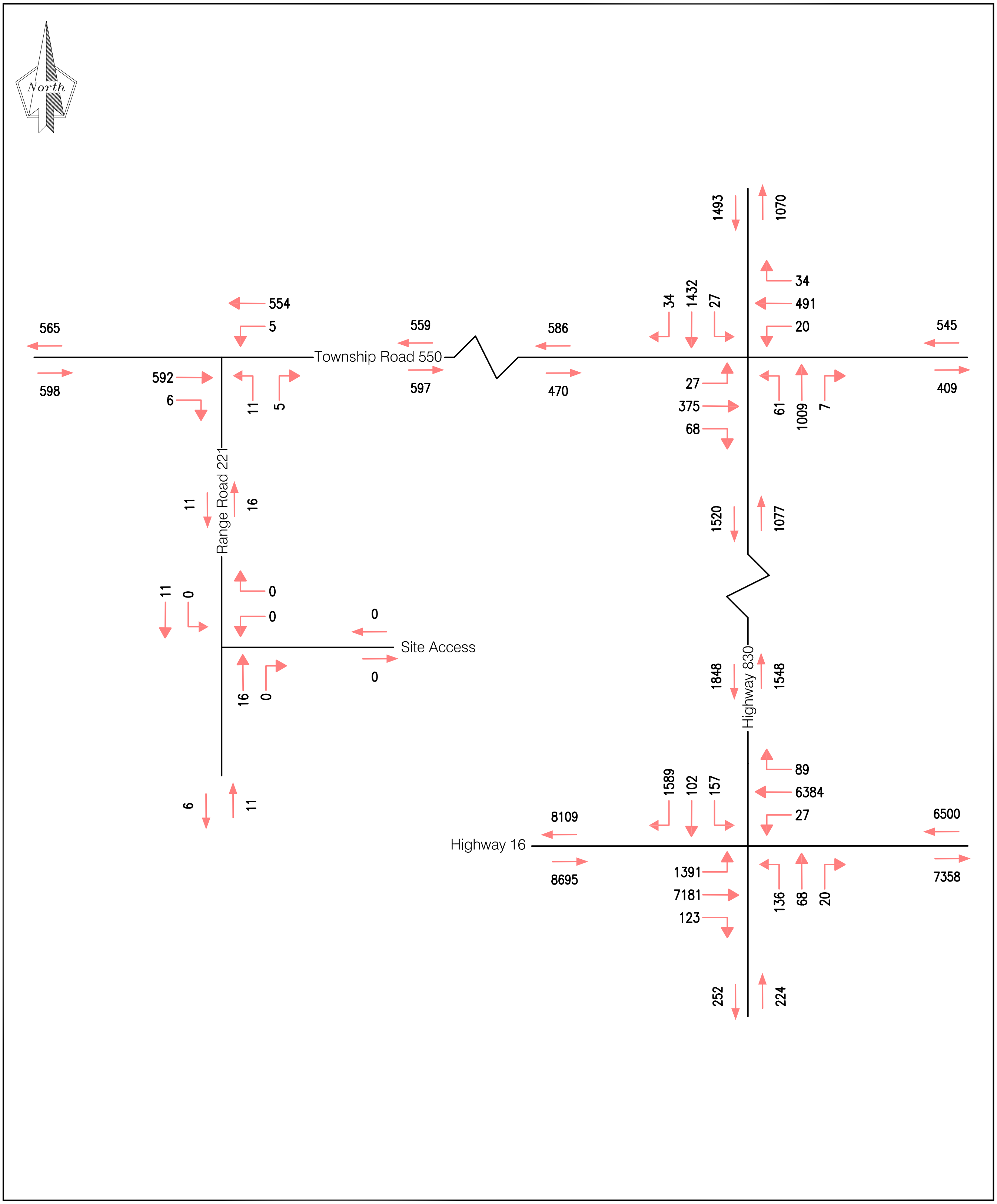



Source:

**Exhibit 1**

N.T.S.

# 2021 Background Traffic Volumes AM (PM) Peak Hour




Source:

**Exhibit 2**

N.T.S.

# 2021 Daily Background Traffic Volumes

To provide a conservative estimate of 2025 background traffic growth at the intersection of Highway 16 and Highway 830, the existing (2014) volumes along Highway 16 were increased by 3.274% for 11 years while the volumes along Highway 830 were increased by 2.742% for 11 years. To be conservative, the existing (2009) volumes at the Township Road 550/Highway 830 intersection were increased by 2.742% per year for 16 years to obtain background traffic volumes for the 2025 horizon.

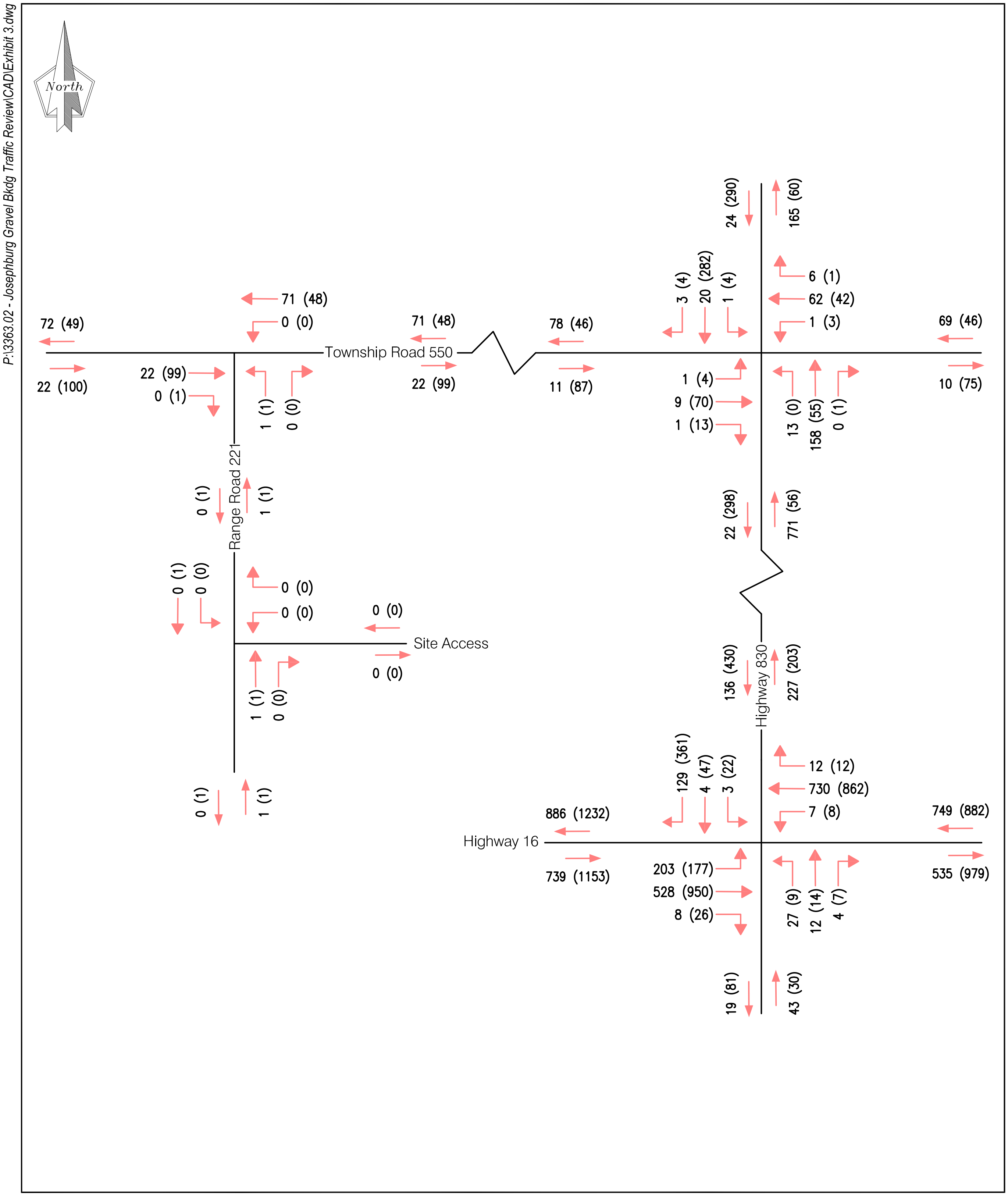
Growth generated at the intersection of Township Road 550 and Highway 830 was carried westbound along Township Road 550 and applied to the east and west through volumes at the Township Road 550/Range Road 221 intersection. No growth was applied to north and south volumes along Range Road 221 as the majority of growth along Range Road 221 is anticipated to be limited to the proposed gravel extraction operation.

**Exhibits 3** and **4**, illustrate the resulting 2025 background traffic volumes for the AM/PM and daily time periods respectively.

## Background Traffic Volume Comparison

The 2021 background traffic volumes were subtracted from the 2025 background traffic volumes to determine the change in background traffic volume estimates since completion of the 2011 TIA. **Exhibits 5** and **6** illustrate the difference in traffic volumes for the AM/PM and Daily time periods respectively.

As shown in Exhibits 5 and 6, the most significant change in background traffic volumes is at the Highway 16/Highway 830 intersection due to the higher traffic volumes measured during the 2014 traffic count completed by Alberta Transportation.



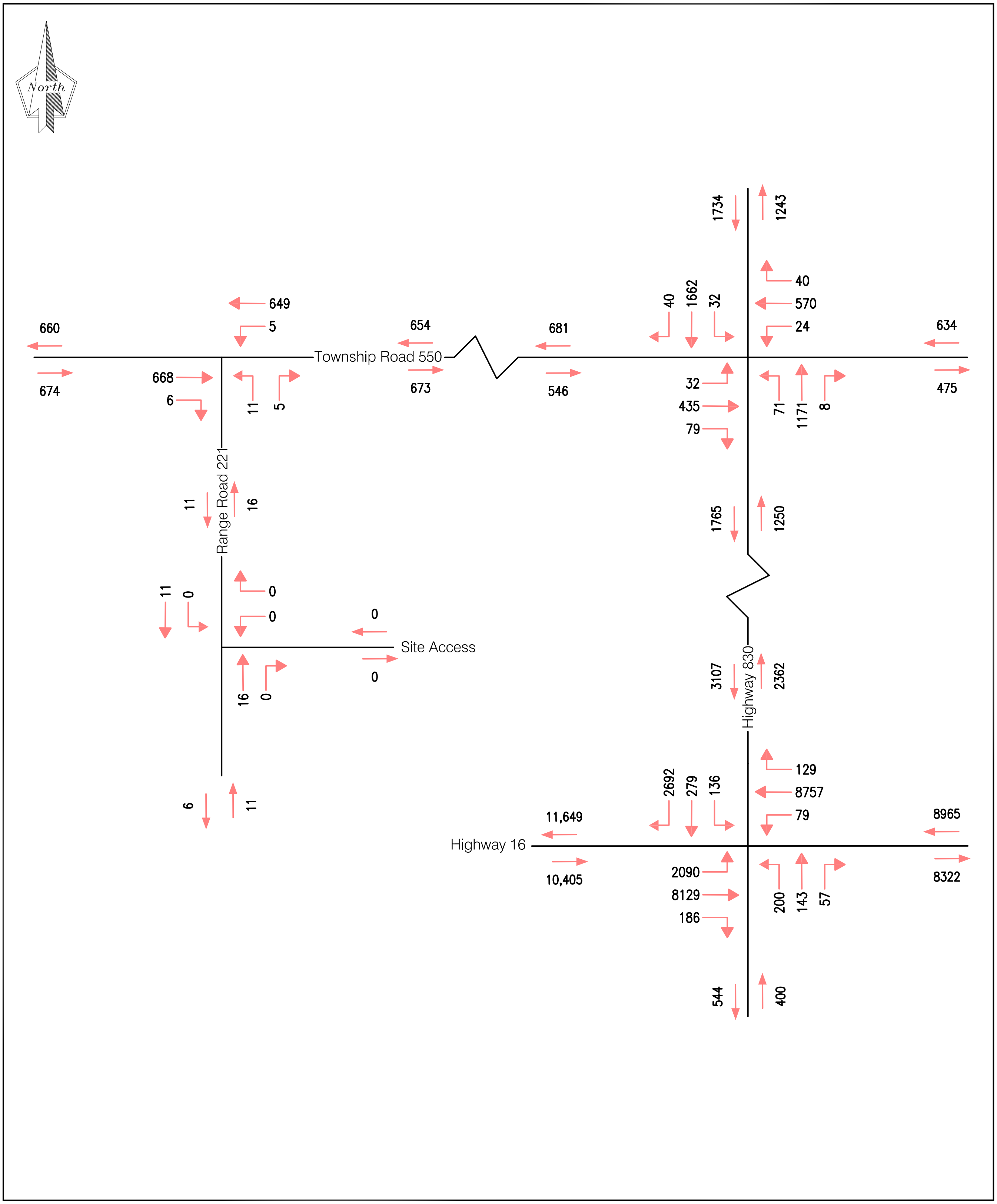

Source:

**Exhibit 3**

N.T.S.

# 2025 Background Traffic Volumes
# AM (PM) Peak Hour

Josephburg Area Gravel Extraction Operation
bunt & associates | Project No. 3366.02

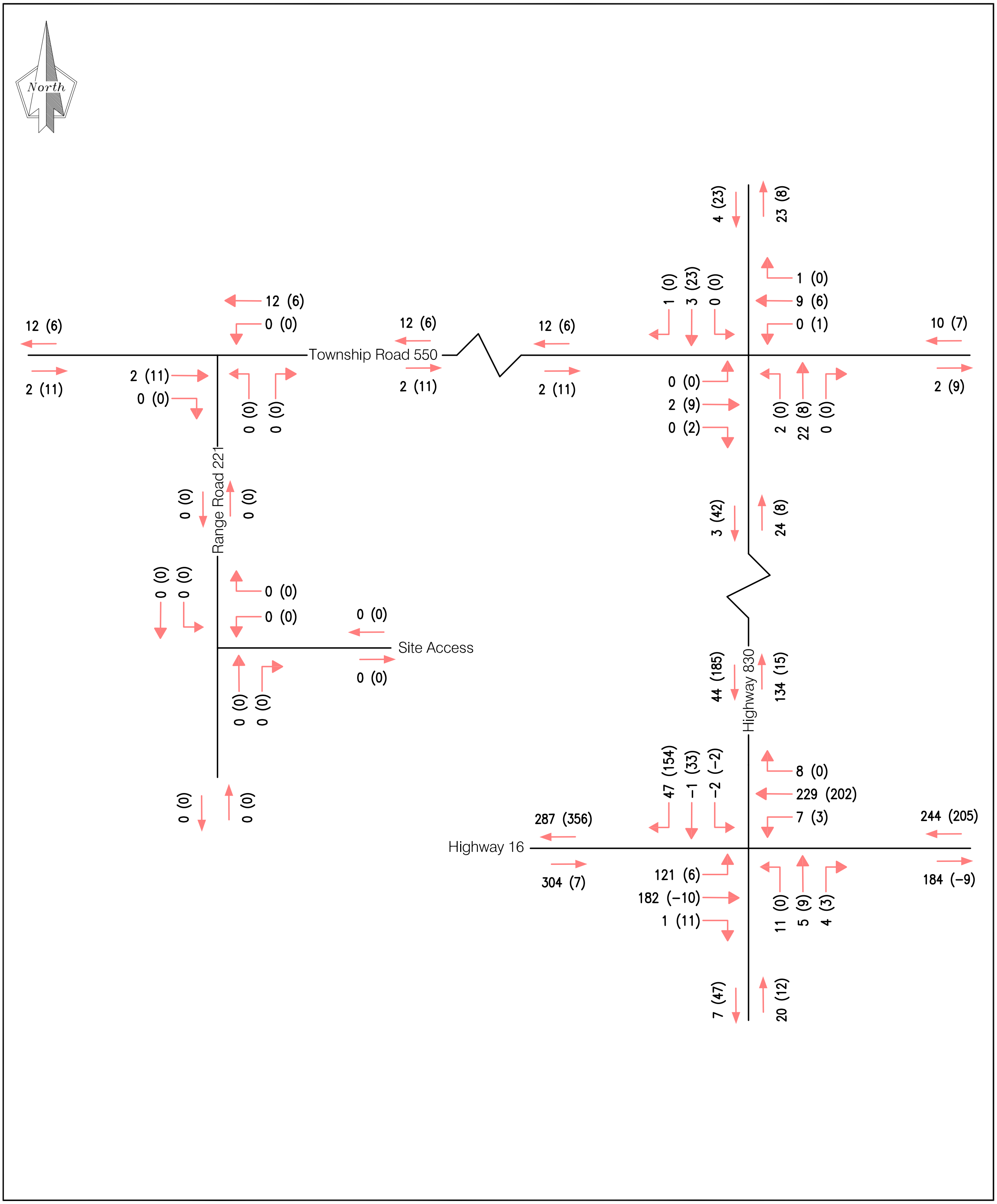



Source:

**Exhibit 4**

N.T.S.

# 2025 Daily Background Traffic Volumes



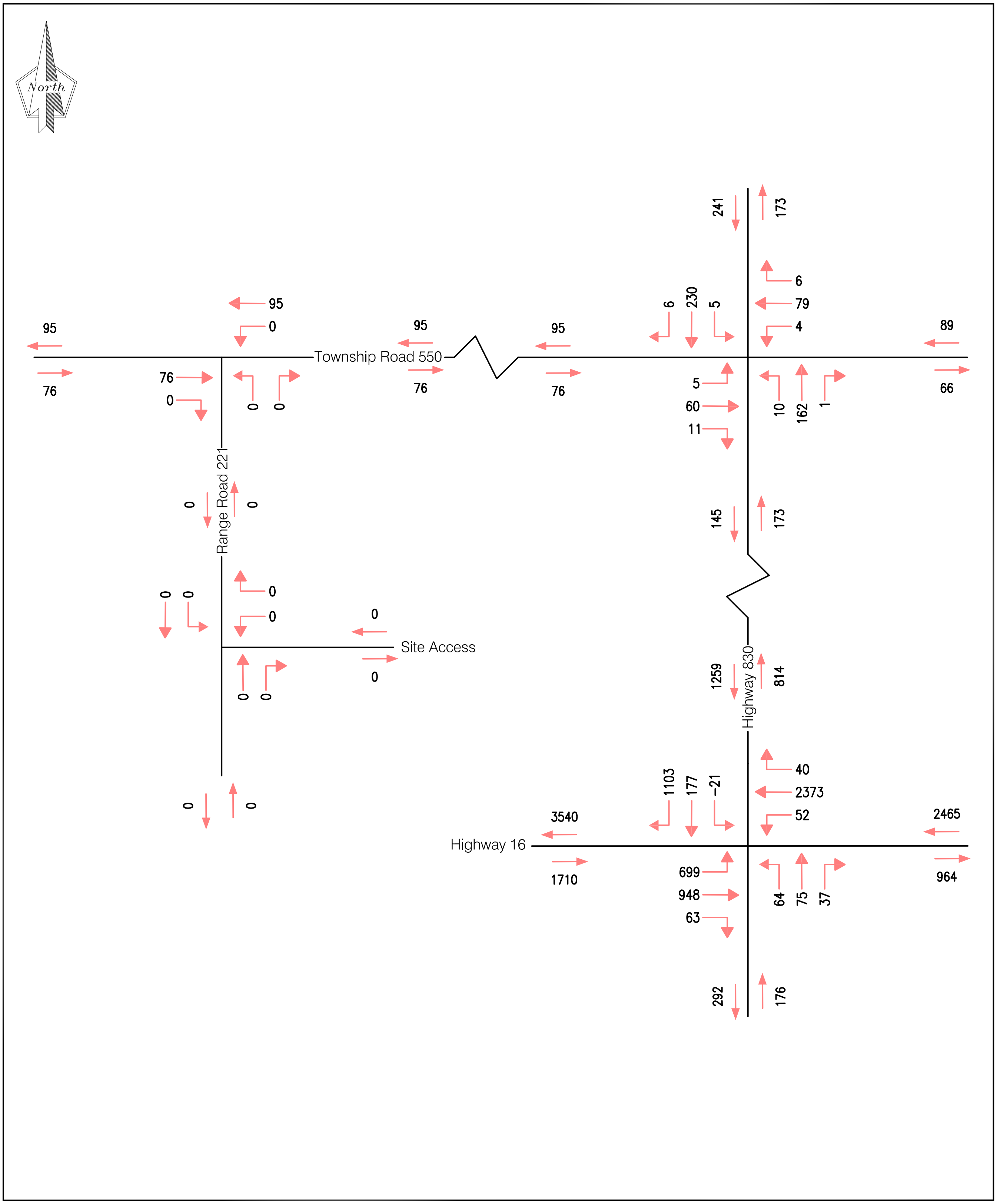

Source:

**Exhibit 5**

N.T.S.

# Difference Between 2025 & 2021 Background Traffic Volumes - AM (PM) Peak Hour

Josephburg Area Gravel Extraction Operation
bunt & associates | Project No. 3366.02




Source:

**Exhibit 6**

N.T.S.

# Difference Between 2025 & 2021 Daily Background Traffic Volumes

## TRANSPORTATION ASSESSMENT

The projected increase in traffic volumes at the Township Road 550/Highway 830 and Township Road 550/Range Road 221 are not anticipated to be significant enough to warrant additional improvements over and above the improvements recommended in the 2011 TIA.

However, as the background traffic volumes have significantly increased at the Highway 16/Highway 830 intersection since completion of the 2011 TIA, a high level review of warrants was completed using 2025 total traffic volumes. The difference in background traffic volumes from Exhibits 4 and 5 were added to the 2021 total traffic volumes from the 2011 TIA to generate 2025 total traffic volume for use in this assessment. The following is a summary of the results based on the analysis completed at the Highway 16/Highway 830 intersection based on 2025 total traffic volumes:

- Eastbound left turn lane with 85 m storage required
- No westbound left turn lane required
- No eastbound or westbound right turn bays warranted
- Traffic signalization warranted
- Partial lighting for unsignalized intersection, full lighting for signalized intersection

The results noted above are consistent with the results of the 2011 TIA; however, signalization of the Highway 16/Highway 830 intersection was not warranted within the 2021 horizon. However, Highway 16 is a controlled access freeway facility and traffic signals are not anticipated to be an acceptable mitigation measure.

Alberta Transportation's Design Bulletin #68/2010, Roundabout Design Guidelines on Provincial Highways, states that roundabouts shall be considered as the first option for intersection designs, where, in the exclusive judgement of the department, a greater degree of traffic control other than a two-way stop is required on a paved roadway. However, existing freeways are considered locations where Alberta Transportation would not wish to use roundabout. Therefore, a roundabout was not considered at the intersection of Highway 16 and Highway 830.

In addition, a Highway 16 Access Management study is currently underway for a portion of Highway 16 including the intersection with Highway 830. Based on the functional plan and staging plan presented at the second and final open house on November 14, 2013, the existing Highway 16/Highway 830 intersection will be closed, Highway 830 will be realigned to the east and a new interchange will be constructed at Highway 16 and the newly aligned Highway 830.

Intersection improvements are identified on the Stage 1 plan of the Highway 16 Access Management study. Although the extents of the improvements are not currently known, it is anticipated that the Highway 16/Highway 830 intersection will remain an unsignalized intersection until such time that a new interchange is constructed east of the existing intersection.

## CONCLUSION

The additional background traffic generated since 2011 is not anticipated to significantly change the results of the 2011 TIA; therefore, the conclusions and recommendations from the 2011 TIA continue to be appropriate.

It is anticipated that the above assessment clearly highlights the anticipated change in background traffic, and illustrates that the projected increase in traffic can be appropriately accommodated on the roadway network recommended in the 2011 TIA.  If you have any questions or comments, please contact the undersigned at 780-732-5373.

Yours truly,
**Bunt & Associates**

Janelle Willis, P. Eng.
Transportation Engineer

# Appendix K

Soil Importation Management Plan

**Purpose:** To ensure Joburg Aggregates Ltd. (Joburg) minimizes the risk that Joburg will be jointly and severally liable for the clean-up of the Joburg Pit (the "**Site**") resulting from the acceptance of fill other than Clean Fill for the use of reclamation material.

**Scope:** This procedure applies to the Site. Awareness and training of this policy will be provided to all employees and contractors at the Site and to customers delivering fill.

**Definitions:**

- "**Acceptable Fill**" means fill that meets all of the following requirements:
  - Results indicating substance concentrations within the material meet *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (AEP, 2016) as amended*;*
  - does not contain chemical or radiological substances from human activities;
  - tests negatively for club root;
  - has not originated or been mixed with any soil, from soil treatment or remediation activities, raw sewage, dry cleaning sites or other cleaning activities, or any other locations with high potential of contamination; and,
  - does not include the constituents or qualities listed in Table 1- Unacceptable Soils include in Schedule 'A;;
  - meets the definition of Clean Fill.
- "**Affiliated Company**" means a company that is related to Joburg Aggregates Ltd. through share structure and/or ownership.
- "**Clean Fill**" means fill with substance concentrations less than those defined under the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (AEP, 2016) and contains no club root spores;
- **"Club Root Testing"** means the completion of a test by an accredited laboratory identifying the presence or absence of club root spores. Required when a source location is, or has been, used for agriculture production in the last 10 years.
- **"Customer**" means either an affiliated company or third-party company that will be import material to the site.
- ***"*Greenfield Site**" means an area of agriculture or forest land, or some other site which has not been previously developed or polluted as confirmed by a Phase I ESA.
- "**Petroflag Test**" means a field portable method for the determination of total petroleum hydrocarbons in soil that does not distinguish between aromatic and aliphatic hydrocarbons, but quantifies all fuels, oils, and greases as total hydrocarbons. Analysis of a 10 gram soil sample is performed using three simple steps: extraction, filtration, and analysis. Petroflag analysis method detection limit is 15ppm, with a 10% +/- MDL.
- **"Environmental Site Assessment (ESA)"** means an investigation in relation to the land to determine the environmental condition of a property.
- "**Phase I ESA**" means a report carried out in accordance with the *Alberta Environmental Site Assessment Standard* (AEP, 2016) or the Phase I Environmental Assessment Guideline for Upstream Oil and Gas Sites, as amended (AENV, 2001b). Required for all non-greenfield sites.
- **"Phase 2 ESA"** means a report carried out in accordance with the *Alberta Environmental Site Assessment Standard* (AEP, 2016) or the Phase 2 Environmental Site Assessment Checklist (ESRD, 2013). Required for all non-greenfield sites when recommended by the Phase 1.

- "**Site Specific Fill Declaration**" means a declaration by Customer, among other thing, agreeing and acknowledging that the fill meets the definition of Clean Fill.
- "**Soil Characterization Report"** means a report outlining sampling methodology and laboratory physical and chemical characterization results. Required for Greenfield Sites.
- "**Third Party Company"** means a company or entity that is unrelated to Joburg Aggregates Ltd. through share structure and/or ownership and is completely independent of Joburg Aggregates Ltd.

**General Requirements:**

In order to provide Joburg with sufficient assurance that fill to be deposited at the Site meets the definition of Acceptable Fill, the following process and due diligence sampling must be followed:

1. Each Customer must be educated about the Imported Fill Material Management Policy and the Site-Specific Fill Declaration.

2. Each Customer must sign a Site-Specific Fill Declaration for each source site where the fill originated. Source sites composed of multiple parcels of adjoining land require one Site Specific Fill Declaration.

3. Each Customer must provide a copy of the Phase I ESA, the Phase 2 ESA (when recommended by the Phase 1) and/or Soil Characterization Report with soil analytical results from an accredited laboratory from the source site where the fill originated in order for Joburg to determine whether the fill qualifies as Acceptable Fill. Documentation must be submitted to Joburg review and be representative of the fill within 6 months of the anticipated delivery date.

4. Joburg, or its designate, will conduct QA/QC Sampling of the fill.

**Fill Acceptance Process and QA/QC Measures:**

1. Joburg Area Environment Manager:
    a. Review the supporting documentation to determine whether the fill from the source site qualifies as Clean Fill and confirm determination to Pit Management.

2. On Site Management:
    a. Confirm the customer has completed and executed a Site-Specific Fill Declaration and provided the necessary reporting required for each source site and that the Area Environment Manager has approved each source site.
    b. Arrange delivery with the customer after the Area Environment Manager has confirmed the fill is acceptable.
    c. Record the following for each load of fill delivered:
        i. Date,
        ii. customer name,
        iii. site source name,
        iv. vehicle license or truck identification number,
        v. weight of load/quantity of fill,
        vi. type of fill and
        vii. location of load placement.
    d. Conduct:

   i. Petroflag test on one sample load per 1,000 $m^3$ of the incoming loads originating from each source site and record and document the Petroflag results, from Third Party Companies.
   ii. Visual inspection on all incoming loads.
 e. Reject loads that do not pass Petroflag, visual inspection for reasons noted below.

3. Monitoring Requirements
   a. Review the Soil Characterization Report and visually inspect all incoming loads of fill for any unacceptable soils as defined in Table 1.
   b. Conduct a Petroflag tests, when required.
   c. Conduct due diligence sampling on Third Party Company incoming loads at a rate of once per approximately 1,000 $m^3$ for the following parameters:
      i. Hydrocarbons
      ii. Volatile and Semi Volatile Organic Compounds (VOC)
      iii. Semi Volatile Organic Compounds (sVOC) including Polycyclic Aromatic Hydrocarbons (PAH)
      iv. Polychlorinated Biphenyls (PCB)
      v. Total Metals (including arsenic and inorganic mercury)
      vi. pH
      vii. Pesticides (oranochlorides)
   d. Joburg will collect a composite sample from the backfill area and analyze for the parameters listed above for the due diligence sampling, prior to covering with fill or upon completion of the delivery.
   e. Annual groundwater quality monitoring prior to and after fill material is used for reclamation, until reclamation certification.

4. Load Rejection
   a. Reject loads if Source Specific Fill Declaration Form is not on file.
   b. Reject loads if the Environment Manager has not confirmed material has been verified as Acceptable Fill.
   c. Reject loads if they do not pass the visual or Petroflag test on during delivery.
   d. Any fill that has been placed on site but is later shown to not meet the criteria of Acceptable Fill via on site sampling will be rejected and must be picked up by the customer with 48 hours of being notified that material has failed testing.

**Record Keeping and Documentation:**

All records, test results, declarations, supporting documentation and other relevant information will be retained on site for the duration of the operation of the fill acceptance program. All documentation will be scanned at the time of receipt and retained electronically by Pit Management and the Environment Manager. Once the fill acceptance program is complete and fill is no longer being received, records may be removed from site but must be archived and retained indefinitely.

**Forms and Templates:**
- Site Specific Fill Declaration

**Records:**
- Site Specific Fill Declarations
- Phase 1 ESA and Phase 2 ESA
- Soil Characterization Reports (or similar)
- Analytical and Club Root Analyses

**References:**


- Alberta Environment. 2001. Phase 1 Environmental Site Assessment Guideline for Upstream Oil and Gas Sites. Alberta Environment, Edmonton, Alberta. Report # ESD/LM/01-1. ISBN: 0- 7785-1421-8 (Printed Edition), 0-7785-1422-6 (On-line Version), Publication No: T/573. 16 pp. https://open.alberta.ca/dataset/ad267908-bdf4-4c97-ad9f-760a547e4245/resource/78d43883-0334-4220-a037-2746648390a1/download/6821.pdf
- Alberta Environment and Parks (AEP), 2016. Alberta Environnemental Site Assessment Standard. https://open.alberta.ca/dataset/3acc7cff-8c50-44e8-8a33-f4b710d9859a/resource/579321b7-5b66-4022-9796-31b1ad094635/download/environmentsiteassessstandard-mar01-2016.pdf
- Alberta Environment and Parks (AEP), 2016. Alberta Tier 1 Soils and Groundwater Remediation Guidelines. Land Policy Branch, Policy and Planning Division. 197 pp. https://open.alberta.ca/dataset/842becf6-dc0c-4cc7-8b29-e3f383133ddc/resource/1b851705-0622-485d-beee-752a627bdfc4/download/2016-albertatier1guidelines-feb02-2016a.pdf+
- Alberta Environment and Sustainable Resource Development (ESRD), May 2013. Phase 2 Environmental Site Assessment Checklist.


**Attachments:**

- Site Specific Fill Declaration

## Schedule "A"
## Table 1

*Table 1*

| UNACCEPTABLE SOILS | |
|---|---|
| **Organic Soil** | Peat |
| **Soils Containing** | Construction, demolition, land-clearing waste |
| | Asphalt |
| | Tires, rubber, or plastic materials |
| | Garbage, or man-made materials |
| | Sludge |
| | Compost |
| | Wood waste |
| | Hydrovac Material |

**SITE SPECIFIC FILL DECLARATION**
This declaration is required to deposit fill at the Joburg Pit.

JOBURG Aggregates Ltd.

**CUSTOMER INFORMATION**

Customer:____________________ Contact Name:____________________
Address:____________________ Contact Title:____________________
____________________ Email Address:____________________
____________________ Phone No: ____________________
Trucking Sub-Contractor:

**SOURCE SITE INFORMATION**

Site Address:____________________
Current Use of Site:____________________
Landowner Information:____________________
Email Address:____________________
Contact Phone No:____________________

**CHARACTERIZATION REQUIREMENTS**

| **Source Site** | ☐ Greenfield | ☐ Residential | ☐ Previously Developed |
|---|---|---|---|

1. Has the site been used for agriculture in the past 10 years?
   ☐ Yes – Results of Clubroot Testing: ____________________
   ☐ No

2. Type of material being imported:
   ☐ Topsoil
   ☐ Subsoil
   ☐ Overburden/Clay

3. Has a Phase 1 ESA or Soil Characterization Report been submitted by the customer?
   ☐ Yes – if other, describe: ____________________
   ☐ No – fill cannot be accepted until information has been received.

4. Are there any known or suspected contaminants of concern?
   ☐ Yes – Describe: ____________________
   ☐ No

5. Are there any notable odors, distinct stains, or visible debris?
   ☐ Yes – Describe: ____________________
   ☐ No

6. Estimated Volume: ____________________

**DECLARATION**

The Customer hereby acknowledges an agrees as follows:

1. The Customer has received and reviewed a copy of the Imported Fill Material Management Policy.
2. All fill delivered to the Joburg Pit meets the requirements of Acceptable Fill as defined in the Imported Fill Material Management Policy and any applicable federal, provincial or local environmental laws.
3. The Customer agrees to defend, indemnify and hold Joburg Aggregates Ltd. harmless from and against any and all claims, demands, causes of action, damages, losses (including consequential losses or damages), liabilities, penalties, fines, fees and expenses (including reasonable attorneys' fees and expenses and the costs of investigation), caused by or resulting from the Customer's breach of this declaration.
4. Joburg may require the Customer to inspect or sample the fill at Customer's sole cost.
5. Joburg reserves the right to inspect and sample fill and the Customer acknowledges that such inspection or sampling as well as Joburg's decision to accept fill based on the information shall not reduce, restrict or otherwise limit the Customer's liability for such fill.
6. Joburg may reject any fill that it determines, in its sole discretion, does not meet the requirements of acceptable fill. In such event Joburg shall notify the Customer that it must remove such fill within 24 hours at its sole cost and risk. In the event the Customer fails to do so Joburg may remove and dispose of such fill in accordance with all applicable laws and the Customer shall reimburse Joburg for the costs thereof within 15 days of the delivery of an invoice.

Date: ___________________

Customer Name: ____________________________________

By: _______________________________________________
I have authority to bind the Customer

Title: _____________________________________________

**SITE APPROVAL (to be completed by Joburg following receipt of signed Declaration)**

Results of the soil characterization report review by Environment Manager/Onsite Manager:

☐ Approved – fill meets the definition of acceptable fill as defined in the Imported Fill Material Management Policy, is accepted, and can be placed in a backfill area (location to be documented) following completing the site due diligence visual, odor and PetroFlag assessment (when required).

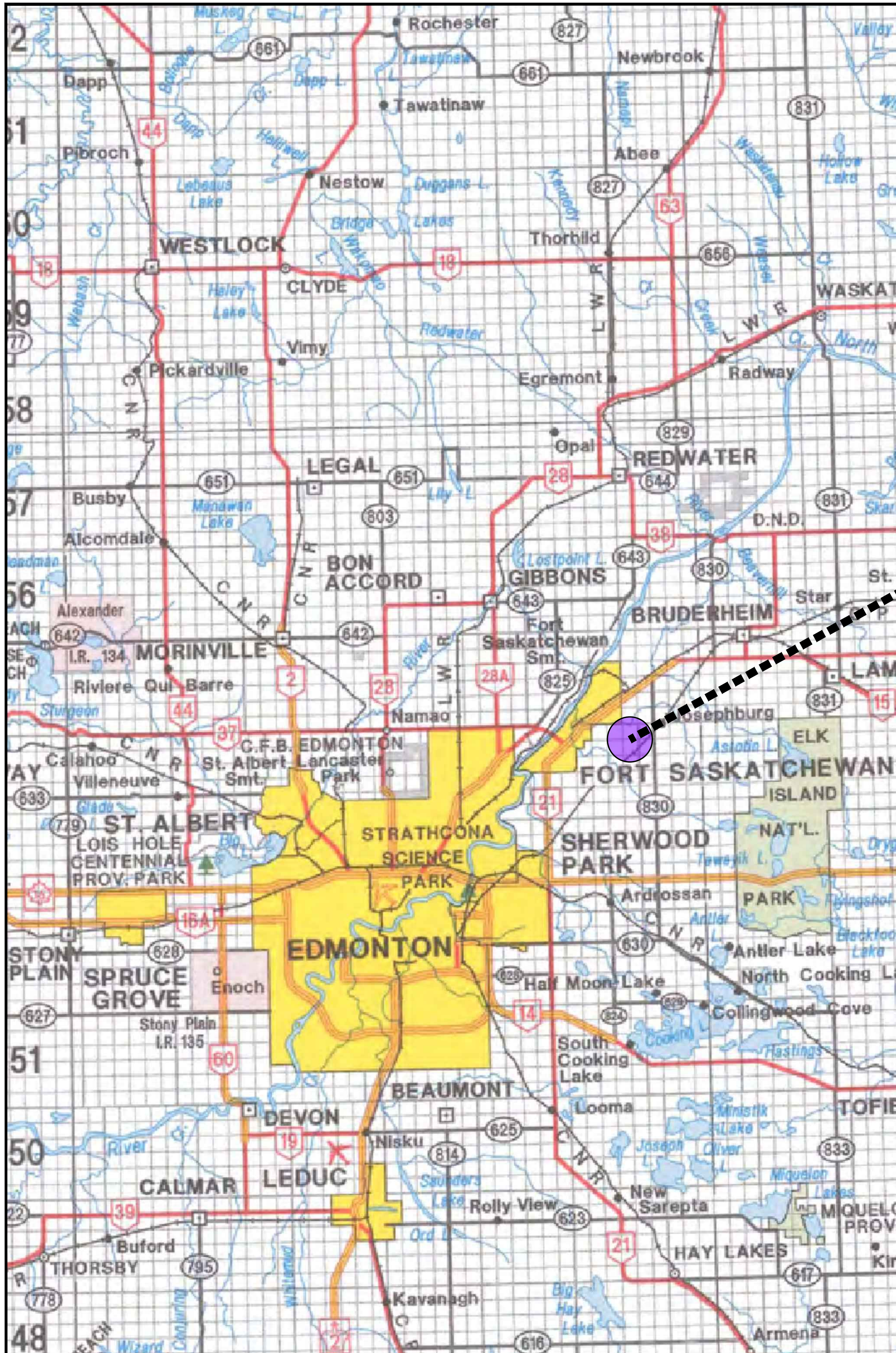
☐ Rejected – load is rejected and cannot be accepted.

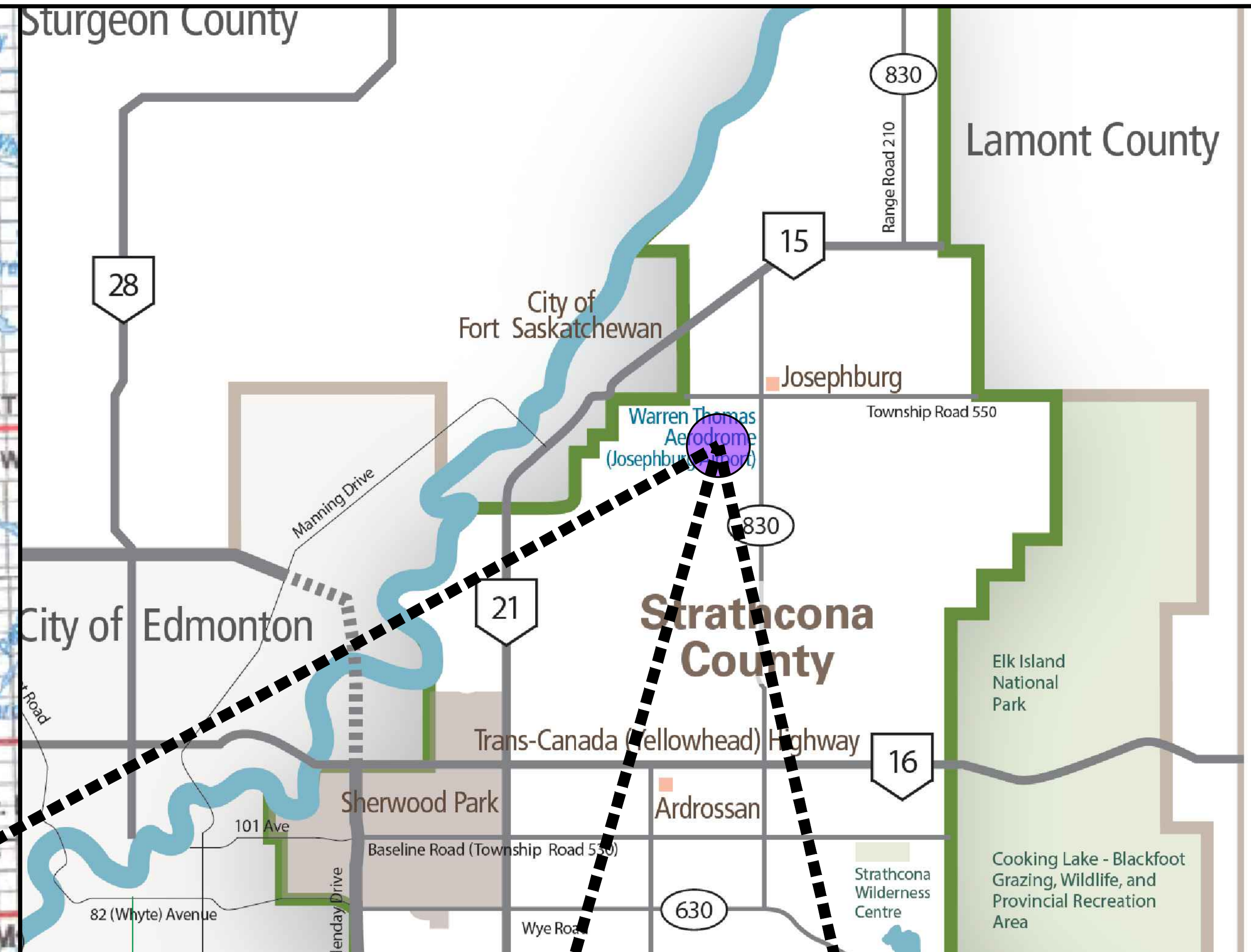
Date: _____________________________________________________ Position: ______________________________

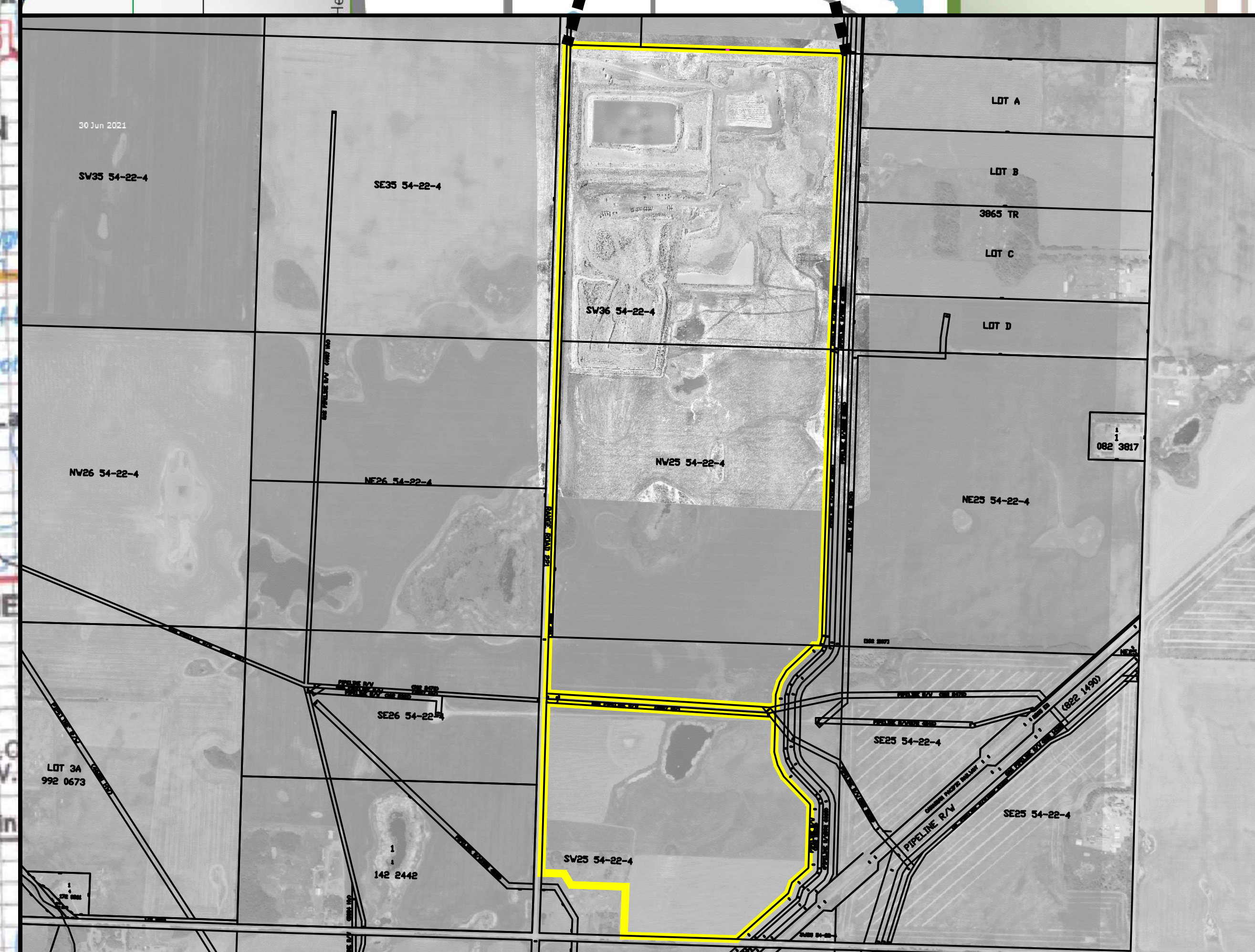
Name: _____________________________________________________ Signature: _____________________________

# Appendix L

Conservation and Reclamation Drawings

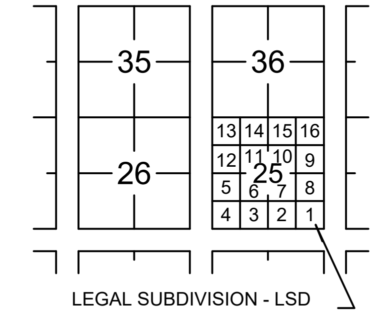



## LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

## LOCATION PLAN

LEGEND

PROPERTY LINES

PIT BOUNDARY (167.93 ha)

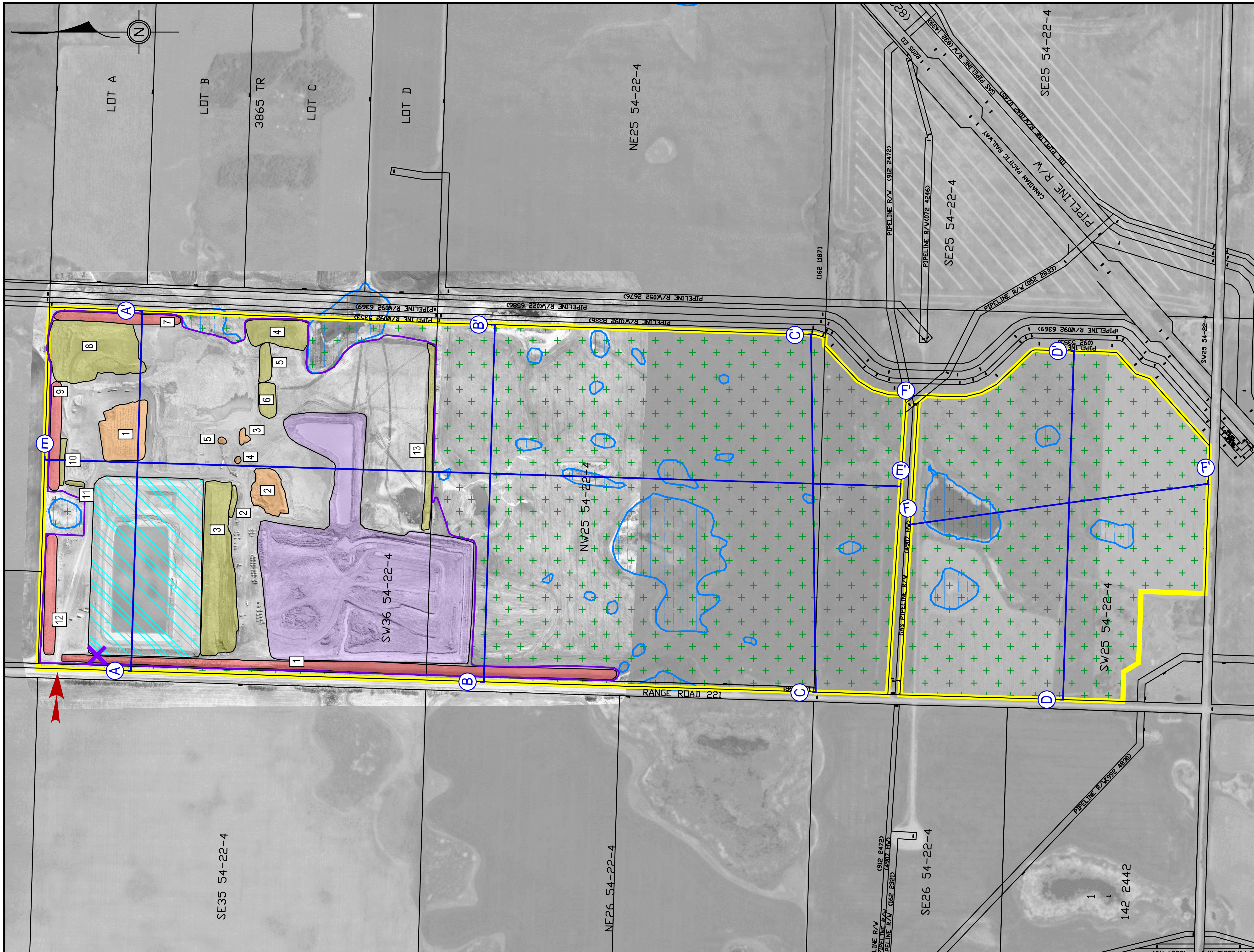
Prepared By: Aspen LAND GROUP

Client: JOBURG Aggregates Ltd.

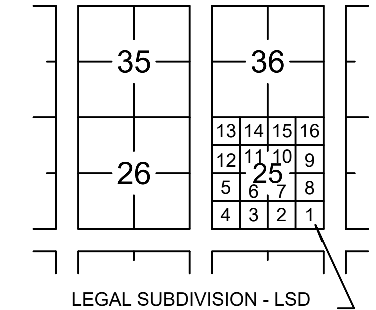
Project: JOBURG PIT

Title: LOCATION PLAN

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | NTS |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | |
| Drawn By: | T. FOY | | 1 - 13 |
| Air Photo: | 2021/2022 | | |
| DATE: | AUGUST 29, 2022 | | |




## LEGAL LAND DESCRIPTION
(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND
- PROPERTY LINES
- PIT BOUNDARY (167.93 ha)
- ACTIVE AREA (59.30 ha)
- UNDISTURBED AREAS (108.63 ha)
- UNDISTURBED WETLANDS
- GROUNDWATER RECHARGE POND
- CURRENT MINING AREA
- LONG TERM SAFETY AND EROSION PROTECTION BERMS-SEEDED
- RECLAMATION MATERIAL STOCKPILES
- PRODUCT STOCKPILES
- WETLAND MATERIAL STOCKPILES (NONE ESTABLISHED TO DATE)
- PIT ACCESS
- OFF-SITE DEWATERING DISCHARGE LOCATION

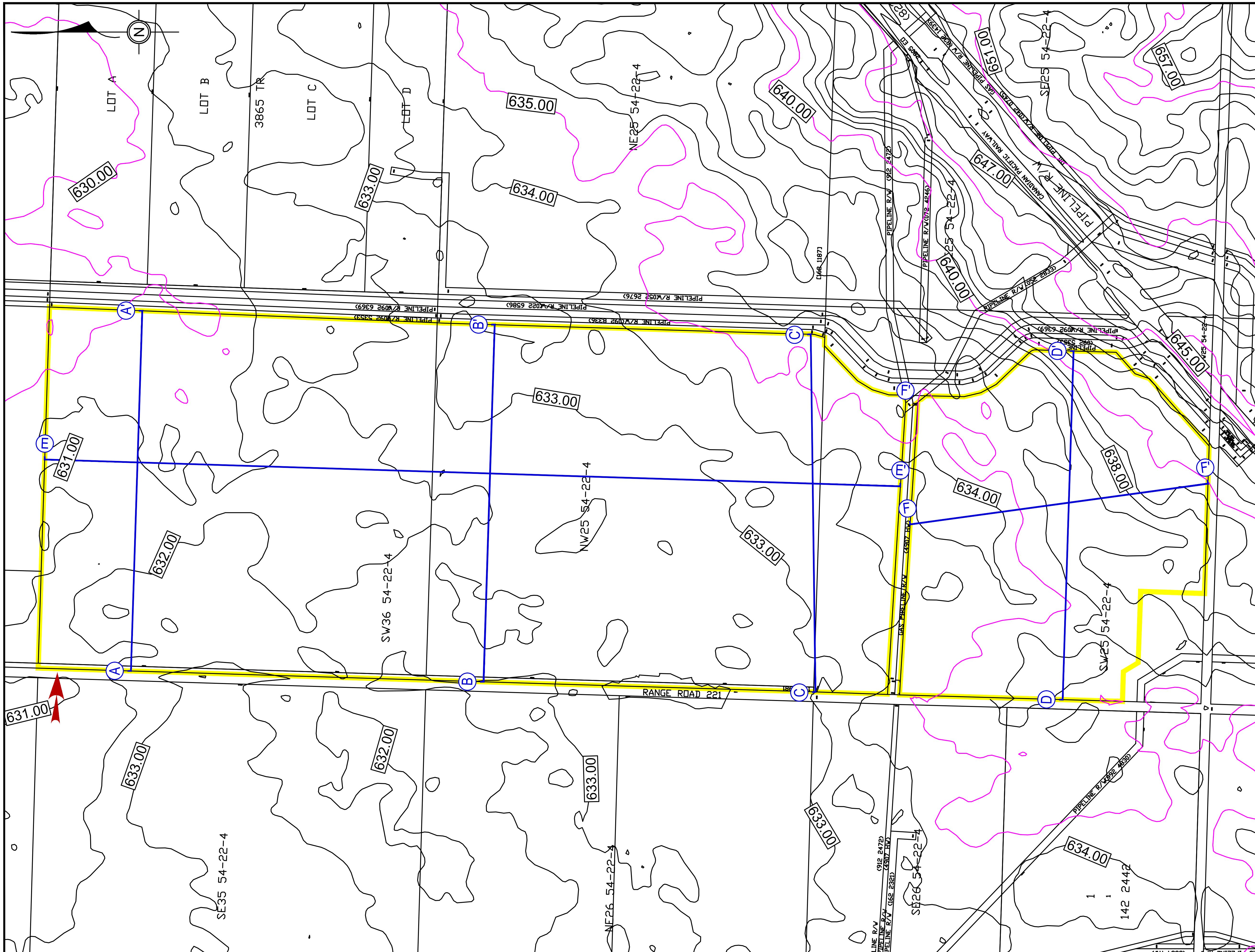
Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
JOBURG PIT

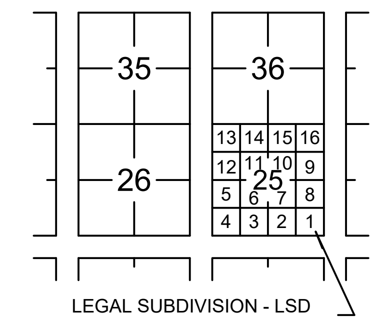
Title
CURRENT CONDITIONS

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | 1: 7500 |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | 2 - 13 |
| Drawn By: | T. FOY | | |
| Air Photo: | 2021/2022 | | |
| DATE: | OCTOBER 17, 2022 | | |




## LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- PROPERTY LINES
- PIT BOUNDARY (167.93 ha)
- PIT ACCESS
- CONTOURS MAJOR (5m)
- CONTOURS MINOR (1m)

Prepared By

Aspen LAND GROUP

Client

JOBURG Aggregates Ltd.

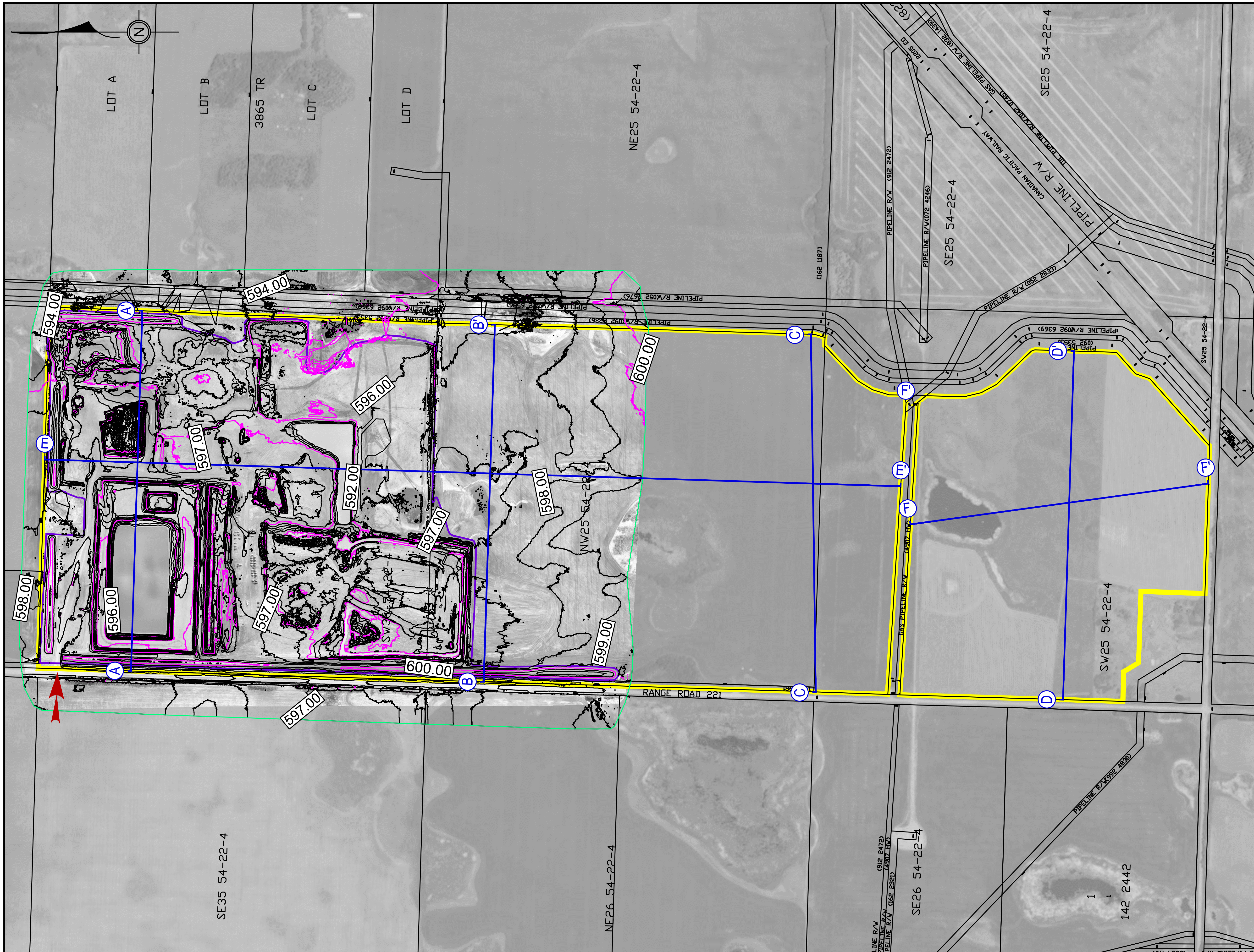
Project

**JOBURG PIT**

Title

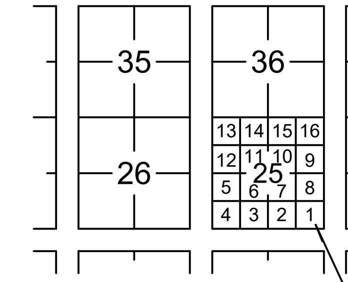
**PRE-DEVELOPMENT CONTOURS**

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | 1: 7500 |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | |
| Drawn By: | T. FOY | | 3 - 13 |
| Air Photo: | NA | | |
| DATE: | AUGUST 30, 2022 | | |




## LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- PROPERTY LINES
- PIT BOUNDARY (167.93 ha)
- ACTIVE AREA (59.30 ha)
- PIT ACCESS
- CONTOURS MAJOR (5m)
- CONTOURS MINOR (1m)

Prepared By

Aspen LAND GROUP

Client

JOBURG Aggregates Ltd.

Project

**JOBURG PIT**

Title

**MAY 2022 UAV CONTOURS**

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | 1: 7500 |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | |
| Drawn By: | T. FOY | | 4 - 13 |
| Air Photo: | 2021/2022 | | |
| DATE: | SEPTEMBER 08, 2022 | | |


LEGAL LAND DESCRIPTION
(W 25-54-22 W4M & SW 36-54-22 W4M)

| 35 | 36 |
|---|---|
| 26 | 25 |

| 13 | 14 | 15 | 16 |
|---|---|---|---|
| 12 | 11 | 10 | 9 |
| 5 | 6 | 7 | 8 |
| 4 | 3 | 2 | 1 |

LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND
- PROPERTY LINES
- PIT BOUNDARY (167.93 ha)
- ACTIVE AREA (59.30 ha)
- UNDISTURBED WETLANDS
- WETLANDS TO BE AVOIDED
- PIT ACCESS

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
JOBURG PIT

Title
PROPOSED MINE SEQUENCING PLAN

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | 1: 7500 |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | 5 - 13 |
| Drawn By: | T. FOY | | |
| Air Photo: | 2021/2022 | | |
| DATE: | SEPTEMBER 08, 2022 | | |

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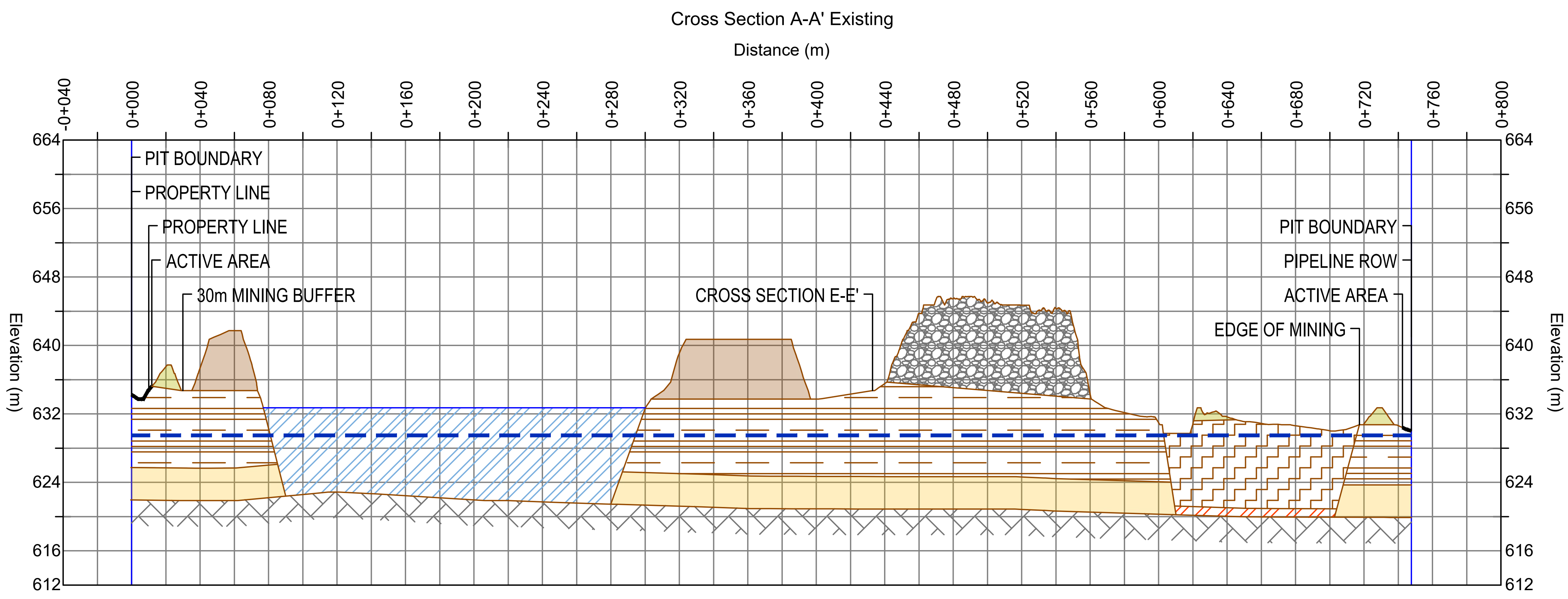


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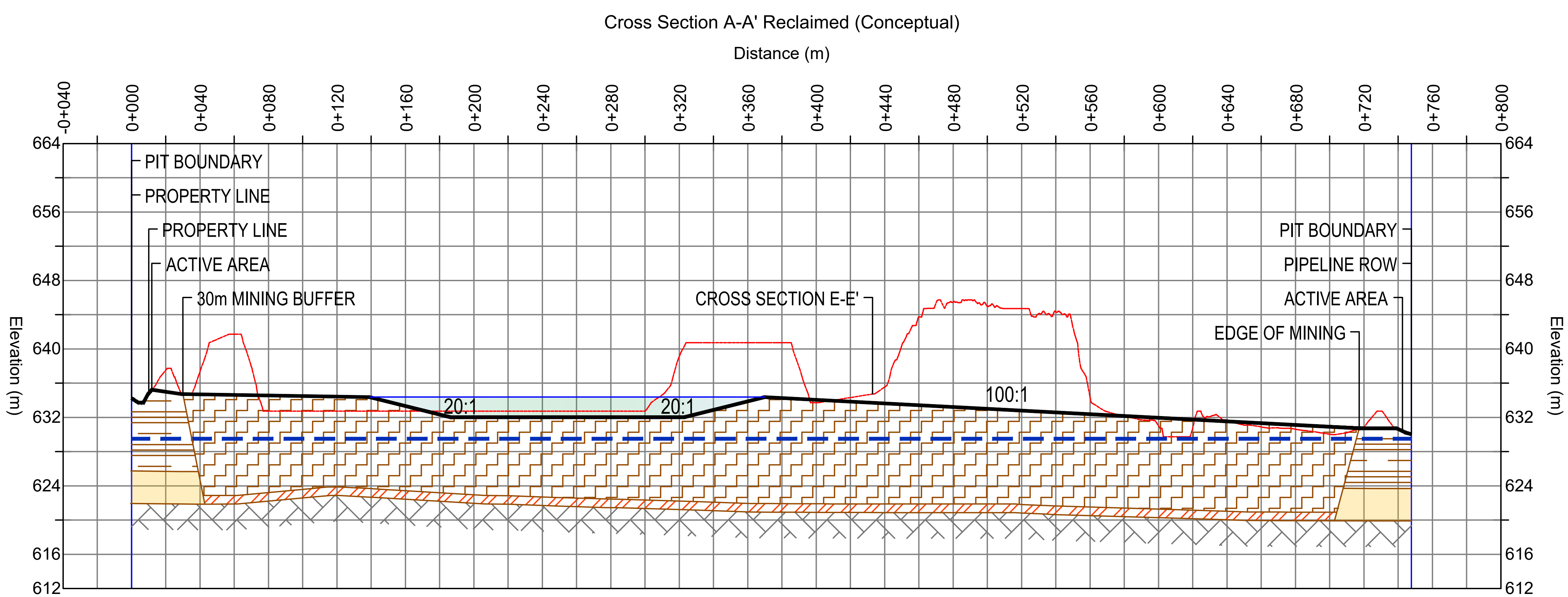
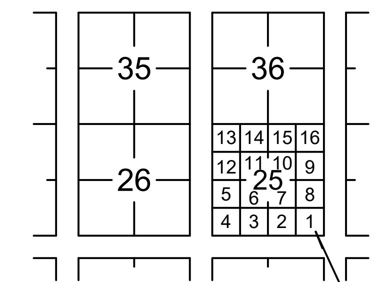



LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- RECLAMATION STOCKPILES
- GROUNDWATER RECHARGE BERM
- PRODUCT PILE
- GROUNDWATER RECHARGE POND
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By

Aspen LAND GROUP

Client

JOBURG Aggregates Ltd.

Project

**JOBURG PIT**

Title

**CROSS SECTION A-A'
EXISTING & RECLAIMED CONDITIONS**

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | AS SHOWN |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | 6 - 13 |
| Drawn By: | T. FOY | | |
| Air Photo: | NA | | |
| DATE: | AUGUST 30, 2022 | | |

SCALE:
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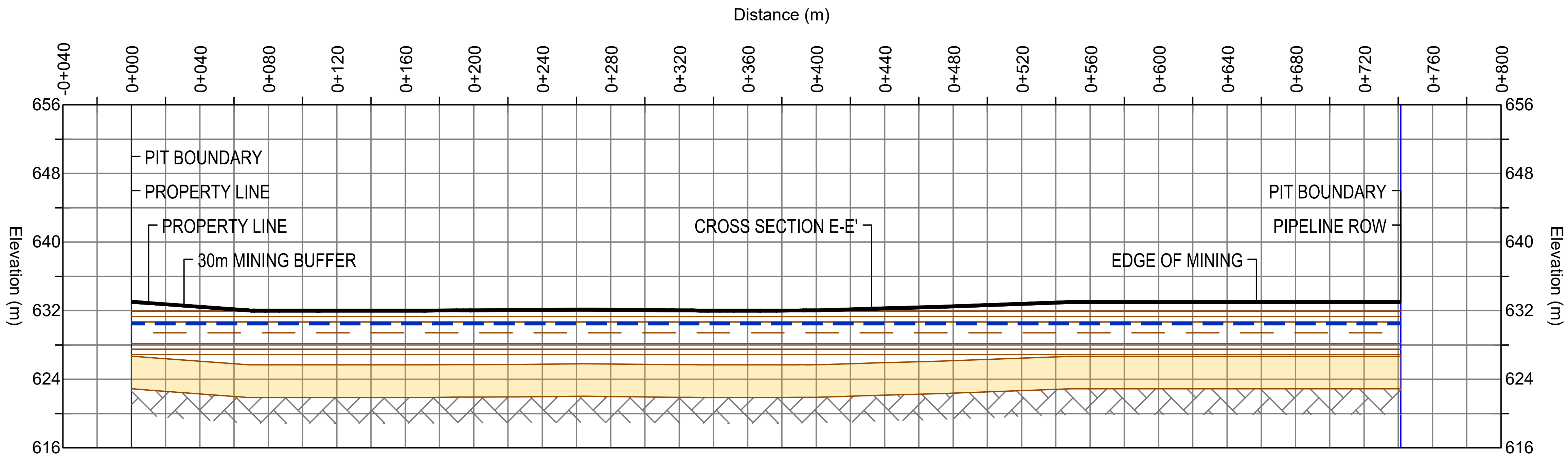
Cross Section B-B' Existing

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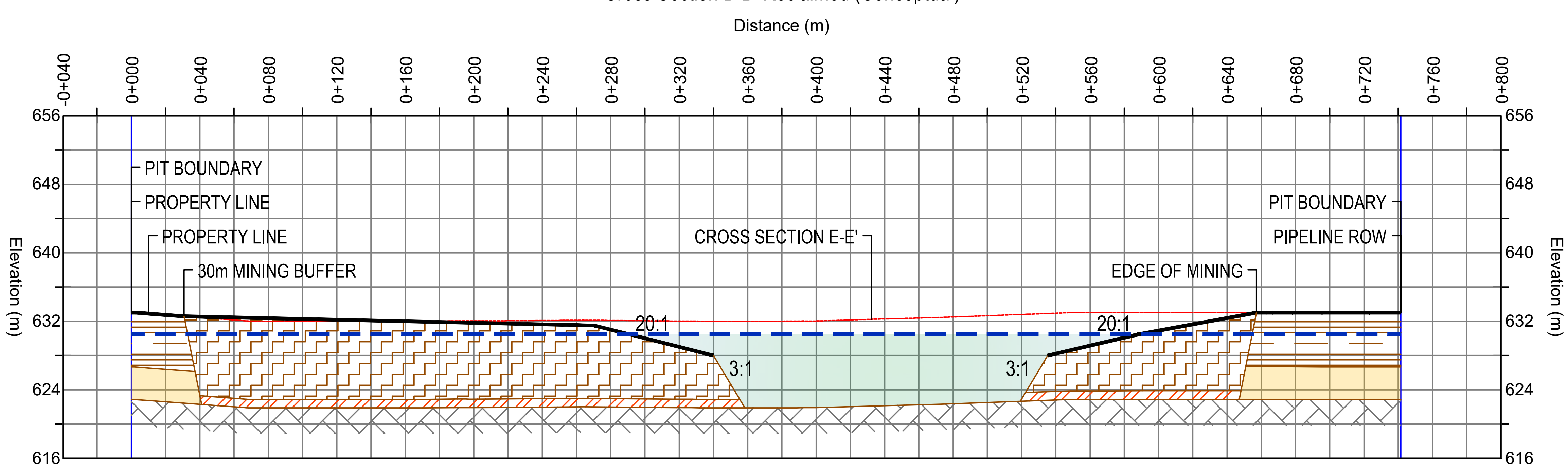
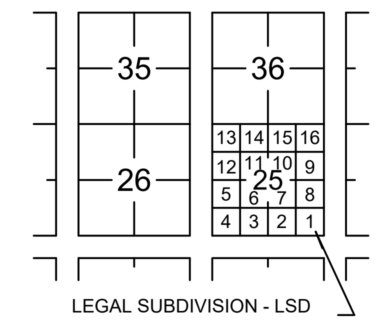
Cross Section B-B' Reclaimed (Conceptual)




LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By

Aspen LAND GROUP

Client

JOBURG Aggregates Ltd.

Project

JOBURG PIT

Title

CROSS SECTION B-B'
EXISTING & RECLAIMED CONDITIONS

| | |
|---|---|
| Checked By: | L. FOY/K. NYSTROM |
| Designed By: | L. FOY/K. NYSTROM |
| Drawn By: | T. FOY |
| Air Photo: | NA |
| DATE: | AUGUST 30, 2022 |

Scale AS SHOWN

Drawing No.

7 - 13

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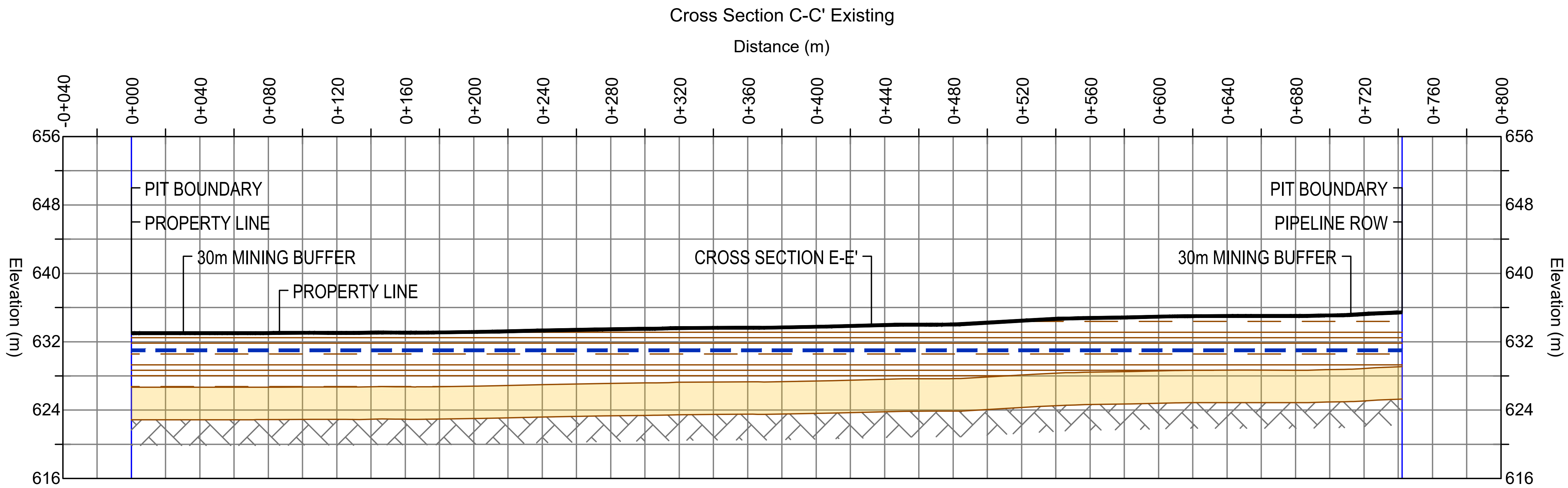


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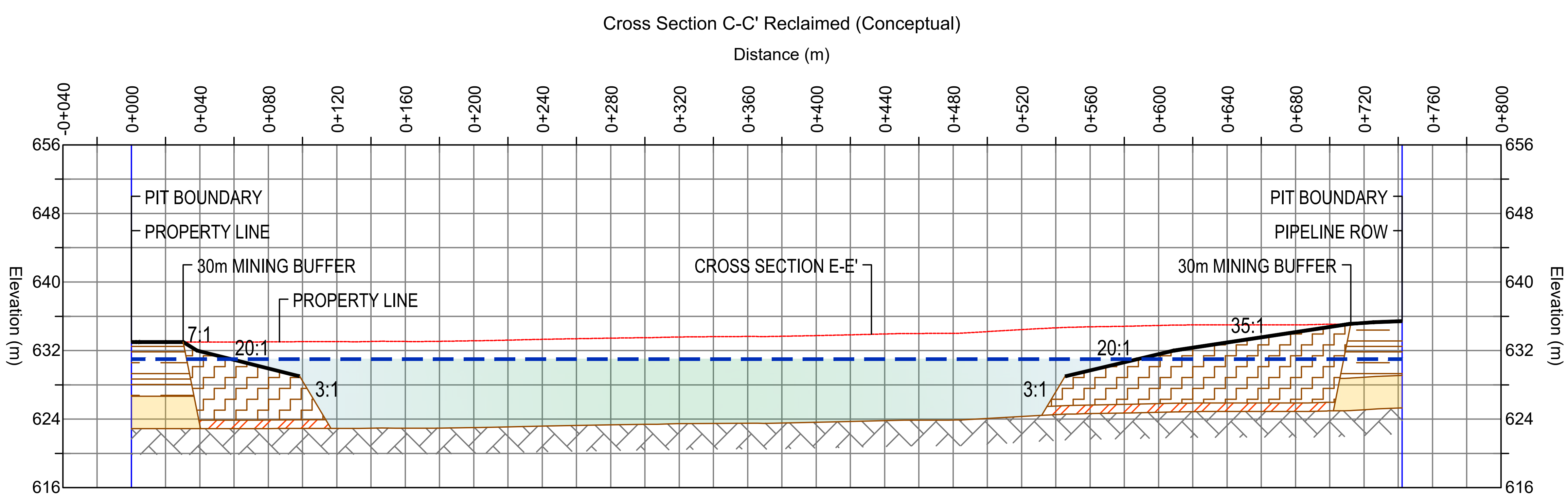
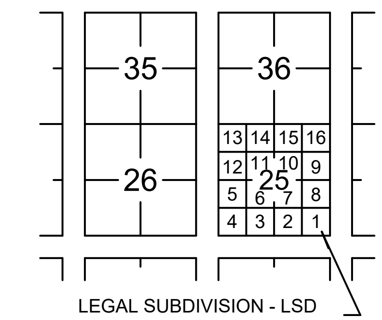



LEGAL LAND DESCRIPTION
(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
JOBURG PIT

Title
CROSS SECTION C-C'
EXISTING & RECLAIMED CONDITIONS

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | AS SHOWN |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | 8 - 13 |
| Drawn By: | T. FOY | | |
| Air Photo: | NA | | |
| DATE: | AUGUST 30, 2022 | | |

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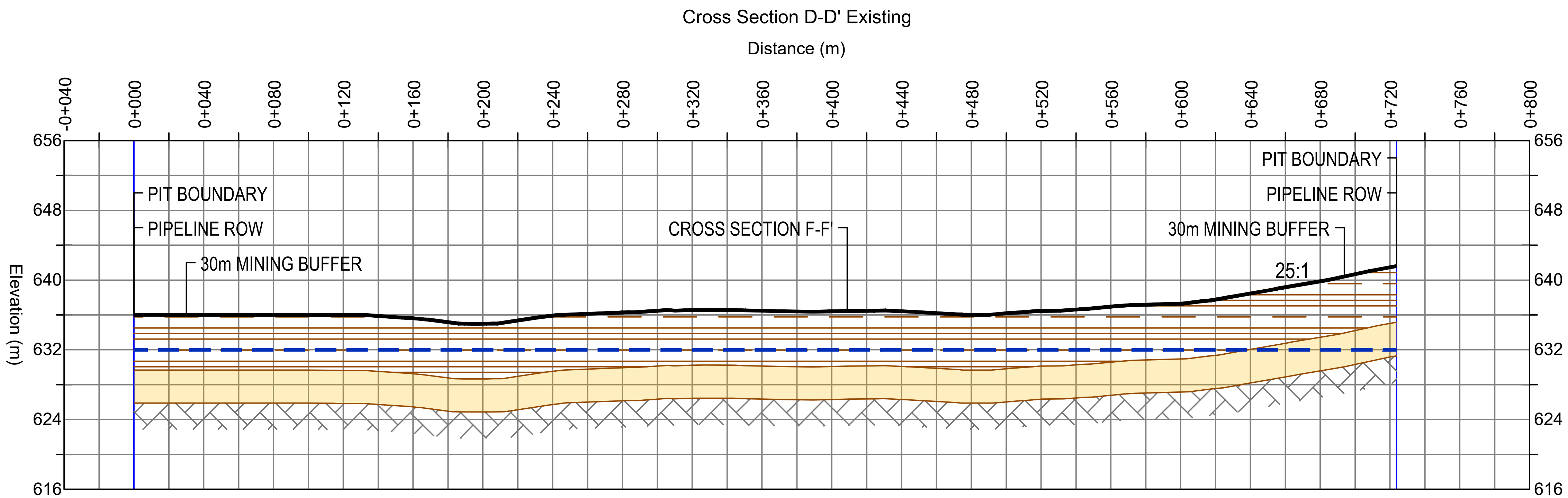


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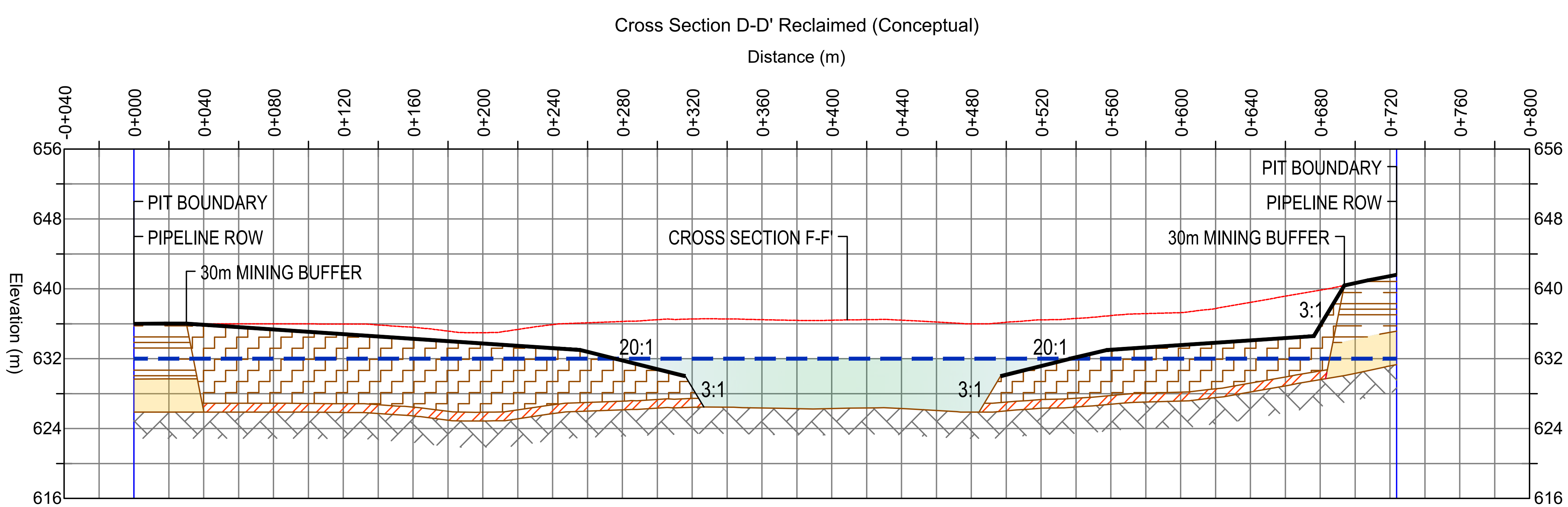
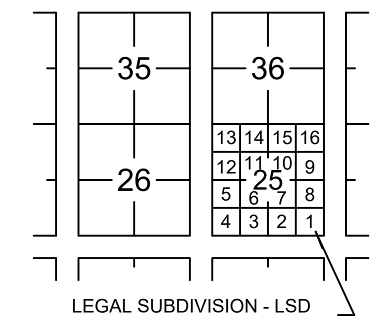



LEGAL LAND DESCRIPTION
(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
**JOBURG PIT**

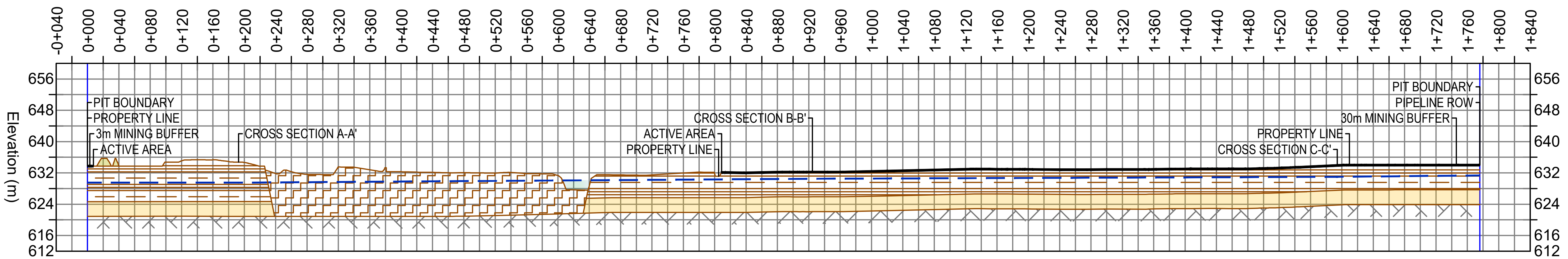
Title
**CROSS SECTION D-D'**
**EXISTING & RECLAIMED CONDITIONS**

| | |
|---|---|
| Checked By: L. FOY/K. NYSTROM | Scale AS SHOWN |
| Designed By: L. FOY/K. NYSTROM | Drawing No. |
| Drawn By: T. FOY | 9 - 13 |
| Air Photo: NA | |
| DATE: AUGUST 30, 2022 | |

SCALE:
V=1:1200
H=1:6000

## Cross Section E-E' Existing

Distance (m)




SCALE:
V=1:1200
H=1:6000

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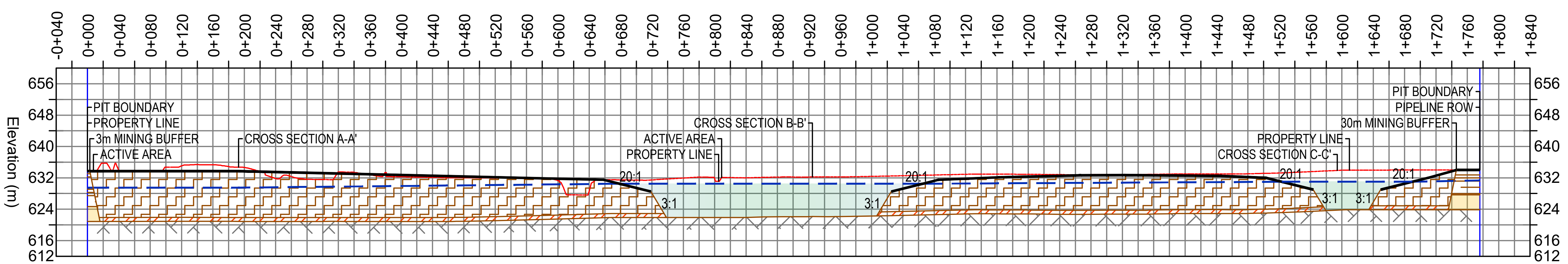
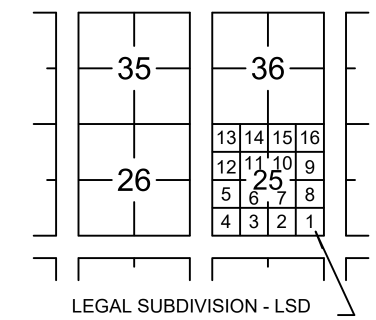
Distance (m)




## LEGAL LAND DESCRIPTION

(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- RECLAMATION STOCKPILES
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
**JOBURG PIT**

Title
**CROSS SECTION E-E'
EXISTING & RECLAIMED CONDITIONS**

| | |
|---|---|
| Checked By: L. FOY/K. NYSTROM | Scale AS SHOWN |
| Designed By: L. FOY/K. NYSTROM | Drawing No. |
| Drawn By: T. FOY | 10 - 13 |
| Air Photo: NA | |
| DATE: AUGUST 25, 2022 | |

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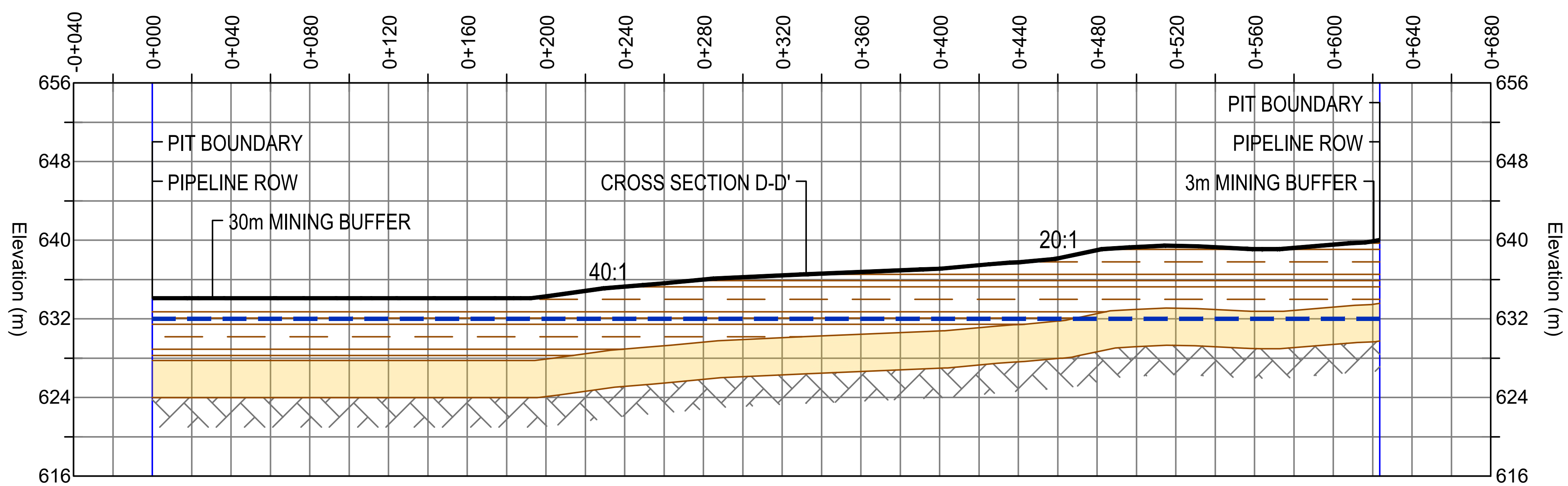
H=1:3000

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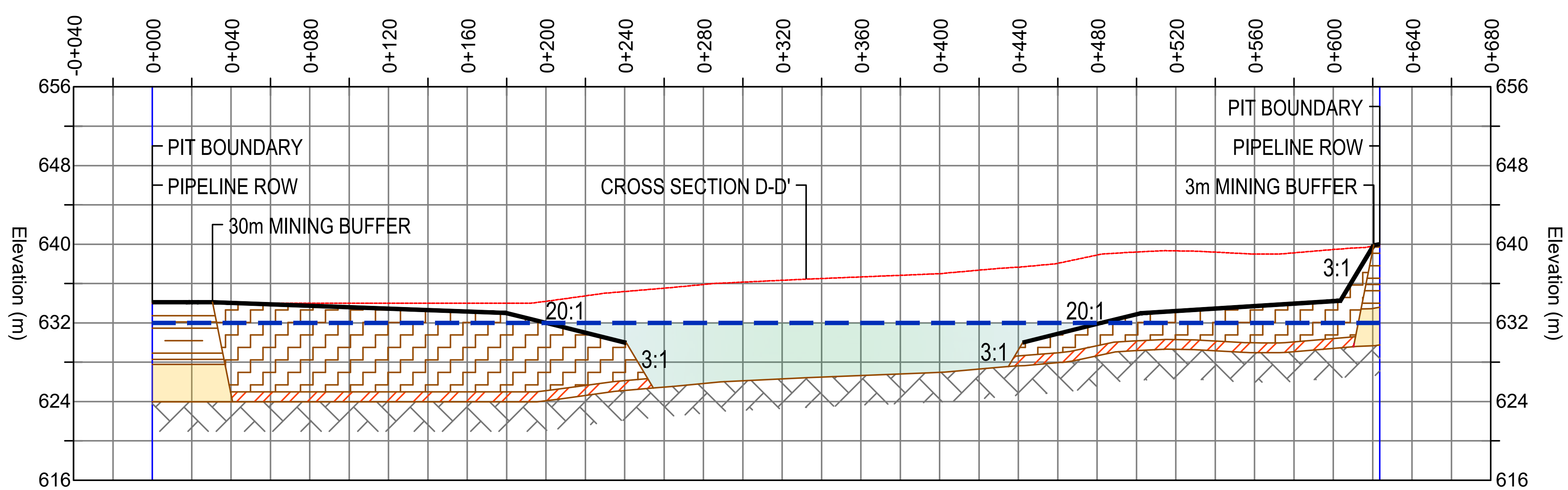


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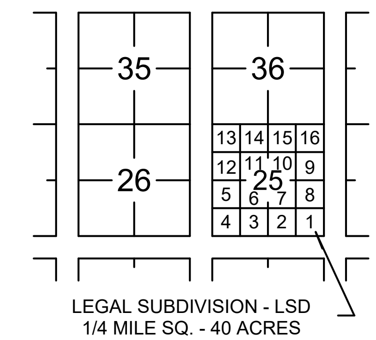


LOCATION PLAN

LEGEND

- TOPSOIL/SUBSOIL
- EXISTING SURFACE
- LOCAL ESTIMATED WATER TABLE SURFACE
- OVERBURDEN (BASED ON TEST HOLE AVERAGES)
- AGGREGATE (BASED ON TEST HOLE AVERAGES)
- REPLACED SAND
- BEDROCK/UNKNOWN
- REPLACED MATERIAL (REJECT SAND, CLAY, IMPORTED MATERIAL AND/OR AGGREGATE)

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
JOBURG PIT

Title
CROSS SECTION F-F'
EXISTING & RECLAIMED CONDITIONS

| | |
|---|---|
| Checked By: L. FOY/K. NYSTROM | Scale AS SHOWN |
| Designed By: L. FOY/K. NYSTROM | Drawing No. |
| Drawn By: T. FOY | 11 - 13 |
| Air Photo: NA | |
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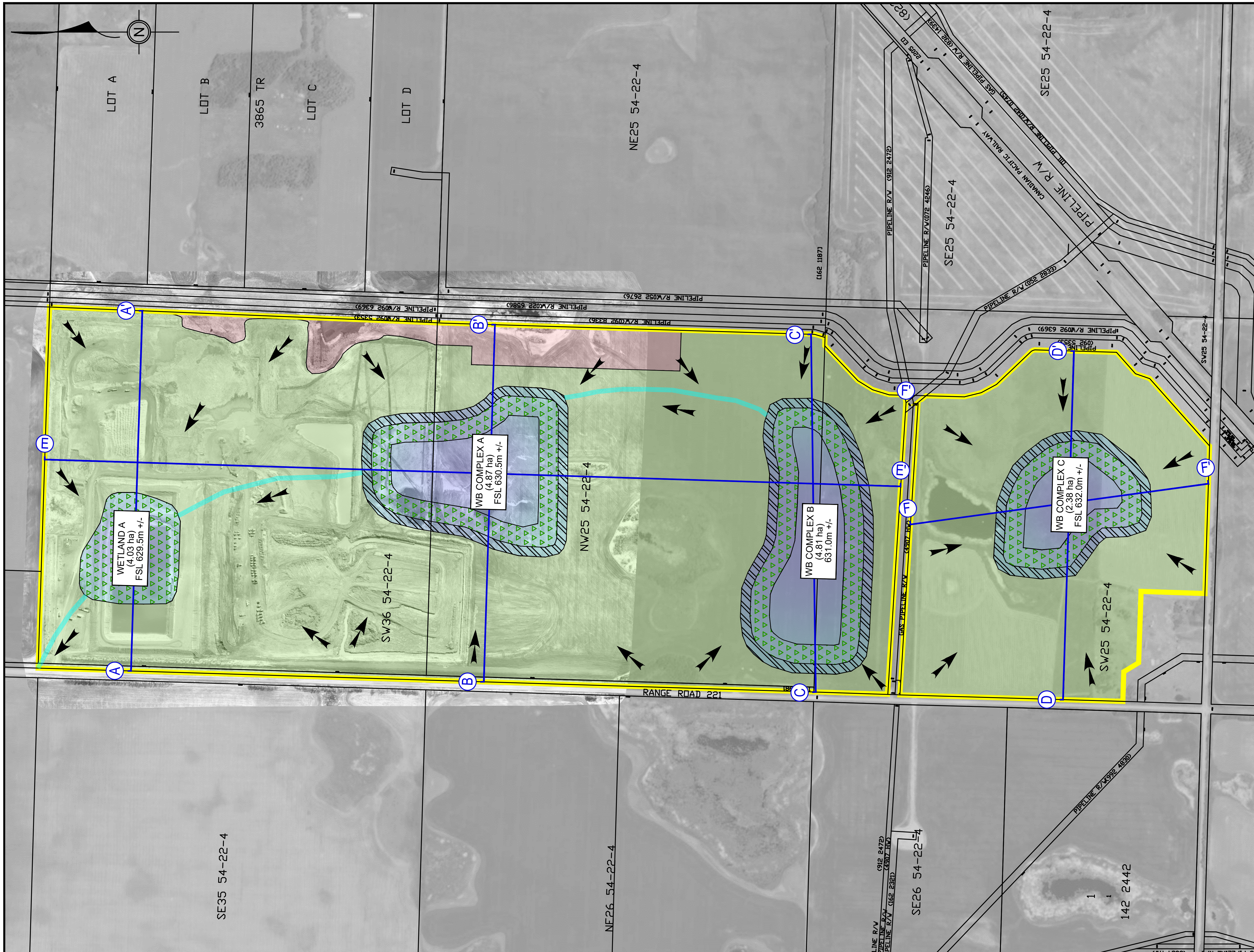


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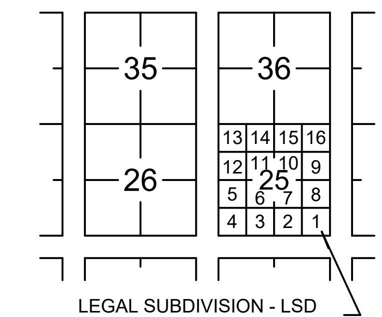



LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

### LEGEND

- PROPERTY LINES
- PIT BOUNDARY (167.93 ha)
- EXAMPLE OF SWALE LOCATION
- RECLAIMED AREA (125.93 ha)
- UNDISTURBED AREAS (6.25 ha)
- TRANSITIONAL VEGETATION/NATURALIZED AREAS (7.32 ha)
- EMERGENT VEGETATION AREA (<2m - 16.37 ha)
- OPEN WATER (>2m DEEP - 12.06 ha)
- DRAINAGE DIRECTION

Prepared By

Aspen LAND GROUP

Client

JOBURG Aggregates Ltd.

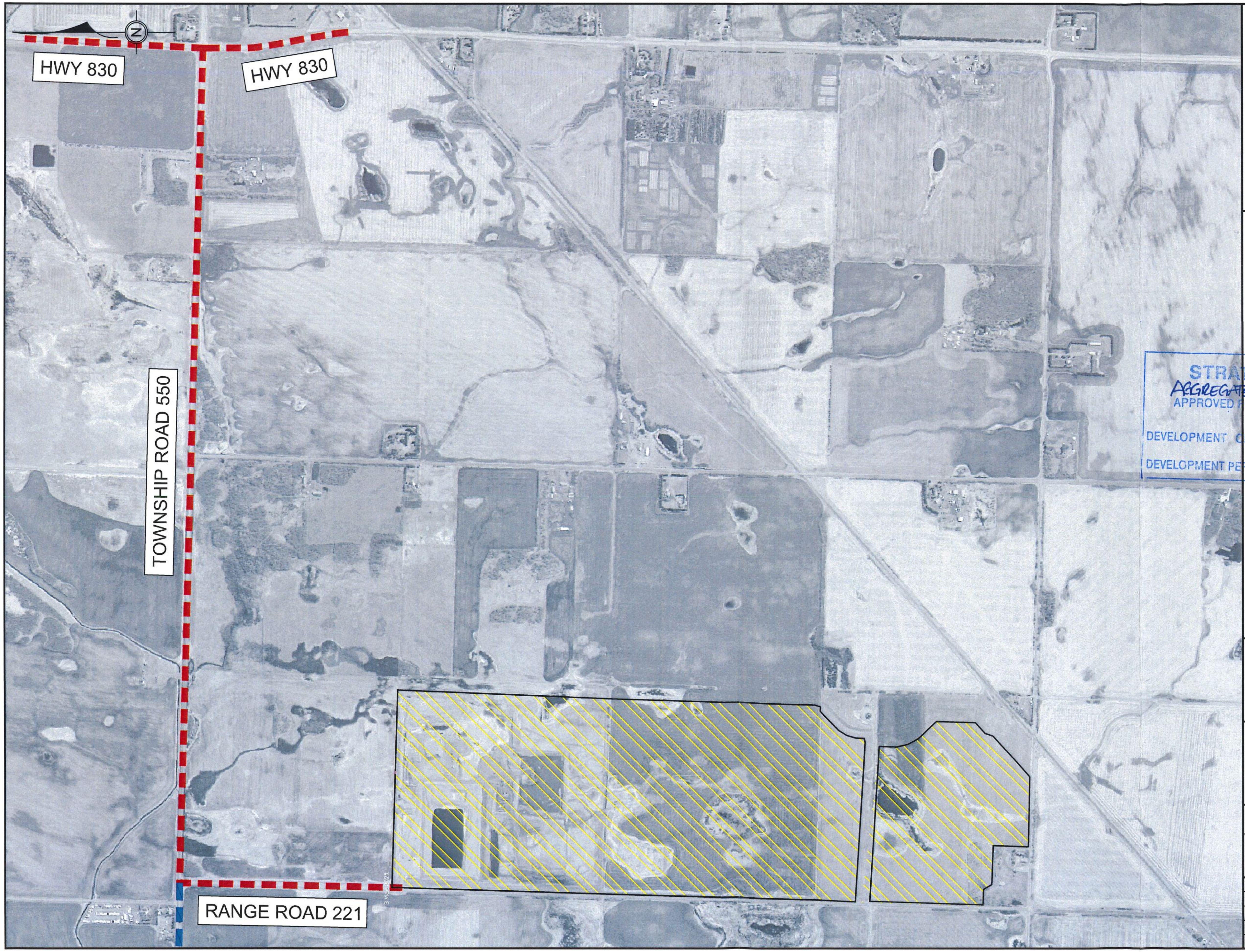
Project

**JOBURG PIT**

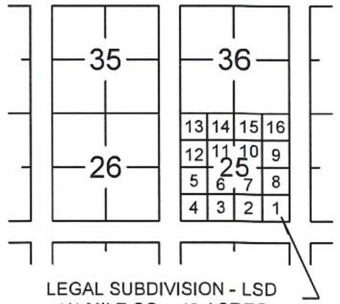
Title

**CONCEPTUAL RECLAMATION PLAN**

| | | | |
|---|---|---|---|
| Checked By: | L. FOY/K. NYSTROM | Scale | 1: 7500 |
| Designed By: | L. FOY/K. NYSTROM | Drawing No. | |
| Drawn By: | T. FOY | | 12 - 13 |
| Air Photo: | 2021/2022 | | |
| DATE: | AUGUST 30, 2022 | | |




LEGAL LAND DESCRIPTION
(W 25-54-22 W4M & SW 36-54-22 W4M)




LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

LOCATION PLAN

LEGEND

PIT AREA (167.93 ha)
HAUL ROUTE
ALTERNATE HAUL ROUTE

STRATHCONA COUNTY
AGGREGATE EXTRACTION USE
APPROVED FOR DEVELOPMENT PERMIT ONLY
DEVELOPMENT OFFICER
DEVELOPMENT PERMIT No 2022-0589-DP DATE Nov. 30 2022

Prepared By
Aspen LAND GROUP

Client
JOBURG Aggregates Ltd.

Project
JOBURG PIT

Title
HAUL ROUTE

| | |
|---|---|
| Checked By: L. FOY/K. NYSTROM | Scale 1: 7500 |
| Designed By: L. FOY/K. NYSTROM | Drawing No. |
| Drawn By: T. FOY | 13 - 13 |
| Air Photo: NA | |
| DATE: AUGUST 30, 2022 | |

# Appendix M (Attached under Separate Cover)

ACI Acoustical Consultants Noise Impact Assessment Report

# Appendix N

Joburg Pit Hauling Regulations and Trucking Form

# Pit Hauling Regulations

JOBURG
Aggregates Ltd.

1. Full PPE Required
   - Hard Hats
   - Steel-Toe Boots
   - Reflective Safety Vests
2. Speed Limit
   a. Inside Pit – 20km/hr
   b. Range Road 221 – 50km/hr
   c. TWP Road 550 – 80km/hr
3. NO Jake Brakes
   a. Cannot be used on Range Road 221 or TWP Road 550 – no exceptions
   b. Once outside our Road Use Agreement area, follow appropriate highway signs/regulations.
4. Access to and from the pit by hauling vehicles.
   a. Must use the designated haul route and follow municipal and provincial standards
   **b. Designated haul route: Off of Hwy 830, east on Twp Rd 550, south of Rge Rd 221**
5. Truck **must be registered with a 2022 ASGA** number.
6. Truck must have copy of Road Use Agreement
   a. Copy can be obtained from Joburg scale house
7. No slamming tailgates when dumping within the pit.
8. All loads must be fully tarped.
9. All vehicles leaving the pit will not enter Range Road 221 or Township Road 550 while school busses are visible.

Joburg Pit Contact: Lucas Bodnar 780-293-2105

Joburg Safety Manager Contact: Glen Frank 780-887-4331

NOTE: ANY VIOLATION OF THESE REGULATIONS WILL BE SUBJECT TO IMMEDIATE DISMISSAL FROM SITE.

# Joburg Trucking Form

JOBURG
Aggregates Ltd.

Trucking Company: ______________________________

Customer (if different than Trucking Co.): _______________________________

Truck Unit #:____________ ASGA #: ____________ GVW: ____________

Material Being Hauled: _______________________________

Delivery Location (Site): ______________________________

Delivery Address: _______________________________

PO # (If Required): ______________________________

Yes ☐ No ☐ I have a copy of the Pit Hauling Regulations and understand that violating any of these rules are grounds for immediate dismissal from site.

Date: ________________________

Name: _______________________ Phone Number: __________________

Signature: ____________________

# Appendix O

Emergency Response Plan and STARS Remote Landing Site Card

JOBURG
Aggregates Ltd.

22 April 2022

ERP Joburg Gravel Pit Operations

Location: **54749 Range Road 221 Strathcona County AB (GPS Co-ordinates) LAT 53 degrees 42”10.80 North – LONG 113 degrees 07”03.72 West or LSD 4-36-54-22W4.** The Site Supervisor will conduct a Site Specific Hazard Assessment prior to any work being done. This will include a tour of the entire work area to re-assess any hazards that have occurred since the last work shift. The current Hazard Assessment will be discussed with workers as part of the Pre-Job meeting. If conditions or job scope change, a new Hazard Assessment shall be completed. Hazard Assessment is a continual process throughout the shift. All employees working on this site to read and sign the Formal JHA for this project, no exceptions!

Site **MUSTER POINT** **will be at the Scale house. Stay there until you are counted!**

Emergency Response Plan ERP

Ref: Part 7 OHS Handi – Guide and Section 10, G&J Safety Manual.

**A)** ***Identification of Potential emergencies***:
Potential Emergencies for this site include but are not limited to:
Equipment fires, Grass fire or Wild fire, Medical Emergency, Vehicle roll over or vehicle collision, Landslide/Mudslide, Spill of fuel or oils, and water related emergencies. Also, weather related such as, extreme cold and wind chills, heavy snow with limited visibility, thunder storms, lightning and tornadoes.

***B) Procedures for dealing with potential emergencies***
**All Fires:** The first line of defence will be the fire extinguishers located on the equipment or at the fire point; the fire department will be called to handle any larger fire. The phone number is **911.** The location of the **fire department** is **55305-Range road 214, phone 780-400-2165.**
**Medical Emergency:** This will be attended to initially by our First Aid qualified personnel. An ambulance shall be called using **911** anytime there is a Medical Emergency. **There is no AED on this site**. **Stars Air Ambulance** can be called for very serious conditions where an Ambulance would not be effective. The number for **Stars is 780-890-3131** site #5793. Use the **GPS co-ordinates** so the crew can locate you. ***Lat 53.42.10.80 North - Long 113.07.03.72 West*** **or use LSD 4-36-54-22W4** if the helipad does not work pick a landing zone free of debris that is reasonably close to the accident site and reasonably level. Have a signal man act as a guide when the aircraft arrives. Have your back to the wind so the aircraft can land into the wind. Do not approach the landed aircraft, wait until they approach you.

**Vehicle Collision or Rollover**: If a **vehicle collision** occurs notify the site Supervisor a.s.a.p. If there are no injuries, fill out the accident report form and take photographs. If possible, do not move the vehicles until a Safety representative arrives. If a **vehicle rollover** occurs, notify the site Supervisor **a.s.a.p.** Do not approach the upset vehicle until the scene is declared safe. Check the operator for injuries and assess the need for medical aid. Assess the further possibility of fire. Protect the environment against spills. Call the necessary emergency services to assist you. Once again, call **Safety** to the scene.

***** No attempt will be made to set the equipment upright until the scene has been assessed for further hazards by the Foreman, Safety, and Maintenance personnel.***

**Mud slide or land slide**: In the event of a mudslide or land slide operators must try to stay in the equipment. Steps have been taken to lessen the risk of such an event by building a retaining berm around the edges of the gravel pit to protect workers from this type of hazard.

**Spills of fuel or Oil**: Spills will be dealt with in accordance with the spills response plan. Ensure you contain the spill; prevent the spill from entering waterways. Clean up the affected area and complete the form for general spills. Safety will contact Alberta Environment for any spill that involves minimum reportable quantities at **780-422-4505 or 1-800-222-6514 24 hrs**.

**Diesel Fuel:** Any amount in excess of 30 liters;

**Used Hydraulic oil:** An amount of more than 5 liters <u>that will have an adverse effect</u>; and

**Spent Engine oil:** An amount of more than 5 liters <u>that will have an adverse effect</u>.

**Water related emergencies:** Once ponds are in use on site lifesaving equipment must be mounted near the edge of the pond to be used if someone should fall in and require rescue.

**Weather related: Thunder Storms** with **heavy down pours** and **lightning**. Watch for heavy rains that will effect traction of the equipment and effect areas where working on slopes or banks. If you are working on a steep slope when heavy rain occurs, you must take the equipment to a safe area that is not hazardous and wait the storm out if temporary. Before re-entering a work area a new Hazard Assessment must be completed taking into account the modified soil conditions. If **lightning** is present in your work area use the 30/30 rule **(if thunder is heard and lightning is seen within 30 seconds of your work area, wait 30 minutes before resuming work)**.

**Tornadoes** are rare but can happen in Alberta. In the unlikely event of a tornado, warn all employees on the worksite using your radios take cover in a low spot or ditch. Watch for flying debris that can injure you. Report this event to the Safety Officer as soon as possible. Extreme cold and wind chills will be monitored and the project will be shut down at the discretion of the Project Manager and the Site Foreman after consultation. Heavy snow and limited visibility will be dealt with the same way as extreme cold and wind chills.

**C)** ***The identification of, location of, and operational procedures for emergency equipment***: Each vehicle or piece of equipment will have a **fire extinguisher** on board. The directions for using the fire extinguishers are located in the Company Safety Manual. Use the PASS system while operating the fire extinguisher for best results. The **# 2 First Aid kit** will be located in the supervisor's pickup truck on site or the office area in the laydown area. If you are using First Aid supplies, document what is used so it can be replaced. Also fill out a First Aid event form and ensure the supervisors get the completed document so it can be given to the safety officer.

**D)** ***The emergency response training requirements:*** Standard First Aid with CPR & AED qualification shall be held by **two** people on site at all times. Drills will be held on site and documented at least annually. If the number of employees on site increase the First Aid levels will also increase according to Table 7 on page S2-7 of the OH&S Handi Guide.

**E)** ***The location and use of emergency facilities*****:** The Foreman's truck is where you will find First Aid supplies; the fire point / muster point will be located at the scale house and will be identified with a muster point sign.

**F)** ***The fire protection requirements*****:** All vehicles and equipment are to have a fire extinguisher. The immediate back-up plan to the fire extinguishers is a second extinguisher from another vehicle or piece of equipment. If the fire is getting worse **call 911** for fire response.

**G)** ***The alarm and emergency communication requirements*****:** Two way radios and cell phones shall be used to sound an alarm or warning. Two way radios shall be used in the rock trucks while hauling on the in and out routes.

**H)** ***The First Aid services required*****:** On site as per table 7 First Aid requirements for a high risk site of 5-9 people located between 20-40 minutes from a hospital. **We will have at all times (2) qualified Standard First Aiders, a number # 2 First Aid kit, and 3 blankets.** Back up medical aid will be to call 911 when an ambulance is required or Stars air ambulance if it is required. The nearest **Hospital** is located in Fort Saskatchewan 9401-86 Ave in Fort Saskatchewan. The hospital phone number is: **780-998-2256**.

**I)** ***Procedures for rescue and evacuation*****:** Specialized Rescue and Evacuation from an overturned vehicle will be done with Fire Rescue by **dialing 911.**

**J)** ***The designated rescue and evacuation workers***. Aside from having designated First Aid first responders there will be no specially trained rescue or evacuation workers on site. All rescues will be handled by Heartland Hall Fire Rescue services activated by **dialing 911**.

## Emergency Classification

**Level 1:** a minor incident or spill that can be dealt with or contained and cleaned up by onsite personnel.

**Level 2:** An intermediate level of incident or spill that may require both on and off site response by trained personnel, but poses no danger to the public

**Level 3:** A major incident that cannot be managed by a single facility, and which may be complicated by fire, explosion, toxic compounds, a threat to life, property and the environment

**Site Notes**:

1. There are no overhead power lines located in the work area. There are high pressure pipelines near the work area, maintain 30 meters from the line unless granted permission to go closer than 30 meters, check the project map for the exact location of the underground pipeline.
2. An OH&S Handi Guide, SDS sheets for all WHIMIS controlled items on the worksite shall be in the possession of the site supervisor in his truck or in the office trailer/ sea can.
3. Equipment that is mobile shall be parked in one area overnight for security reasons unless running the equipment back to the lay down area is not feasible. This will be at the discretion of the Site Supervisor. All efforts are to be made to reduce the risk of theft from company equipment in the off hours.
4. Keys for all vehicle and equipment shall be removed for quiet hours and the Site Supervisor shall control the keys and secure them
5. Radio control will be used on site as well as cell phones for communication, remember distracted driving laws apply here in the gravel pit.
6. Smoking, ensure your buts are not thrown out on the ground and ensure they are put out
7. Toilets have been provided on site as per Part 24 of the OH&S code. We are in compliance with Sect 357(2) of the code. The number of toilets can be found in the OH&S Handi Guide page S7-1
8. Both noise and dust will be monitored on this project at various stages. Do your part to reduce noise and dust that travels off site
9. Seat belts to be worn in all vehicles and equipment at all times
10. Refuelling vehicles will be done at one central point. No smoking within 7.5 meters of the refuelling point
11. Spills response is everyone's duty. In the event of a spill all work shall cease and everyone will gather at the spill area to help with the containment and clean up.
12. **Muster point** will be at the laydown area and will be marked with a sign. Stay there until you are counted!
13. **You must report immediately all Near miss', All types of Incidents including equipment damage and damage to the clients property, All vehicle and equipment Accidents no matter how minor, and all Injuries no matter how slight to your supervisor asap!**

## 14.To report a serious accident to OH&S call 780-415-8690 or 1-866-415-8690

## 15.Joburg Emergency Contacts

**Safety Manager - Glen Frank (780) 887-4331**
**Pit Manager - Ryan Brown (780) 233-3583**
**Sales Manager - Lucas Bodnar (780) 293-2105**

**STARS®** **Site Number** 5793
**Location** SW 36-54-22-W4

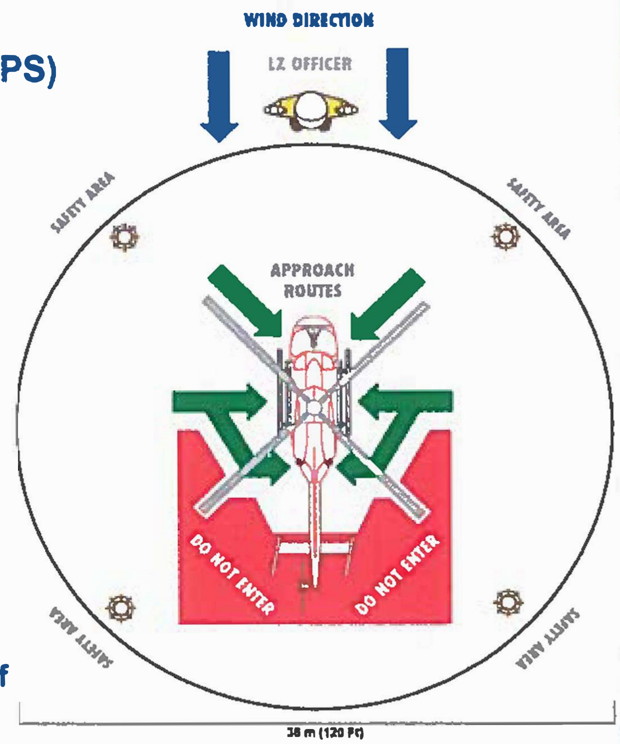
# Remote Site Landing Zone Reference Card

**In the event of a SITE EMERGENCY**
**PHONE the STARS Emergency Link Centre®**

| TOLL FREE | OR | DIRECT |
|---|---|---|
| 1-888-888-4567 | | 403-299-0932 |

## BE PREPARED WITH THE FOLLOWING INFORMATION

1. STARS Site Number
2. Location of site (Legal Land Description or GPS)
3. Contact phone number at the site
4. Known hazards on-site
5. If applicable, is there a monitor on-site confirming the presence of $H_2S$



STARS LANDING ZONE

## SAFETY GUIDELINES

- the landing zone should be on level ground, (less than 5% slope) at least 36 x 36 metres (120 x 120 ft) and more, if possible, to include a safety zone
- check for loose debris in landing zone THIS IS OF VITAL IMPORTANCE
- ensure no one approaches the helicopter STARS crew will approach you when safe to do so
- everyone should be at least 30 metres from landing zone during landing and takeoff, due to possibility of injury from loose debris caused by rotor downwash
- movement around aircraft is to be in safe areas only
- if necessary, provide road blocks approximately 500 metres on either side of the landing zone

## PRE-LANDING CHECKLIST

The STARS Emergency Link Centre will require the following information from the site:

| TERRAIN | LANDING ZONE MARKINGS | HAZARDS |
|---|---|---|
| level or sloping | 4 turbo flares or strobe flares (no chemical flares) | signs |
| type of surface | 4 highway cones (days only) | vehicles |
| dust, loose snow, | Extra strobes, flares, or cones on upwind side | trees |
| rocks, bushes, | | equipment |
| stumps, etc. | | wires |

aci Acoustical Consultants Inc.
5031 – 210 Street
Edmonton, Alberta, Canada T6M 0A8
Phone: (780) 499-1591
www.aciacoustical.com

# Environmental Noise Impact Assessment
For The

# Joburg Aggregates
# (SW & NW 25-54-22-W4M)

Prepared for:

**Joburg Aggregates**

Prepared by:
P. Froment, B.Sc., B.Ed., P.L.(Eng.)
**aci Acoustical Consultants Inc.**
Edmonton, Alberta
APEGA Permit to Practice #P7735

PROFESSIONAL LICENSEE (ENGINEERING) ALBERTA
PATRICK FROMENT
Member ID :196923

**10/31/2022**

**PERMIT TO PRACTICE**
**ACI ACOUSTICAL CONSULTANTS INC.**
Signature
Date 10/31/2022
**PERMIT NUMBER: P 7735**
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

**aci Project #:22-051**
**10/31/2022**

## Disclaimer

This report has been prepared by acl Acoustical Consultants Inc. (acl) in response to a specific request for service from, and for the exclusive use of, the Client to whom the report is addressed. The report has been prepared in a manner consistent with a level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. The findings contained in this report are based, in part, upon information provided by others. acl does not vouch for the accuracy of information provided by others or how that may impact the accuracy of the results presented in the report. The information contained in this report is not intended for use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed, with the exception of the applicable regulatory authority to whom this document may be submitted. Any, calculation methods and noise models prepared by acl are considered proprietary professional work product and shall remain the copyright property of acl who authorizes only the Client to use and make copies of the report.

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Unless otherwise stated, the suggestions, recommendations, and opinions given in this report are intended only for guidance of the Client in the design of the specific project. The extent and detail of investigations, necessary to determine all of the relevant conditions which may affect potential project construction costs would normally be greater than has been carried out for design purposes. Any Contractors bidding on, or undertaking work discussed in this report, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, including but not limited to proposed construction techniques, materials selected, schedule, safety, and equipment capabilities.

## Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Joburg Aggregates to conduct an environmental noise impact assessment (NIA) for their existing Joburg Pit (the Project) in Strathcona County, AB. As part of the study, a long-term noise monitoring was conducted at two locations within the study area. In addition, detailed on-site measurements were conducted throughout the site during crushing operations. The information from the noise monitoring, the on-site measurements and operational information were used to generate a computer noise model of the study area under current and future conditions. The results of the noise model were used to evaluate the noise impact of the Project operations for residential receptors within 2.0 km of the Project boundaries. Site work was conducted for aci in September and October 2022, by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

The results of Current Configuration noise modeling scenario matched well with the noise monitoring results and indicated $L_{eq}$ sound levels ranging from 25.4 dBA to 45.4 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries.

The results of the Pit Operations noise modeling scenario representing equipment involved in stripping, aggregate and clay extraction, stockpiling, loading trucks, and reclamation indicated $L_{eq}$ sound levels ranging from 25.1 dBA to 43.5 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The most significant noise contributor for this scenario was from the scrapers.

The results of the Hauling noise modeling scenario representing the haul trucks and loaders indicated $L_{eq}$ sound levels ranging from 0 dBA to 25.0 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries.

The results of the Aggregate Processing and Washing noise modeling scenario representing equipment associated with crushing, screening, and washing indicated $L_{eq}$ sound levels ranging from 25.4 dBA to 46.3 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The most significant noise contributor for this scenario was from the shaker tables.

The results of the Mitigation Case noise modeling scenario resulted in $L_{eq}$ sound levels ranging from 25.0 dBA to 41.7 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The relative difference when compared to the Current Configuration scenario was -0.3 to -3.7 dBA. To achieve these results recommendations were provided for the location of the equipment, the configuration of the site and lastly, by the utilization of strategically placed stockpiles.

**Table of Contents**

## List of Tables



## List of Figures

## 1.0 Introduction

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Joburg Aggregates to conduct an environmental noise impact assessment (NIA) for their existing Joburg Pit (the Project) in Strathcona County, AB. As part of the study, a long-term noise monitoring was conducted at two locations within the study area. In addition, detailed on-site measurements were conducted throughout the site during crushing operations. The information from the noise monitoring, the on-site measurements and operational information were used to generate a computer noise model of the study area under current and future conditions. The results of the noise model were used to evaluate the noise impact of the Project operations for residential receptors within 2.0 km of the Project boundaries. Site work was conducted for aci in September and October 2022, by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

## 2.0 Location & Operational Description

### 2.1. Location Description

The Project is located approximately 3 km southwest of Josephburg, Alberta, at SW & NW 25-54-22-W4M within Strathcona County, as indicated in Figure 1. The entrance to the pit is directly east of Range Road 221 and 800 m south of Township Road 550. Presently there are 30[1] residential receptor locations found within 2.0 km of the Project with the nearest approximately 785 m northeast of the Project's northeast border.

In addition to the Project, other operations within the study area that contribute to the overall noise climate include the Warren Thomas Aerodrome (runway is approximately 2.7 km from the site), the Canadian Pacific rail line (directly adjacent to the southeast corner of the Project). In addition, the Project is within 3.0 km of the southeastern boundary of the Alberta Heartland Region (AHR). The AHR includes +40 companies in a variety of sectors, including producing and processing oil, gas, and petrochemicals, as well as advanced manufacturing. Due to the relative size of these facilities, their noise emissions are subjectively audible[2] within the Project site.

Topographically, the Project is found within an area that is relatively flat with minimal changes in elevation. Elevation contours for the entire study area have been included in the noise model. The vegetation in the area consists mainly of grain crops with varying areas of trees and shrubs. Given the relative distance between the noise sources and closest impacted residences, the vegetative sound absorption is considered moderate.

[1] This was based on subjective confirmation. Any missing locations can still be identified in the colour noise contours figures.
[2] Subjectively observed during the site visit.

## 3.0 Operational Description

### 3.1. Hours of Operations

Joburg is proposing changes to the hours of operation at the pit as described below:

#### 3.1.1. Pit Operations (including stripping, aggregate and clay extraction, stockpiling, loading trucks and reclamation)

- Monday through Saturday from 6:00 to 19:00
- No Sundays or Statutory Holidays

#### 3.1.2. Product Hauling

- Monday through Saturday from 6:00 to 19:00
- No Sundays or Statutory Holidays

#### 3.1.3. Aggregate Processing (including crushing, screening, and washing)

- 7 days a week, 24 hours a day[1]

### 3.2. Mine Sequencing & Stages of Excavation

As indicated in Figure 1, the extraction area is divided into 29 excavation sites. The initial excavation and current operations are occurring in the northern phases (MB1A – MB4A & MB17A – MB20A). Specifically, processing and stockpiling is occurring in phases MB17A – MB20A, however these will be the last cuts. Following the completion of MB9B work will progress throughout the site before terminating in the southernmost phases of the Project (MB1B - MB9B).

#### 3.2.1. Pit Operations

Pit operations includes, stripping of reclamation material, extraction of clay and aggregate, processing of aggregate material, hauling of product material (clay and aggregate) and reclamation. The stripping operations involve the stripping of vegetation, topsoil, subsoil, and overburden, which will either be stockpiled or directly placed. Reclamation operations involves replacement of reclamation material (screenings, overburden, subsoil, topsoil) in previous areas of aggregate or clay extraction followed by seeding. The equipment associated with both operations will move throughout the entire site and has been modeled as such.

[1] Based on current demands it is estimated crushing will occur for periods of approximately 20-30 days, per mining block.

The specific equipment associated with these operations includes:

- Six - Cat 627 motor scrapers (or equivalent)
- One - Cat 140 grader (or equivalent)
- Three - Cat 345 track excavators (or equivalent),
- Six - Volvo A40 haul trucks (or equivalent),
- One -Cat D8 dozer (or equivalent)
- Two- Cat D6 dozers (or equivalent)

### 3.2.2. Product Hauling

The hauling operations involve the loading of the product (with the use of a wheel-loader(s)) into the tractor trailers for delivery off-site. During peak hauling months, it is anticipated that an average of 60 truck loads (one way) will be completed per day. Each truck must enter and leave the site, therefore there will be a total of 120 trips per day (1 inbound and 1 outbound for each truck).

### 3.2.3. Aggregate Processing & Washing

The crushing operations involve the screening and washing of aggregate material which is then crushed and moved (using conveyors) to various stockpiles around the site. Equipment associated with this operation includes:

- 36' belt feeder with hydraulic grizzly
- 20" x 8' – 3 deck inclined screen
- Two - 60" cone crusher
- Conveyors - 6 of 36"x50' transfer conveyors
- 36" "Tele-stacker" conveyor
- 36" x 100' radial stacking conveyor for reject sand
- Diesel-electric generator and switch gear
- Two - Cat 980 (or equivalent) loader
- Three - Volvo A40 haul trucks (or equivalent),

## 4.0 Measurement Methods

### 4.1. Environmental Noise Monitoring

As part of the study, a long-term environmental noise monitoring was conducted at two locations within the study area. The north noise monitoring location, as shown in Figure 2, was selected to determine the noise contributions of current configuration of the operations for the Project. This location was also used as a calibration tool for the noise model to ensure of agreement between the current noise climate and the representative noise model.

The south noise monitoring location, as shown in Figure 3, was selected as a representative case of the typical ambient noise levels of the study area, while there were no crushing activities at the Project site.

The noise monitoring was conducted over a 2-week period from October 4 – October 18, 2022 (14 days in total). The noise monitoring was conducted collecting broadband A-weighted and C-weighted as well as 1/3 octave band sound levels. In addition, the noise monitoring was accompanied by a digital audio recording for more detailed post process analysis. A local weather monitoring station was used throughout the entire noise monitoring period to obtain the wind speed, wind direction, temperature, relative humidity, barometric pressure, and rainfall.

Refer to Appendix I for a detailed description of all measurement equipment used in addition to calibration records, Appendix II for a description of the acoustical terminology, and Appendix III for a list of common noise sources. The noise measurement instrumentation was calibrated at the start of the monitoring and then checked afterwards to ensure that there had been no calibration drift over the duration of the monitoring.

### 4.2. Short Term Sound Level Measurements

Short-term sound level measurements were performed on Wednesday September 21, 2022, throughout the Project site. The purpose of the measurements was to obtain noise level data of the existing equipment, under operation, that is currently in use for this Project, particularly for the crushing operations. This information was then used to determine the sound power levels for the representative Project equipment which was then used in the computer noise model. In addition, the measurements allowed for the observation of specific procedures and operations associated with the Project.

While on-site, all short-term sound level measurements were conducted using approximately 60-second Leq sampling while the equipment was under full load. Therefore, the data obtained is representative of the equipment's maximum noise levels. The information gathered consisted of broadband linear, A-weighted, C-weighted and 1/3 octave band sound levels. The weather during the sound level measurements was overcast with calm wind.

All noise measurement instrumentation was calibrated at the start of the measurements and then checked afterwards to ensure that there had been no calibration drift over the duration of the measurements. Refer to Appendix I for the calibration records.

## 5.0 Computer Noise Modeling Methods

### 5.1. Noise Modeling Parameters

The computer noise modeling was conducted using the CADNA/A (Version 2022 MR2, build: 193.5260) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and various stationary sources. In addition, topographical features such as land contours, vegetation, and bodies of water can be included. Finally, meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction can be included in the calculations.

The calculation method used for noise propagation follows the ISO standard 9613-2. All receiver locations were assumed as being downwind from the source(s). In particular, as stated in Section 5 of the ISO document:

> *"Downwind propagation conditions for the method specified in this part of IS0 9613 are as specified in 5.4.3.3 of IS0 1996-2:1987, namely*
>
> - *wind direction within an angle of ± 45⁰ of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and*
> - *wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.*
>
> *The equations for calculating the average downwind sound pressure level LAT(DW) in this part of IS0 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.*
>
> *These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights".*

A temperature of $10^0$C and a relative humidity of 70% were used in the model[1]. Due to the relative distances involved and the type of vegetation that exists in the study area a ground absorption value of 0.8 was used in the model, which is representative of the ground conditions in the study area. Vegetation was not included in the model and as a result, all sound level propagation calculations are considered representative of summertime conditions for all surrounding residents[1].

## 5.2. Noise Modeling Scenarios

As part of the study, various scenarios were modeled for the various stages and phases of the Project[2]. The scenarios are as follows:

1) Current Configuration Conditions: This scenario was representative of the current configuration case conditions with existing site equipment and configuration. The baseline noise monitoring data was used as a calibration method for the model.

2) Pit Operations (including stripping, aggregate and clay extraction, stockpiling, loading trucks and reclamation): This included activities associated the stripping and removal & reclamation of the vegetation, topsoil and subsoil (Phases MB6A, MB12A & MB9B were investigated).

3) Hauling of product: This included all activities associated with the loading and hauling of the product. (Phases MB17A, MB9A & MB9B were investigated).

4) Aggregate Processing, Washing & Hauling (including crushing, screening, and washing): This scenario was representative of the screening and crushing of material: This included activities associated with the aggregate extraction, processing (Crushing) of material in addition to general operations of the pit. This also included activities associated with the loading of the product in addition to hauling along Range Road 221. (Phases MB4A, MB9A & MB9B were investigated).[3]

5) Noise Mitigation for Current Conditions: This included equipment and activities associated with the existing site equipment and configuration with the addition of noise mitigation recommendations.

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[1] This is consistent with common practices of other regulating bodies. The values chosen are intended to result in projected sound levels for all surrounding residents reflective of summertime conditions.

[2] Not each Phase found within Figure 1 was modeled. Instead, specific Phases were chosen that represented equal impacts for the east and west noise climates.

[3] It should be noted that washing did not occur in 2022. However, it has been included in the modeling scenarios.

## 5.3. Noise Sources & Site Parameters

All data used in the model representing the Project equipment was obtained from i) on-site[1] short-term sound level measurements as described in Section 4.2 or ii) from measurements conducted for previous projects on similar/equivalent equipment. All measurements were conducted while the equipment was under full-load (i.e. not idling). In addition, all noise sources in the model assume that the equipment is operating throughout the entire operating period, therefore there has been no reduction of the noise levels to account for typical breaks that occur during typical work-shifts.

For all noise modeling scenarios, the noise sources associated with the Project have been modeled as traveling or stationary point sources at their appropriate heights that radiate noise equally in all directions (spherically & cylindrically), described in Appendix IV. Directionality has not been applied to any equipment. In addition to the noise sources, buildings associated with the site were included in the model, where applicable. The various heights of the buildings associated with crushing were based on observations made at the Project site on Wednesday, September 2, 2022.

All sound power levels (SWLs) used in each of the modeling scenarios are provided in Appendix IV.

## 5.4. Elevation Changes

Elevation contours were implemented into the model. Current elevations within the Project site were obtained from a drone flight conducted in May 2022 while the remainder of the elevation contours for the for the study area (i.e. outside of the Project limit) were provided by Sameng Inc. All equipment was modeled at their approximate height and depth within the pit.

## 5.5. Modeling Confidence

As mentioned previously, the algorithms used for the noise modeling follow the ISO 9613 standard. The published accuracy for this standard is ±3 dBA between 100 m – 1,000 m. Accuracy levels beyond 1,000 m are not published. Experience based on similar noise models conducted over large distances shows that, as expected, as the distance increases, the associated accuracy in prediction decreases. Experience has shown that environmental factors such as wind, temperature inversions, topography and ground cover all have increasing effects over distances larger than approximately 1,500 m.

[1] It should be noted that field measurements are the preferred method of obtaining sound level data as theoretical data or extrapolation techniques can lead to inaccuracies.

## 6.0 Noise Descriptors

Environmental noise levels from industrial noise sources are commonly described in terms of equivalent sound levels or $L_{eq}$. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These $L_{eq}$ in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) $L_{eq}$Day and night-time (22:00 to 07:00) $L_{eq}$Night while other criteria use the entire 24-hour period as $L_{eq}$24. Another method of conveying long term noise levels utilizes statistical descriptors. Since the projected noise levels are representative of when the Project while under full operation the $L_{eq}$ descriptor will be referenced in all tables.

## 7.0 Results and Discussion

### 7.1. Short-Term Sound Level Measurements

As previously mentioned, short-term sound level measurements were performed on September 21 and October 25, 2022, at the Project site. Measurements were conducted at various locations around the site to determine the contribution of the various noise sources. The results of each measurement can be found in Table 1.

**Table 1. Short-Term Sound Level Measurement Results**

| Measurement Number | Description | Distance (m) | Sound Pressure Level (dBA) |
|---|---|---|---|
| 1 | Shaker Table | 5 | 85.6 |
| 2 | Shaker Table | 10 | 82.1 |
| 3 | Shaker + Crush | 10 | 82.0 |
| 4 | Shaker + Crush | 20 | 79.5 |
| 5 | Shaker + Crush | 25 | 77.2 |
| 6 | Cone Crusher | 5 | 89.9 |
| 7 | Cone Crusher | 7 | 87.4 |
| 8 | Interior Area | 6 | 91.1 |
| 9 | Genset | 5 | 84.2 |
| 10 | Genset | 8 | 82.0 |
| 11 | Shaker 3 | 5 | 85.5 |
| 12 | Open Window to Genset | 5 | 88.4 |
| 13 | Feeder | 5 | 85.6 |
| 14 | Shaker 3 | 5 | 84.8 |
| 15 | Shaker 1 & 2 | 10 | 86.7 |
| 16 | Shaker 1 & 2 | 20 | 83.0 |
| 17 | Shaker 1 & 2 | 30 | 80.4 |
| 18 | Rock Truck | 4 | 76.6 |
| 19 | Water Pump | 5 | 78.2 |
| 20 | Small Generator | 1 | 59.4 |

## 7.2. Environmental Noise Monitoring

The results obtained from the environmental noise monitoring are presented in Table 2 and Figures 4 – 6, respectively (broadband A-weighted $L_{eq}$ sound levels and 1/3 octave band $L_{eq}$ sound levels provided). For the purposes of the data analysis, two (2) 24-hour periods (October 6 - 7, 2022, and October 17 – 18, 2022) will be reviewed. Each 24-hour time period has been separated between operational and non-operational hours. The analysis for each noise monitoring location can be found below.

**Table 2. Monitored Noise Monitoring $L_{eq}$ Sound Levels**

| Location | Date | | Operational Hours[1] (07:00 – 18:30) | Non-Operational Hours (18:30 – 07:00) |
|---|---|---|---|---|
| | | | $L_{eq}$ (dBA) | |
| South Monitor | October 6 - 7, 2022 | | 42.9 | 40.6 |
| North Monitor | October 17 - 18, 2022 | | 54.2 | 40.3 |

### 7.2.1. Southern Monitoring Location (Ambient)

The results from the southern noise monitoring location indicated $L_{eq}$ noise levels of 42.9 & 40.6 dBA, respectively, between the operational and non-operational hours. The October 6 - 7, 2021 time period was selected for the southern noise monitoring location as the meteorological conditions were favorable (low wind speeds) and the crusher was not in operation. This was confirmed by Joburg representatives and from the audio recording at the southern and northern locations. The $L_{eq}$ results for the southern noise monitoring location have not been adjusted in anyway, thus it would be anticipated that the $L_{eq}$ noise levels of 42.9 & 40.6 dBA are representative of the "typical" noise climate of the area.

### 7.2.2. Northern Monitoring Location

The results from the northern noise monitoring location indicate $L_{eq}$ noise levels of 54.2 & 40.3 dBA, respectively, between the operational and non-operational hours. This would be anticipated due to the proximity of the northern noise monitoring relative to the Project equipment. The October 17 - 18, 2022 time period was selected for this location as the meteorological conditions were favorable (low wind speeds with the noise monitor downwind from the crushing equipment) and the site (in particular, the crushing equipment) was fully operational. This was verified in reviewing the overall broadband noise levels in addition to the simultaneous audio recording.

[1] The hours provided are based on the audibility of equipment in the audio recording for the north monitor.

Differently from the southern noise monitoring results, the $L_{eq}$ results for the northern noise monitoring location have been adjusted by the isolation (removal) of any abnormal noise events such as birds chirping, train passages, aircraft fly-overs, etc. Therefore, the results provided in Table 2 are representative of the contributions of the Project at the noise monitoring location during "typical" conditions when the site is fully operational. Refer to Appendix V for a detailed list of the removed data including the start/stop times, the duration of the removed data, and the reason for the removal. Again, based on the favorable weather conditions and site operations, it is anticipated that the $L_{eq}$ noise level of 54.2 dBA accurately represents the noise contributions from the site this location.

#### 7.2.3. Weather Conditions

The weather conditions during the October 6 - 7, 2022, noise monitoring period were mild to moderate (primarily between 5 - 10 km/hr) and predominately from the south/southwest. The temperature ranged from 0°C to 20°C. The relative humidity varied between approximately 38% - 100%.

The weather conditions during the October 17 - 18, 2022, noise monitoring period were mild to moderate (primarily between 0 - 10 km/hr) and predominately from the south/southwest, thus resulting in downwind conditions from the crushing equipment to the noise monitor. The temperature ranged from 0°C to 22°C. The relative humidity varied between approximately 27% - 93%.

Weather data obtained from the weather station are presented in Appendix VI.

## 7.3. Computer Noise Modelling

### 7.3.1. Current Configuration Scenario

The projected $L_{eq}$ results of the Current Configuration Case noise modeling at the monitoring location is provided in Table 3. As mentioned previously, the noise monitoring data was used as a calibration tool for the noise model. The relative difference between the modeling and monitoring results is also provided. As indicated in Table 3, the modeling data matches very well with the measured values.

**Table 3. Current Configuration Noise Modeling Results at North Monitor Location**

| Location | Monitor Average $L_{eq}$Day (dBA) | Model $L_{eq}$Day (dBA) | Relative Difference (dBA) |
|---|---|---|---|
| Monitoring Location | 54.2 | 54.5 | 0.3 |

The results of the Current Configuration Case noise modeling at the various residential receptor locations within the study are presented in Table 3 and in Figure 7. The projected $L_{eq}$ noise levels range from 25.4 to 45.4 dBA. In general, the projected existing noise levels of the residential receptor locations decrease as their relative distance to the Project increases. It should be noted however, that in certain cases, as reflected in the colour noise contours in Figure 7, due to the existing berming/stockpile on-site and changes in the topography, certain residential receptors further from the project could potentially have higher noise levels than other locations that are closer in proximity to the Project.

**Table 4. Current Configuration Case Noise Modeling Results**

| Receptor (Distance from Project Boundary) | Current Case Leq (dBA) | Receptor (Distance from Project Boundary) | Current Case Leq (dBA) |
|---|---|---|---|
| R-01 (815m) | 42.2 | R-16 (1740m) | 28.2 |
| R-02 (860m) | 42.6 | R-17 (1670m) | 28.6 |
| R-03 (730m) | 43.9 | R-18 (560m) | 34.7 |
| R-04 (745m) | 45.4 | R-19 (1180m) | 32.1 |
| R-05 (890m) | 40.6 | R-20 (1270m) | 32.4 |
| R-06 (720m) | 44.5 | R-21 (1580m) | 31.8 |
| R-07 (750m) | 39.0 | R-22 (1750m) | 31.1 |
| R-08 (1350m) | 33.5 | R-23 (1590m) | 32.2 |
| R-09 (1300m) | 31.4 | R-24 (1680m) | 33.7 |
| R-10 (980m) | 33.1 | R-25 (1040m) | 39.3 |
| R-11 (1150m) | 31.0 | R-26 (860m) | 40.8 |
| R-12 (1450m) | 28.3 | R-27 (840m) | 41.1 |
| R-13 (1800m) | 27.5 | R-28 (940m) | 40.3 |
| R-14 (1950m) | 25.4 | R-29 (1770m) | 34.1 |
| R-15 (1150m) | 29.1 | R-30 (1800m) | 33.9 |
| | | | |
| Minimum | 25.4 | Maximum | 45.4 |

Table 4 indicates that the highest projected noise levels will be for resident R-04, which was anticipated due to the distance from this residence to the Project site. Table 5 indicates that the most significant noise contributor to R-04 will be from the two shaker tables. This was anticipated and is consistent with the measurements on-site which indicated that the shaker tables were the most significant noise sources on site.

**Table 5. Broadband Sound Level Contributions at Resident R-04 (Current Case)**

| Noise Source | dBA |
|---|---|
| Shaker #1 | 40.4 |
| Shaker #2 | 40.4 |
| Cone Crusher #2 | 36.3 |
| Cone Crusher #1 | 35.8 |
| Genset #2 | 33.9 |
| Shaker #3 | 28.8 |
| Genset Side | 25.8 |
| Feeder | 25.1 |
| Rock Truck | 24.2 |
| Genset #1 | 23.0 |
| Loader (Feeder) | 21.8 |
| Haul Truck | 18.5 |
| Loader (Haul) | 17.4 |
| Water Pump | 15.9 |
| Electric Generator | 0.0 |

### 7.3.2. Pit Operations Scenario

The results of the Pit Operations noise modeling scenario representing equipment involved in stripping, aggregate and clay extraction, stockpiling, loading trucks, and reclamation are presented in Table 6. An example from Phase MB9B is illustrated in Figure 8[1]. The blue highlighted cells indicate the highest project noise levels for each resident during that given operational phase.

**Table 6. Residential Sound Pressure Levels for Pit Operations**

| Receptor (Distance from Project Boundary) | MB6A | MB12A | MB9B | Receptor (Distance from Project Boundary) | MB6A | MB12A | MB9B |
|---|---|---|---|---|---|---|---|
| | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) |
| R-01 (815m) | 37.1 | 33.7 | 29.7 | R-16 (1740m) | 27.4 | 29.9 | 32.6 |
| R-02 (860m) | 38.3 | 35.1 | 31.2 | R-17 (1670m) | 27.8 | 30.4 | 33.0 |
| R-03 (730m) | 39.5 | 36.0 | 31.8 | R-18 (560m) | 34.3 | 38.7 | 43.5 |
| R-04 (745m) | 41.4 | 38.6 | 34.7 | R-19 (1180m) | 31.4 | 34.4 | 37.0 |
| R-05 (890m) | 39.6 | 38.1 | 35.0 | R-20 (1270m) | 31.6 | 34.5 | 36.5 |
| R-06 (720m) | 42.2 | 40.3 | 37.0 | R-21 (1580m) | 30.8 | 33.0 | 34.2 |
| R-07 (750m) | 37.4 | 41.8 | 40.2 | R-22 (1750m) | 30.1 | 32.1 | 33.1 |
| R-08 (1350m) | 32.2 | 34.0 | 35.0 | R-23 (1590m) | 31.2 | 33.3 | 34.2 |
| R-09 (1300m) | 31.1 | 33.5 | 35.3 | R-24 (1680m) | 32.3 | 34.7 | 33.9 |
| R-10 (980m) | 32.4 | 35.3 | 37.8 | R-25 (1040m) | 34.7 | 31.8 | 28.3 |
| R-11 (1150m) | 30.0 | 33.1 | 36.9 | R-26 (860m) | 35.7 | 32.4 | 28.4 |
| R-12 (1450m) | 28.0 | 30.9 | 34.6 | R-27 (840m) | 36.0 | 32.6 | 28.5 |
| R-13 (1800m) | 26.2 | 28.9 | 32.3 | R-28 (940m) | 35.3 | 32.0 | 28.0 |
| R-14 (1950m) | 25.1 | 28.0 | 31.9 | R-29 (1770m) | 30.7 | 28.3 | 25.5 |
| R-15 (1150m) | 28.9 | 32.5 | 37.8 | R-30 (1800m) | 30.5 | 28.2 | 25.4 |
| | | | | | | | |
| Minimum | 25.1 | 28.0 | 25.9 | Maximum | 42.2 | 41.8 | 43.5 |

Table 6 indicates that there is a significant variation in the $L_{eq}$ noise levels for the various residents under the various phases of the operations. The $L_{eq}$ noise levels range from 25.1 dBA to 43.5 dBA. In general, the contribution from the Project at each of the residences is most significant when operations are nearest to their location. The highest anticipated noise levels of any resident are for R-18 when the Project operations are in Phase MB9B. This was anticipated due to the proximity of this residential location relative to the Project equipment.

[1] The color contours were only generated for Phase MB9B for this stage as this is the phase in which the highest projected noise levels are projected to occur.

Table 7 indicates that the most significant noise contributor to R-18 will be from the scrapers. This was anticipated and is consistent with previous, similar projects in which the scrapers are often one of the most significant noise sources, particularly when considering that it is possible that six (6) will be operating at the same time and under full-load[1].

**Table 7. Phase MB9B – R-18 - Broadband Sound Level Contributions from Pit Operations**

| Noise Source | dBA |
|---|---|
| Scrapers | 42.1 |
| Grader | 32.0 |
| D8 Dozer | 31.5 |
| Excavator #1 | 30.1 |
| Rock Truck | 29.8 |
| D6 Dozers | 27.9 |
| Excavator #2 | 26.9 |
| Excavator #3 | 25.2 |

[1] It should again be noted that these are conservative estimates.

7.3.3. Hauling Scenario

The results of the Hauling noise modeling scenario representing equipment representing the haul trucks and loaders are presented in Table 8. An example from Phase MB9B is illustrated in Figure 9[1]. The blue highlighted cells indicate the highest project noise levels for each resident during that given operational phase.

**Table 8. Residential Sound Pressure Levels for Hauling Operations**

| Receptor (Distance from Project Boundary) | MB17A | MB12A | MB9B | Receptor (Distance from Project Boundary) | MB17A | MB12A | MB9B |
|---|---|---|---|---|---|---|---|
| | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) | $L_{eq}$ (dBA) |
| R-01 (815m) | 21.6 | 20.2 | 19.9 | R-16 (1740m) | 4.3 | 8.3 | 13.6 |
| R-02 (860m) | 20.8 | 20.7 | 20.4 | R-17 (1670m) | 4.8 | 8.9 | 14.1 |
| R-03 (730m) | 22.0 | 22.1 | 21.8 | R-18 (560m) | 11.3 | 16.9 | 25.0 |
| R-04 (745m) | 21.0 | 23.3 | 23.3 | R-19 (1180m) | 8.2 | 13.4 | 18.8 |
| R-05 (890m) | 19.5 | 21.7 | 22.1 | R-20 (1270m) | 8.4 | 13.7 | 18.5 |
| R-06 (720m) | 20.4 | 24.6 | 24.0 | R-21 (1580m) | 7.8 | 12.6 | 16.3 |
| R-07 (750m) | 13.9 | 20.6 | 23.4 | R-22 (1750m) | 7.5 | 11.7 | 15.0 |
| R-08 (1350m) | 10.6 | 13.6 | 17.6 | R-23 (1590m) | 8.1 | 13.1 | 16.4 |
| R-09 (1300m) | 9.2 | 12.5 | 17.4 | R-24 (1680m) | 11.0 | 14.3 | 17.5 |
| R-10 (980m) | 10.2 | 14.1 | 20.1 | R-25 (1040m) | 20.1 | 19.4 | 19.1 |
| R-11 (1150m) | 7.3 | 11.3 | 18.4 | R-26 (860m) | 23.1 | 21.8 | 21.6 |
| R-12 (1450m) | 5.2 | 8.9 | 15.8 | R-27 (840m) | 23.6 | 22.3 | 22.0 |
| R-13 (1800m) | 3.2 | 6.7 | 13.1 | R-28 (940m) | 22.6 | 21.2 | 20.9 |
| R-14 (1950m) | 0.0 | 5.6 | 12.3 | R-29 (1770m) | 14.3 | 12.1 | 11.5 |
| R-15 (1150m) | 3.2 | 10.2 | 18.8 | R-30 (1800m) | 14.1 | 11.9 | 11.2 |
| | | | | | | | |
| Minimum | 0.0 | 5.6 | 11.5 | Maximum | 23.6 | 24.6 | 25.0 |

Table 8 indicates variation in the noise levels for the various residents under the various phases of the operations with the $L_{eq}$ noise levels ranging from 0 dBA to 25.0 dBA. In general, the contribution from the Project at each of the residences is most significant when operations are nearest to their location. The highest anticipated noise levels of any resident are for R-18 when the Project operations are in Phase MB9B. Again, this was anticipated due to the proximity of these residential locations relative to the Project equipment. Table 9 provides the contributions from the loader and haul trucks for R-18 during Phase MB9B.

[1] The color contours were only generated for Phase MB9B for this stage as this is the phase in which the highest projected noise levels are projected to occur.

**Table 9. Phase MB9B – R-18 - Broadband Sound Level Contributions from Hauling Operations**

| Noise Source | dBA |
|---|---|
| Loader (Haul) | 22.7 |
| Haul Trucks | 21.2 |

### 7.3.4. Aggregate Processing and Washing Scenario

The results of the Aggregate Processing and Washing noise modeling scenario representing equipment associated with crushing, screening, and washing are presented in Table 10. An example from Phase MB9B is illustrated in Figure 10[1]. The blue highlighted cells indicate the highest project noise levels for each resident during that given operational phase.

**Table 10. Residential Sound Pressure Levels for Processing & Washing Operations**

| Receptor (Distance from Project Boundary) | MB4A $L_{eq}$ (dBA) | MB9A $L_{eq}$ (dBA) | MB9B $L_{eq}$ (dBA) |
|---|---|---|---|
| R-01 (815m) | 40.8 | 38.3 | 32.8 |
| R-02 (860m) | 42.6 | 40.5 | 36.3 |
| R-03 (730m) | 43.9 | 41.4 | 36.8 |
| R-04 (745m) | 43.1 | 44.4 | 38.0 |
| R-05 (890m) | 40.6 | 41.3 | 38.4 |
| R-06 (720m) | 44.5 | 46.2 | 41.7 |
| R-07 (750m) | 39.0 | 43.4 | 43.9 |
| R-08 (1350m) | 33.5 | 35.3 | 37.3 |
| R-09 (1300m) | 31.4 | 34.7 | 37.4 |
| R-10 (980m) | 33.1 | 36.4 | 39.9 |
| R-11 (1150m) | 30.9 | 34.1 | 38.7 |
| R-12 (1450m) | 28.2 | 32.6 | 36.3 |
| R-13 (1800m) | 27.4 | 30.7 | 33.9 |
| R-14 (1950m) | 25.4 | 28.9 | 33.0 |
| R-15 (1150m) | 29.1 | 33.4 | 38.8 |
| | | | |
| Minimum | 25.4 | 28.9 | 28.5 |

| Receptor (Distance from Project Boundary) | MB4A $L_{eq}$ (dBA) | MB9A $L_{eq}$ (dBA) | MB9B $L_{eq}$ (dBA) |
|---|---|---|---|
| R-16 (1740m) | 28.1 | 31.7 | 36.0 |
| R-17 (1670m) | 28.6 | 32.1 | 34.5 |
| R-18 (560m) | 34.6 | 42.8 | 46.3 |
| R-19 (1180m) | 32.1 | 35.6 | 38.2 |
| R-20 (1270m) | 32.4 | 35.6 | 37.4 |
| R-21 (1580m) | 31.7 | 34.3 | 36.7 |
| R-22 (1750m) | 31.1 | 33.4 | 35.6 |
| R-23 (1590m) | 32.1 | 34.6 | 36.7 |
| R-24 (1680m) | 33.7 | 37.8 | 38.0 |
| R-25 (1040m) | 39.3 | 35.0 | 31.1 |
| R-26 (860m) | 40.7 | 35.5 | 31.2 |
| R-27 (840m) | 41.0 | 35.7 | 31.3 |
| R-28 (940m) | 40.2 | 35.1 | 30.9 |
| R-29 (1770m) | 34.1 | 31.4 | 28.6 |
| R-30 (1800m) | 33.9 | 31.3 | 28.5 |
| | | | |
| Maximum | 44.5 | 46.2 | 46.3 |

Table 10 indicates that there is a significant variation in the noise levels for the various residents under the various phases of the operations with the $L_{eq}$ noise levels ranging from 25.4 dBA to 46.3 dBA. In general, the contribution from the Project at each of the residences is most significant when operations are nearest

[1] The color contours were only generated for Phase MB9B for this stage as this is the phase in which the highest projected noise levels are projected to occur.

to their location. The highest anticipated noise levels of any resident are for R-18 when the Project operations are in Phase MB9B. Again, this was anticipated due to the proximity of these residential locations relative to the Project equipment.

Table 11 indicates that the most significant noise contributor to R-18 will be from the shakers which is consistent with current case configuration scenario and previous similar projects.

**Table 11. Phase MB9B – R-18 - Broadband Sound Level Contributions from Processing Operations**

| Noise Source | dBA |
|---|---|
| Shaker #2 | 42.0 |
| Shaker #1 | 39.2 |
| Cone Crusher #1 | 37.9 |
| Cone Crusher #2 | 37.4 |
| Genset #2 | 33.9 |
| Shaker #3 | 30.4 |
| Genset Side | 28.2 |
| Feeder | 27.9 |
| Loader (Feeder) | 27.7 |
| Rock Truck | 26.6 |
| Genset #1 | 24.7 |
| Water Pump | 20.8 |
| Electric Generator | 0.0 |

## 7.4. Mitigation Case Scenario for Current Case Conditions

### 7.4.1. Description of Changes

To achieve the projected noise levels provided in the following tables and figures, the following modifications have been implemented into the model:

1) Strategically Placed Screening or Product Stockpile: The stockpile was placed directly east of the crushing equipment (within 40 m). The benefit of this stockpile is that it close to the crushing equipment which i) is optimal for the shielding of the crushing equipment and ii) it can be easily created with the use of the conveyors. This additionally will allow for the shielding of the equipment for all residents east of the Project. The height of the stockpile was 10 m tall relative to the existing ground[1].
2) Acoustical Silencer/Shroud for Generator: The second generator currently operating in the northwest portion of the crushing site was modeled with an acoustical shield/shroud that was consistent with the existing generator in the central portion of the crushing site. This provides a significant reduction in the overall contributions from the generator (15 dBA reduction) which reduced the overall noise impact for all residential locations.

[1] Based on May 2022 topographical information.

### 7.4.2. Noise Modeling Results

The results of the Mitigation Case noise modeling scenario (for MB4A) are presented in Table 12 and Figure 11. In addition, the relative difference between the Current Configuration Case and the Mitigation Case has also been provided in Table 12.

**Table 12. Residential Sound Pressure Levels for Mitigation Case Scenario (MB4A)**

| Receptor (Distance from Project Boundary) | Mitigation Case MB4A Project Leq (dBA) | Current Case MB4A Project Leq (dBA) | Relative Difference between Cases (dBA) | Receptor (Distance from Project Boundary) | Mitigation Case MB4A Project Leq (dBA) | Current Case MB4A Project Leq (dBA) | Relative Difference between Cases (dBA) |
|---|---|---|---|---|---|---|---|
| R-01 (815m) | 39.2 | 42.2 | -3.0 | R-16 (1740m) | 27.6 | 28.2 | -0.6 |
| R-02 (860m) | 39.6 | 42.6 | -3.0 | R-17 (1670m) | 28.1 | 28.6 | -0.5 |
| R-03 (730m) | 40.9 | 43.9 | -3.0 | R-18 (560m) | 34.3 | 34.7 | -0.4 |
| R-04 (745m) | 41.7 | 45.4 | -3.7 | R-19 (1180m) | 31.8 | 32.1 | -0.3 |
| R-05 (890m) | 39.9 | 40.6 | -0.7 | R-20 (1270m) | 32.1 | 32.4 | -0.3 |
| R-06 (720m) | 41.1 | 44.5 | -3.4 | R-21 (1580m) | 31.5 | 31.8 | -0.3 |
| R-07 (750m) | 38.4 | 39.0 | -0.6 | R-22 (1750m) | 30.8 | 31.1 | -0.3 |
| R-08 (1350m) | 32.7 | 33.5 | -0.8 | R-23 (1590m) | 31.9 | 32.2 | -0.3 |
| R-09 (1300m) | 31.0 | 31.4 | -0.4 | R-24 (1680m) | 33.3 | 33.7 | -0.4 |
| R-10 (980m) | 32.2 | 33.1 | -0.9 | R-25 (1040m) | 37.5 | 39.3 | -1.8 |
| R-11 (1150m) | 29.9 | 31.0 | -1.1 | R-26 (860m) | 39.1 | 40.8 | -1.7 |
| R-12 (1450m) | 27.8 | 28.3 | -0.5 | R-27 (840m) | 39.4 | 41.1 | -1.7 |
| R-13 (1800m) | 26.0 | 27.5 | -1.5 | R-28 (940m) | 38.6 | 40.3 | -1.7 |
| R-14 (1950m) | 25.0 | 25.4 | -0.4 | R-29 (1770m) | 32.4 | 34.1 | -1.7 |
| R-15 (1150m) | 28.8 | 29.1 | -0.3 | R-30 (1800m) | 32.2 | 33.9 | -1.7 |
| | | | | | | | |
| Minimum | 25.0 | 25.4 | -3.7 | Maximum | 41.7 | 45.4 | -0.3 |

As shown in Table 12, there is a relatively significant reduction in the projected noise levels when comparing the two modeling scenarios. The projected difference in noise levels range from -0.3 dBA to -3.7 dBA with overall $L_{eq}$ noise levels for residents ranging from 25.0 – 41.7 dBA.

This most significant reduction was for Receptor R-04, which had their projected noise levels reduced by 3.7 dBA. As indicated in Table 13, the largest reduction was from the second generator followed by the shakers and cone crushers. For the generator, the significant reduction can be attributed to the acoustical silencer in addition to the path between the source and receiver being obstructed by the stockpiles/berms. The stockpile immediately adjacent to the crushing equipment is projected to have a significant impact on the contributions of the shaker tables and cone crushers.

**Table 13. Phase MB4A - R-04 - Broadband Sound Level Contributions from Processing Operations**

| Noise Source | Current Case | Mitigation Case | Relative Difference between Cases (dBA) |
|---|---|---|---|
| | MB4A Project Leq (dBA) | MB4A Project Leq (dBA) | |
| Shaker #1 | 40.4 | 36.8 | **-3.6** |
| Shaker #2 | 40.4 | 36.8 | **-3.6** |
| Cone Crusher #2 | 36.3 | 32.2 | **-4.1** |
| Cone Crusher #1 | 35.8 | 32.2 | **-3.6** |
| Genset #2 | 33.9 | 13.8 | **-20.1** |
| Shaker #3 | 28.8 | 26.1 | **-2.7** |
| Genset Side | 25.8 | 23.5 | **-2.3** |
| Feeder | 25.1 | 25.1 | **0.0** |
| Rock Truck | 24.2 | 24.2 | **0.0** |
| Genset #1 | 23.0 | 22.5 | **-0.5** |
| Loader (Feeder) | 21.8 | 21.8 | **0.0** |
| Haul Truck | 18.5 | 18.5 | **0.0** |
| Loader (Haul) | 17.4 | 17.4 | **0.0** |
| Water Pump | 15.9 | 15.9 | **0.0** |
| Electric Generator | 0.0 | 0 | **0.0** |

## 8.0 Potential Noise Mitigation Recommendations

In addition to the noise mitigation strategies provided in the previous section, there are additional mitigation strategies that can be employed to reduce the noise impact of the Project on the nearby residents. The following are general noise mitigation approaches that can be used for all stages of the extraction:

- Initially, replace large, loud pieces of equipment with smaller, quieter pieces of equipment[1] provided the same amount of work can be performed.
- Reduce the noise from the loudest noise sources with the use of larger mufflers or noise attenuation enclosures.
- Reduce the number of pieces of equipment operating at a given time, where possible. This can be particularly effective for times in which residents might be more sensitive to noise (e.g. early mornings, weekends, etc.)

In situations where the majority of the equipment is stationary (i.e. crushers, screeners, generators, etc.) the most effective mitigation approaches are as follows:

- Strategically placing stockpiles or earth berms around the Project stationary or work areas equipment. This approach has the most minimal impact on the typical operations of the pit and its acoustical performance is very good due to the density and potentially absorptive characteristics of the stockpile.
- Consider the directionality of stationary pieces of equipment. For stationary equipment, where possible should be positioned away from most impacted receptors. For mobile equipment, the direction of the exhaust and backup alarms should also be considered, where possible.

It is, however, understood that certain mitigation recommendations may not be practically or economically feasible.

[1] This should be verified with the manufacturer.

## 9.0 Conclusion

A long-term environmental noise monitoring was conducted at two locations within the study area. The first location was selected to determine the noise contributions of current configuration of the operations for the Project while the second location was selected as a representative case of the typical ambient noise levels of the study area, while there were no crushing activities at the Project site. In addition, the results from the first noise monitoring location were used as a calibration tool to model the projected existing noise climate of the study area from contributions from the Project.

The results of Current Configuration noise modeling scenario matched well with the noise monitoring results and indicated $L_{eq}$ sound levels ranging from 25.4 dBA to 45.4 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries.

The results of the Pit Operations noise modeling scenario representing equipment involved in stripping, aggregate and clay extraction, stockpiling, loading trucks, and reclamation indicated $L_{eq}$ sound levels ranging from 25.1 dBA to 43.5 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The most significant noise contributor for this scenario was from the scrapers.

The results of the Hauling noise modeling scenario representing the haul trucks and loaders indicated $L_{eq}$ sound levels ranging from 0 dBA to 25.0 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries.

The results of the Aggregate Processing and Washing noise modeling scenario representing equipment associated with crushing, screening, and washing indicated $L_{eq}$ sound levels ranging from 25.4 dBA to 46.3 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The most significant noise contributor for this scenario was from the shaker tables.

The results of the Mitigation Case noise modeling scenario resulted in $L_{eq}$ sound levels ranging from 25.0 dBA to 41.7 dBA for modeled residential receptor locations within 2.0 km of the Project boundaries. The relative difference when compared to the Current Configuration scenario was -0.3 to -3.7 dBA. To achieve these results recommendations were provided for the location of the equipment, the configuration of the site and lastly, by the utilization of strategically placed stockpiles.

## 10.0 References


- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993*, Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996*, Geneva Switzerland.
- *Engineering Noise Control, Theory and Practice*. David A. Bies and Colin H. Hansen, 2003, Spon Press
- *Noise and Vibration Control Engineering, Principles and Applications*. Istvan L. Ver and Leo L. Beranek, 2006, John Wiley & Sons Inc.

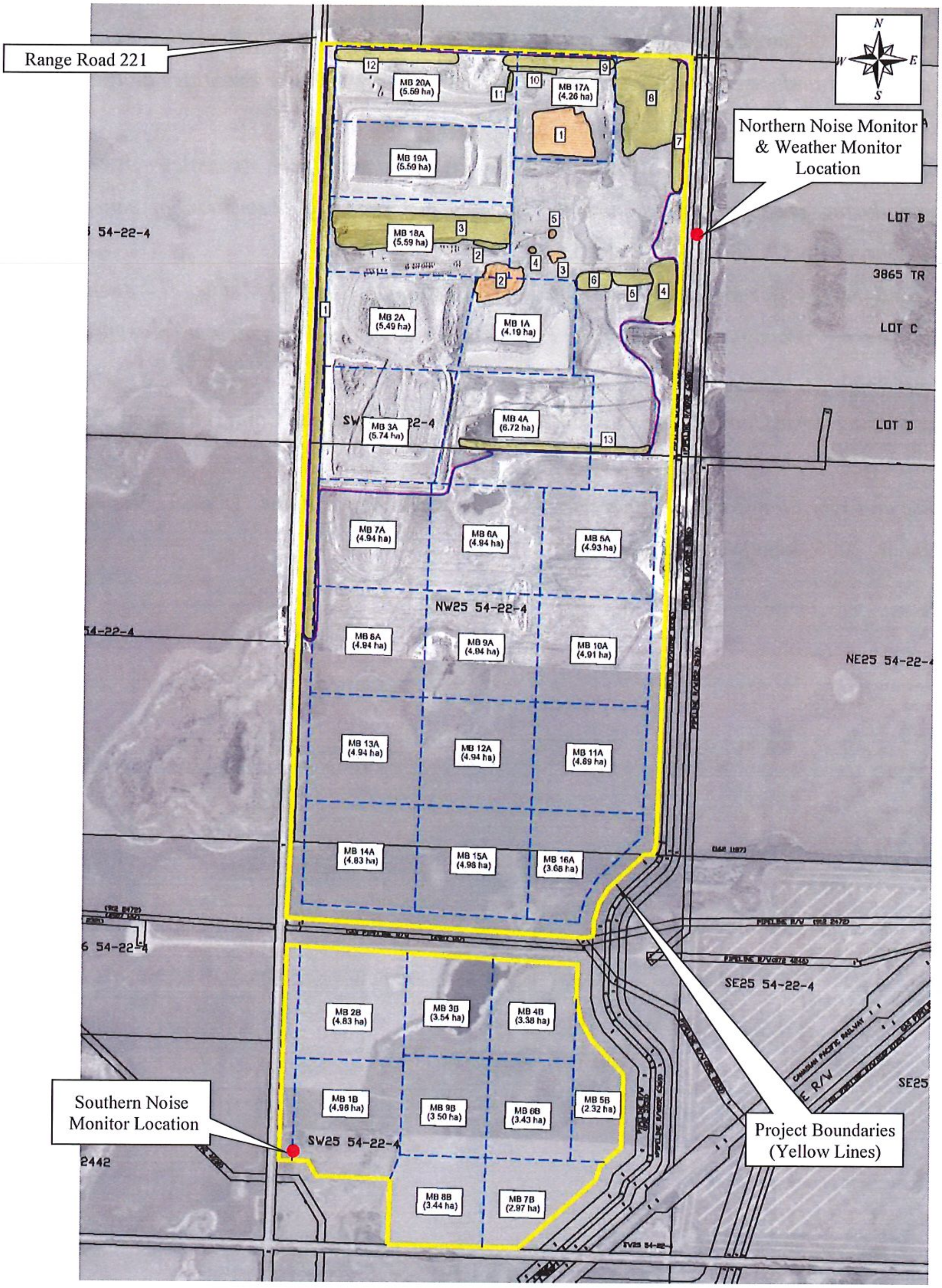


**Figure 1. Study Area & Mine Sequencing Plan**


**Figure 2. Northern Noise & Weather Monitor**

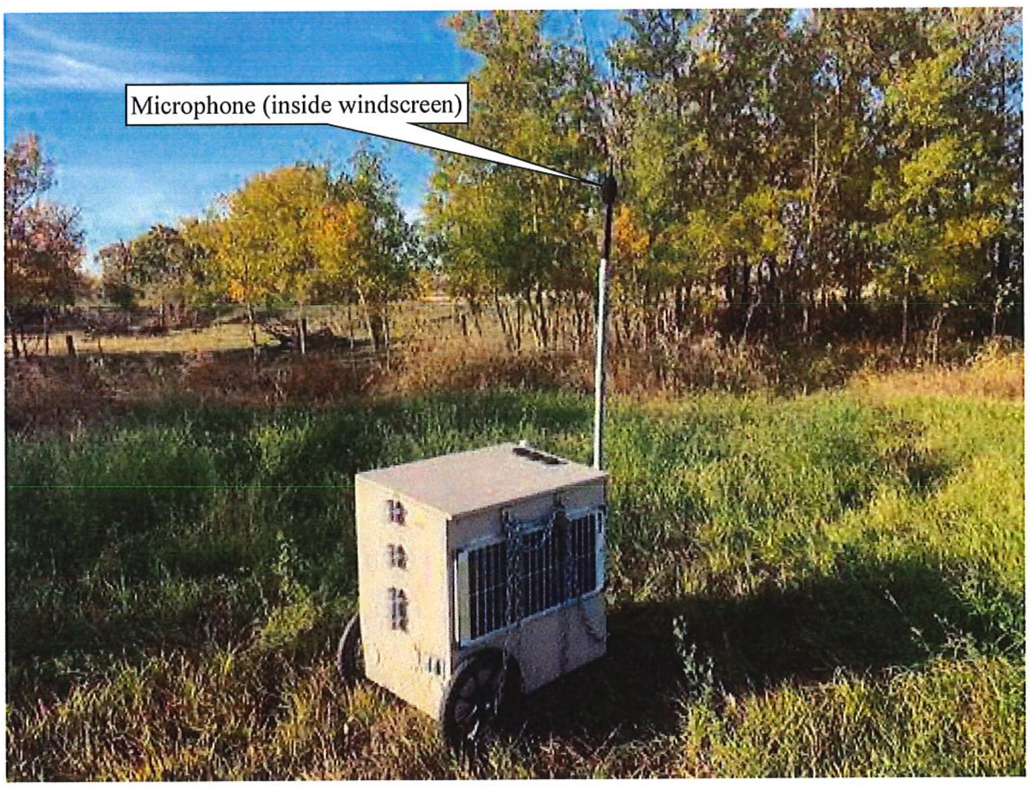


**Figure 3. Southern Noise Monitor**

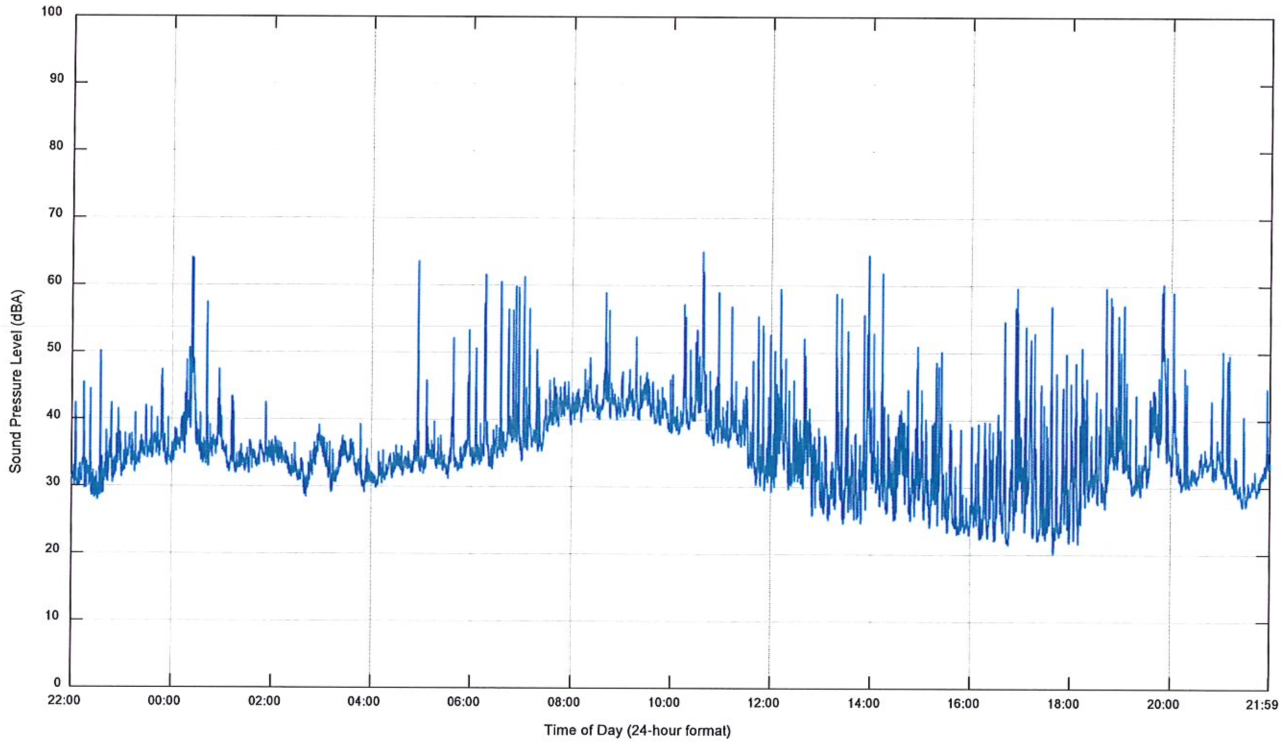


**Figure 4. Southern Monitor – October 6 - 7, 2022 15-Second $L_{eq}$ Sound Levels**

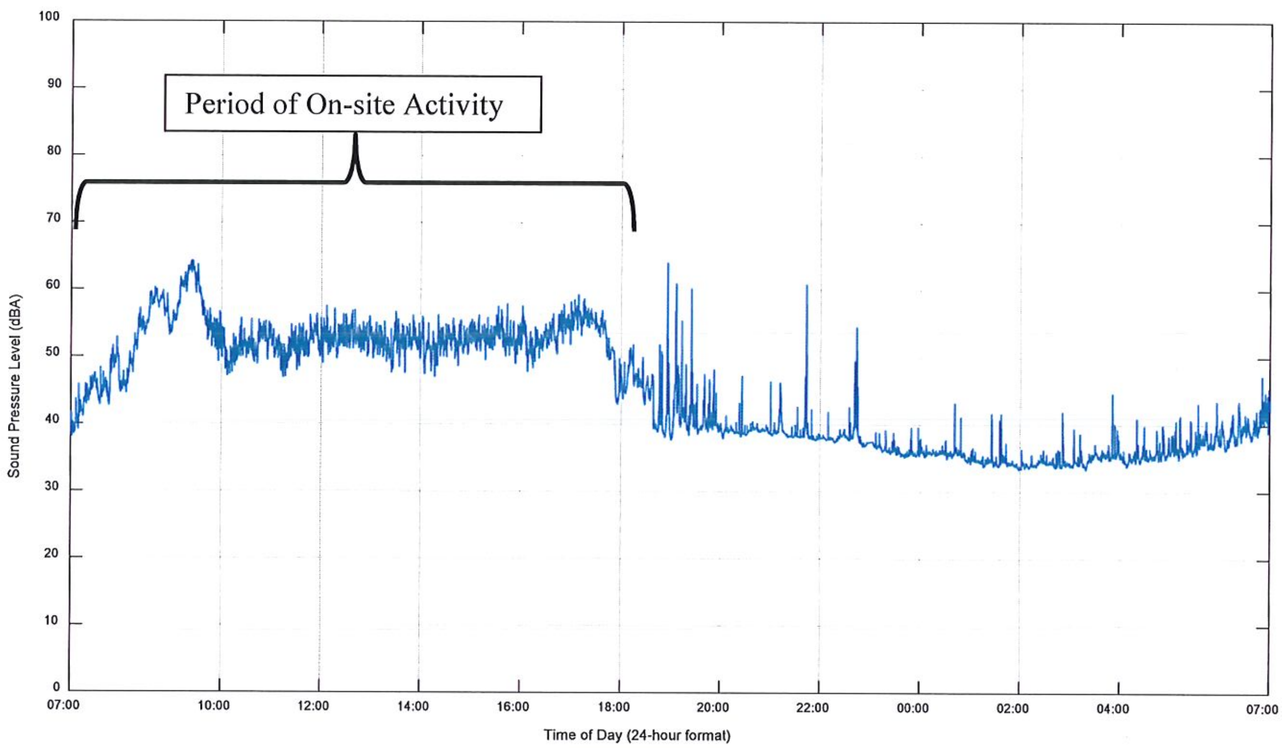


**Figure 5. Northern Monitor – October 17 - 18, 2022 15-Second $L_{eq}$ Sound Levels**

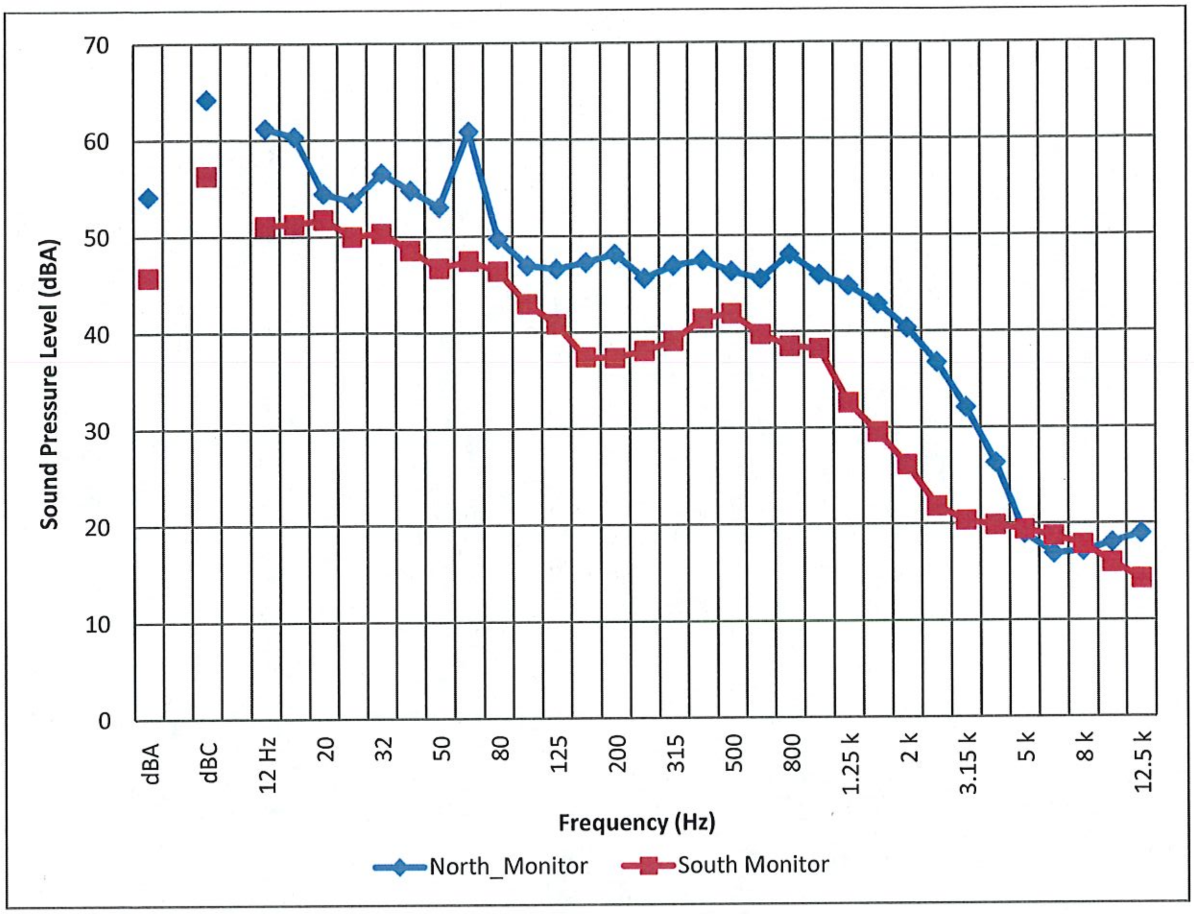


**Figure 6. Noise Monitoring 1/3 Octave Band Sound Levels**

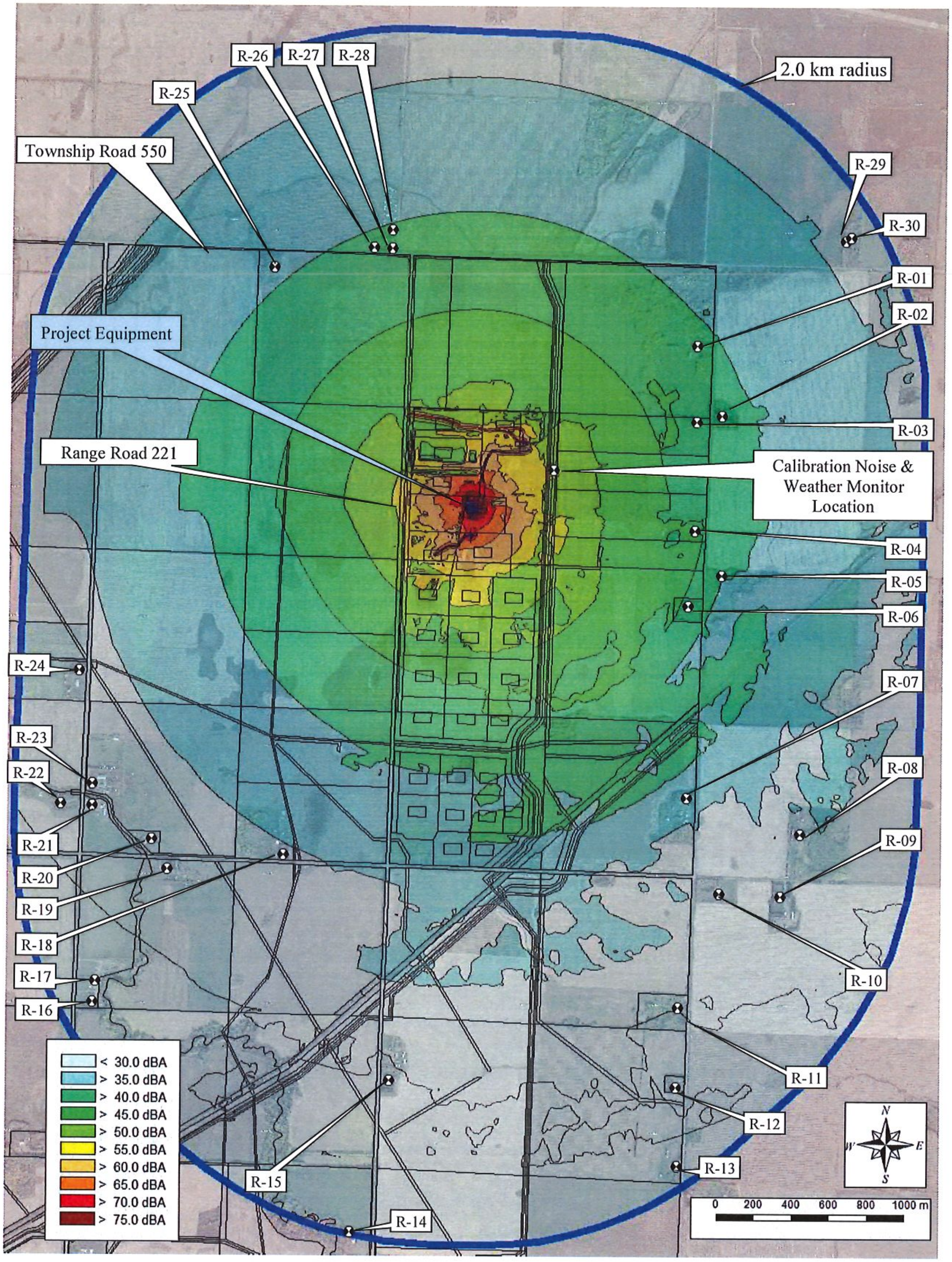


**Figure 7. Current Configuration Case Scenario - $L_{eq}$ Sound Levels**

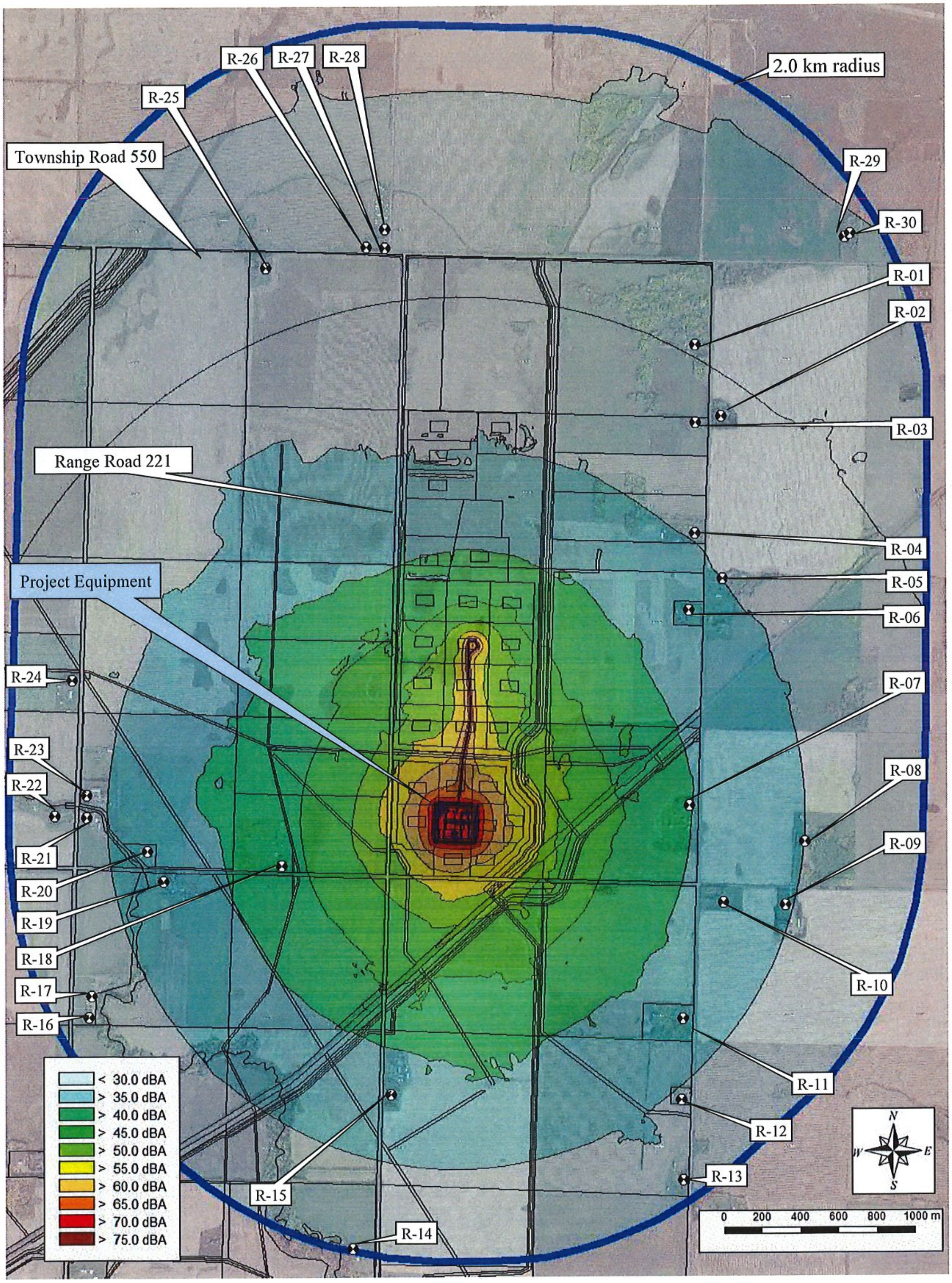


**Figure 8. Pit Operations Scenario (Phase MB9B) - $L_{eq}$ Sound Levels**

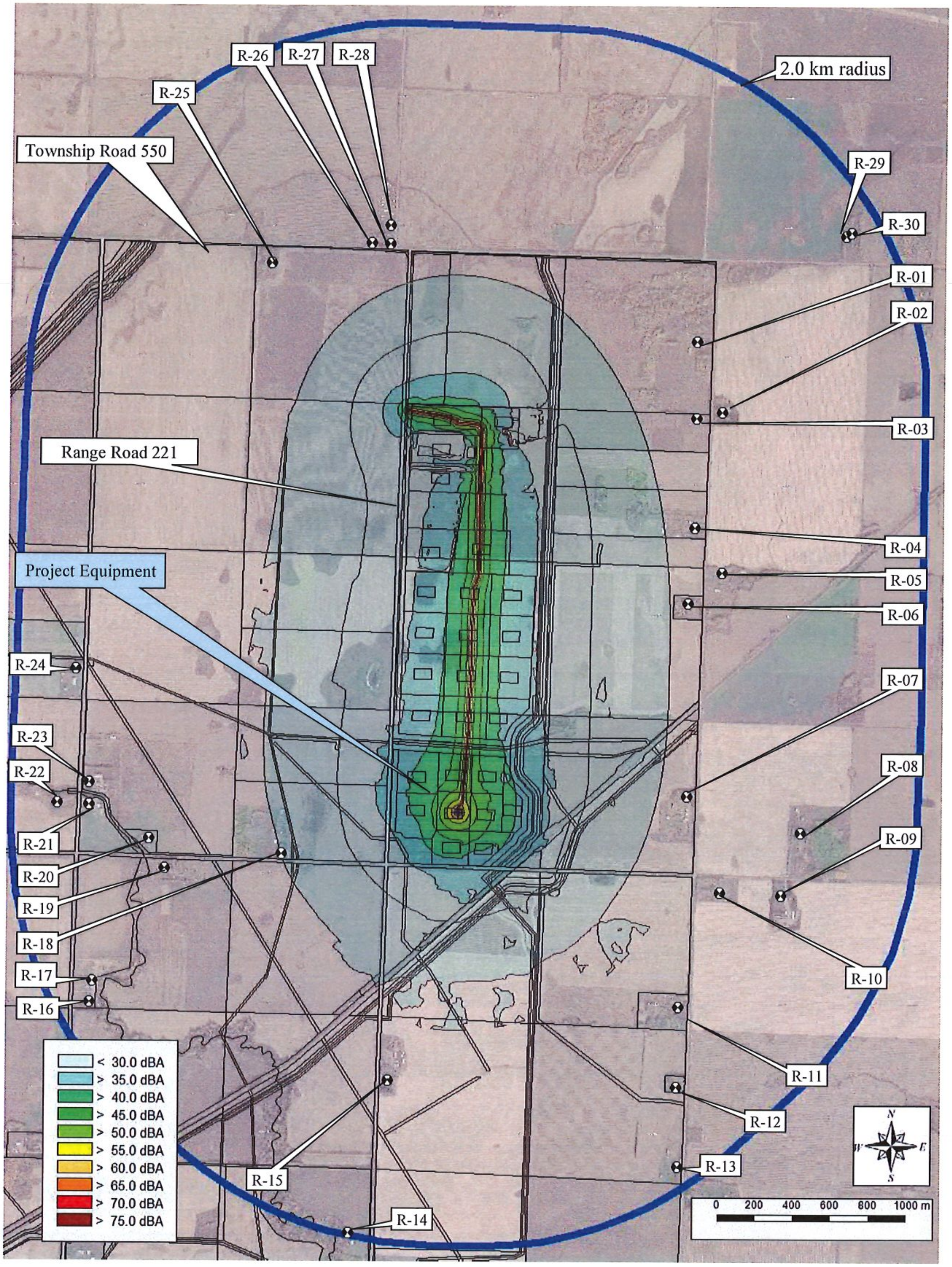


**Figure 9. Hauling Operations Scenario (Phase MB9B) - $L_{eq}$ Sound Levels**

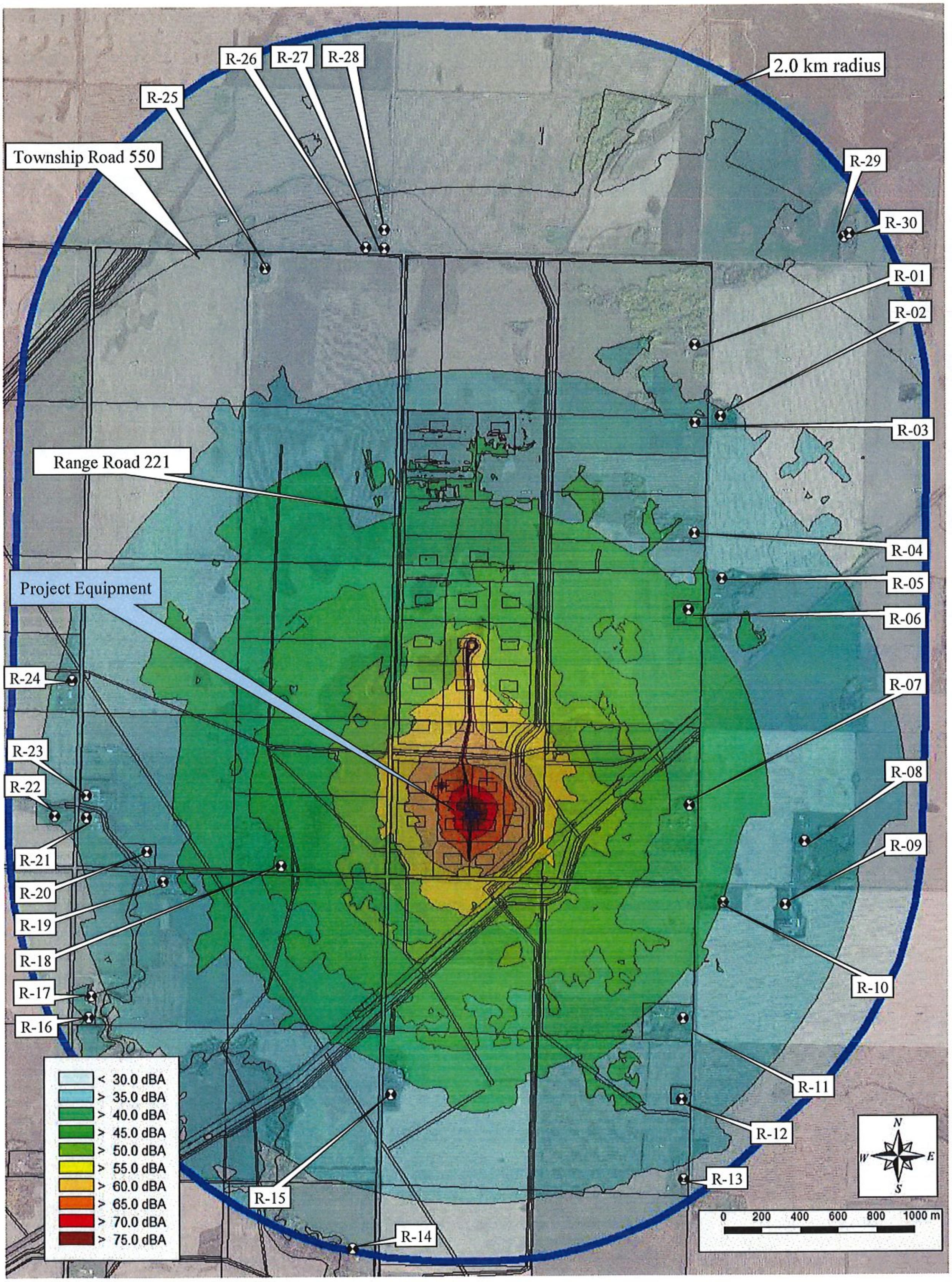


**Figure 10. Aggregate Processing Scenario (Phase MB9B) - $L_{eq}$ Sound Levels**

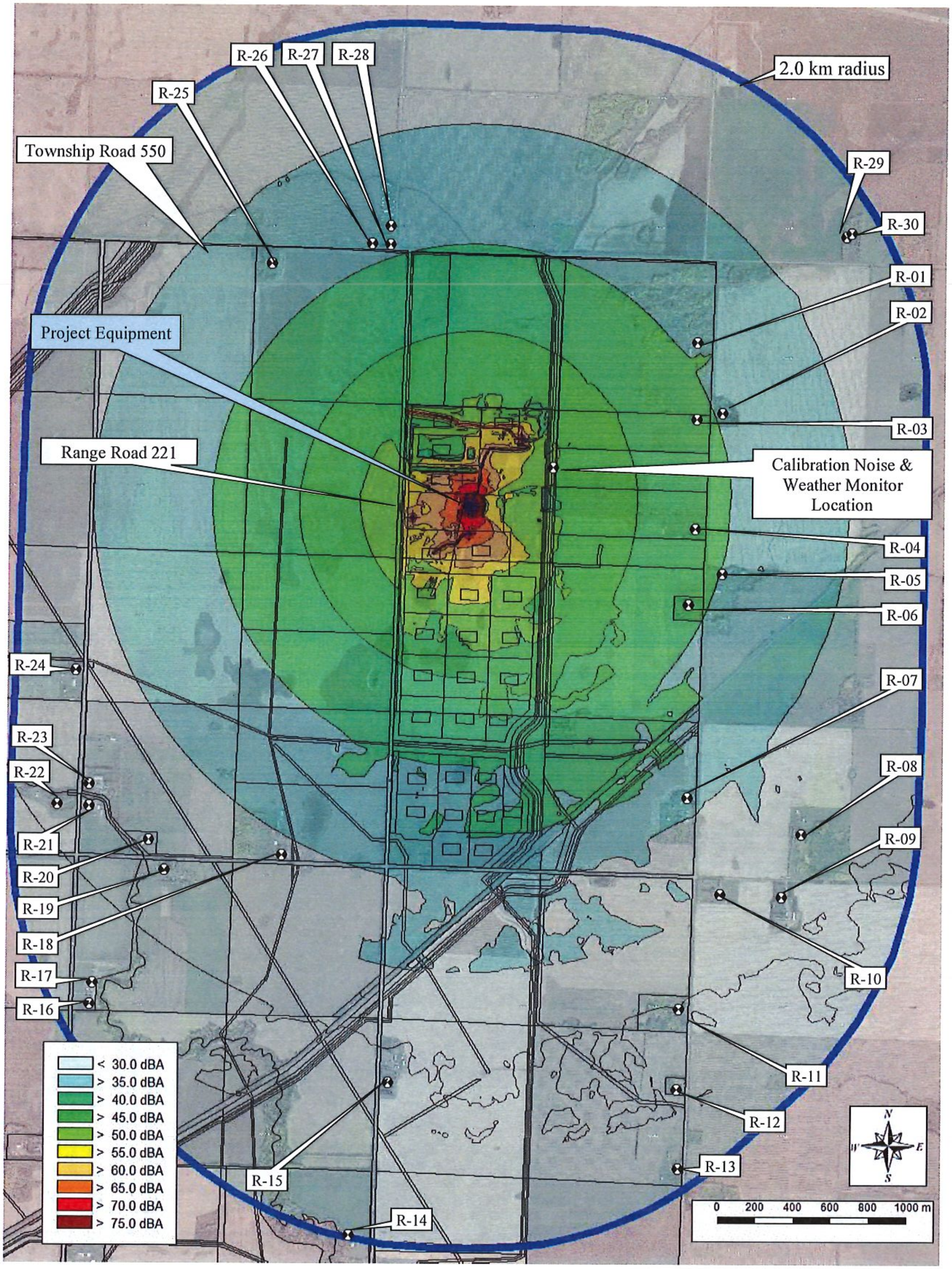


**Figure 11. Mitigation Case Scenario - $L_{eq}$ Sound Levels**

# Appendix I MEASUREMENT EQUIPMENT USED

**Noise Monitors**

The environmental noise monitoring equipment used consisted of a Brüel and Kjær Type 2250/2270 Precision Integrating Sound Level Meter enclosed in an environmental case, a tripod, a weather protective microphone hood, and an external battery. The system acquired data in 15-second $L_{eq}$ samples using 1/3 octave band frequency analysis and overall A-weighted and C-weighted sound levels. The sound level meter conforms to Type 1, ANSI S1.4, ANSI S1.43, IEC 61672-1, IEC 60651, IEC 60804 and DIN 45657. The 1/3 octave filters conform to S1.11 – Type 0-C, and IEC 61260 – Class 0. The calibrator conforms to IEC 942 and ANSI S1.40. The sound level meter, pre-amplifier and microphone were certified on May 19, 2021 / March 04, 2021 and the calibrator (type B&K 4231) was certified on September 06, 2022 by a NIST NVLAP Accredited Calibration Laboratory for all requirements of ISO 17025: 1999 and relevant requirements of ISO 9002:1994, ISO 9001:2000 and ANSI/NCSL Z540: 1994 Part 1. Simultaneous digital audio was recorded directly on the sound level meter using a 8 kHz sample rate for more detailed post-processing analysis. Refer to the next section in the Appendix for a detailed description of the various acoustical descriptive terms used.

**Weather Monitor**

The weather monitoring equipment used for the study consisted of an Orion Weather Station 9510-A-1 with a WXT520 Self-Aspirating Radiation Shield Sensor Unit, a Weather MicroServer 9590 Data-logger, and a Lightning Arrestor. The Data-logger and batteries were located in a grounded, weather protective case. The Sensor Unit was mounted on a sturdy survey tripod (with supporting guy-wires) at approximately 5.0 m above ground. The system was set up to record data in 1-minute samples obtaining the wind-speed, peak wind-speed, and wind-direction in a rolling 2-minute average as well as the 1-minute temperature, relative humidity, barometric pressure, rain rate and total rain accumulation.

**Record of Calibration Results**

| Description | Date | Time | Pre / Post | Calibration Level | Calibrator Model | Serial Number |
|---|---|---|---|---|---|---|
| North Location | 04-Oct-22 | 10:05 | Pre | 93.9 dBA | B&K 4231 | 2575493 |
| North Location | 18-Oct-22 | 09:05 | Post | 93.8 dBA | B&K 4231 | 2575493 |
| | | | | | | |
| South Location | 04-Oct-22 | 11:30 | Pre | 93.9 dBA | B&K 4231 | 2575493 |
| South Location | 18-Oct-22 | 09:50 | Post | 93.9 dBA | B&K 4231 | 2575493 |

## B&K 2250 Unit #1 SLM Calibration Certificate

CALIBRATED BY TRANSCAT

# CERTIFICATE OF CALIBRATION

**Customer:** ACI ACOUSTICAL CONSULTANTS INC
5031-210 STREET NW
EDMONTON, AB T6M 0A8

**PO Number:** BILAWCHUK-CC

ANAB ACCREDITED ISO/IEC 17025 CALIBRATION LABORATORY
ANAB AC-2489.07

ilac-MRA

**Certificate/SO Number: 17-Q1Y7V-20-1 Revision 0**

**Manufacturer:** Bruel & Kjaer
**Model Number:** 2250
**Description:** Sound Level Meter
**Serial Number:** 2488495
**ID:** Unit #1

**As-Found:** In Tolerance
**As-Left:** In Tolerance

**Issue Date:** May 19, 2021
**Calibration Date:** May 19, 2021

**Calibrated To:** Manufacturer Specification
**Calibration Procedure:** 1-AC28548-3

Transcat Calibration Laboratories have been audited and found in compliance with ISO/IEC 17025:2017. Accredited calibrations performed within the Lab Scope of Accreditation are indicated by the presence of the Accrediting Body Logo and Certificate Number. Any measurements on an accredited calibration not covered by the Lab Scope of Accreditation are listed in the notes section of the certificate. SCC, NRC, CLAS or ANAB do not guarantee the accuracy of an individual calibration by accredited laboratories.

Transcat calibrations, as applicable, are performed in compliance with the requirements of the Transcat Quality Manual QAC-P01-000, the customer Purchase Order and/or Quality Agreement requirements, ISO 9001:2015, ANSI/NCSL Z540.1-1994 (R2002), and ISO 10012:2003, as applicable. When specified contractually, the requirements of ISO TS16949:2009, 10CFR21, 10CFR50 App. B, ASME NQA-1:2012, and ANSI/NCSL Z540.3-2006 (R2013) are also covered.

Complete records of work performed are maintained by Transcat and are available for inspection. Laboratory standards used in the performance of this calibration are listed on this certificate.

Transcat documents the traceability of measurements to the SI units through the National Institute of Standards and Technology(NIST), or the National Research Council of Canada (NRC), or other national measurement institutes (NMI) that are signatories to the CIPM Mutual Recognition Arrangement, or accepted fundamental and/or natural physical constants, or by the use of specified methods, consensus standards or ratio type measurements. Documentation supporting traceability information is available for review upon written request at a Transcat facility. The measured quantity and the measurement uncertainty are required for further dissemination of traceability.

Uncertainties are reported with a coverage factor k=2, providing a level of confidence of approximately 95%. All calibrations have been performed using processes having a TUR of 4:1 or better (3:1 for mass calibrations), unless otherwise noted. The Test Uncertainty Ratio (TUR) is calculated in accordance with NCSL International RP-18. For mass calibrations: Conventional mass referenced to 8.0 g/cm³.

The results in this report relate only to the item calibrated or tested. Recorded calibration data is valid at the time of calibration within the stated uncertainties at the environmental conditions noted. The determination of compliance to the specification is specific to the model/serial no./ID no. referenced above based on the tolerances shown; these tolerances are either the original equipment manufacturers(OEM's) warranted specifications or the client's requested specifications. Any number of factors can cause a unit to drift out of tolerance at any time following its calibration. Limitations on the uses of this instrument are detailed in the OEM's operating instructions. This certificate may not be reproduced except in full, without the written approval of Transcat. Additional information, if applicable may be included on separate report(s).

**Date Received:** May 12, 2021
**Service Level :** R9

Certificate - Page 1 of 7

**Customer Number:** 9-330269-000
OPS-F20-014R8 04/01/21 FP001R9 4/9/2021

## B&K 2250 Unit #5 SLM Calibration Certificate

**Scantek, Inc.**
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP® CALIBRATION
NVLAP Lab Code: 200625-0

# Calibration Certificate No.46081

*Instrument:* **Sound Level Meter**
*Model:* **2250**
*Manufacturer:* **Brüel and Kjær**
*Serial number:* **2722894**
*Tested with:* **Microphone 4189 s/n 271977**
**Preamplifier ZC0032 s/n 13895**
*Type (class):* **1**
*Customer:* **ACI Acoustical Consultants Inc.**
*Tel/Fax:* **780-414-6373 / 780-414-6376**

*Date Calibrated:* **3/4/2021** *Cal Due:*

| *Status:* | Received | Sent |
|---|---|---|
| *In tolerance:* | X | X |
| *Out of tolerance:* | | |
| *See comments:* | | |

*Contains non-accredited tests:* __Yes _X_ No
*Calibration service:* __ Basic _X_ Standard
*Address:* **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

**Tested in accordance with the following procedures and standards:**
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

**Instrumentation used for calibration:** Nor-1504 Norsonic Test System:

| Instrument - Manufacturer | Description | S/N | Cal. Date | Traceability evidence Cal. Lab / Accreditation | Cal. Due |
|---|---|---|---|---|---|
| 483B-Norsonic | SME Cal Unit | 31052 | Oct 31, 2020 | Scantek, Inc./ NVLAP | Oct 31, 2021 |
| DS-360-SRS | Function Generator | 33584 | Oct 23, 2019 | ACR Env./ A2LA | Oct 23, 2021 |
| 34401A-Agilent Technologies | Digital Voltmeter | MY47011118 | Feb 4, 2021 | ACR Env. / A2LA | Feb 4, 2022 |
| HM30-Thommen | Meteo Station | 1040170/39633 | Dec 7, 2020 | ACR Env./ A2LA | Dec 7, 2021 |
| PC Program 1019 Norsonic | Calibration software | v.6.1T | Validated Nov 2014 | Scantek, Inc. | - |
| 1251-Norsonic | Calibrator | 30878 | Oct 26, 2020 | Scantek, Inc./ NVLAP | Oct 26, 2021 |

**Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).**

**Environmental conditions:**

| Temperature (°C) | Barometric pressure (kPa) | Relative Humidity (%) |
|---|---|---|
| 22.8 | 99.52 | 44.9 |

| Calibrated by: | Lydon Dawkins | Authorized signatory: | William D. Gallagher |
|---|---|---|---|
| Signature | Lydon Dawkins | Signature | William D Gallagher |
| Date | 3/4/2021 | Date | 3/5/2021 |


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## B&K 2250 Unit #5 Microphone Calibration Certificate

**Scantek, Inc.**
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

# Calibration Certificate No.46082

*Instrument:* Microphone
*Model:* 4189
*Manufacturer:* Brüel & Kjær
*Serial number:* 271977
*Composed of:*

*Date Calibrated:* 3/4/2021 *Cal Due:*

| *Status:* | Received | Sent |
|---|---|---|
| *In tolerance:* | X | X |
| *Out of tolerance:* | | |
| *See comments:* | | |

*Contains non-accredited tests:* __Yes _X_ No

*Customer:* ACI Acoustical Consultants Inc.
*Tel/Fax:* 780-414-6373/780-414-6376
*Address:* 5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8

**Tested in accordance with the following procedures and standards:**
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

**Instrumentation used for calibration:** N-1504 Norsonic Test System:

| Instrument - Manufacturer | Description | S/N | Cal. Date | Traceability evidence<br>Cal. Lab / Accreditation | Cal. Due |
|---|---|---|---|---|---|
| 483B-Norsonic | SME Cal Unit | 31052 | Oct 31, 2020 | Scantek, Inc./ NVLAP | Oct 31, 2021 |
| DS-360-SRS | Function Generator | 33584 | Oct 23, 2019 | ACR Env./ A2LA | Oct 23, 2021 |
| 34401A-Agilent Technologies | Digital Voltmeter | MY47011118 | Feb 4, 2021 | ACR Env. / A2LA | Feb 4, 2022 |
| HM30-Thommen | Meteo Station | 1040170/39633 | Dec 7, 2020 | ACR Env./ A2LA | Dec 7, 2021 |
| PC Program 1017 Norsonic | Calibration software | v.6.1T | Validated Nov 2014 | Scantek, Inc. | - |
| 1253-Norsonic | Calibrator | 28326 | Oct 26, 2020 | Scantek, Inc./ NVLAP | Oct 26, 2021 |
| 1203-Norsonic | Preamplifier | 14059 | March 3, 2021 | Scantek, Inc./ NVLAP | March 3, 2022 |
| 4180-Brüel&Kjær | Microphone | 2246115 | Oct 1, 2019 | DPLA / DANAK | Oct 1, 2021 |

**Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)**

| Calibrated by: | Lydon Dawkins | Authorized signatory: | William D. Gallagher |
|---|---|---|---|
| Signature | Lydon Dawkins | Signature | William D Gallagher |
| Date | 3/4/2021 | Date | 3/5/2021 |


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## B&K 4231 Unit #6 Calibrator Calibration Certificate

**Scantek, Inc.**
CALIBRATION LABORATORY
ISO 17025: 2017, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

# Calibration Certificate No.48553

| | | | |
|---|---|---|---|
| *Instrument:* | **Acoustical Calibrator** | *Date Calibrated:* **9/6/2022** | *Cal Due:* |
| *Model:* | **4231** | *Status:* | **Received** / **Sent** |
| *Manufacturer:* | **Brüel and Kjær** | *In tolerance:* | X / X |
| *Serial number:* | **2656414** | *Out of tolerance:* | |
| *Class (IEC 60942):* | **1** | *See comments:* | |
| *Barometer type:* | | *Contains non-accredited tests:* | __Yes _X_ No |
| *Barometer s/n:* | | | |
| *Customer:* | **ACI Acoustical Consultants Inc.** | *Address:* | **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8** |
| *Tel/Fax:* | **780-414-6373 / 780-414-6376** | | |

**Tested in accordance with the following procedures and standards:**
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

**Instrumentation used for calibration:** Nor-1504 Norsonic Test System:

| Instrument - Manufacturer | Description | S/N | Cal. Date | Traceability evidence Cal. Lab / Accreditation | Cal. Due |
|---|---|---|---|---|---|
| 483B-Norsonic | SME Cal Unit | 31052 | Nov 8, 2021 | Scantek, Inc./ NVLAP | Nov 8, 2022 |
| DS-360-SRS | Function Generator | 88077 | Dec 3, 2020 | ACR Env./ A2LA | Dec 3, 2022 |
| 34401A-Agilent Technologies | Digital Voltmeter | MY47011118 | Mar 10, 2022 | ACR Env. / A2LA | Mar 10, 2023 |
| PTU300-Vaisala | EnvironmentalMonitor | P5011262 | Sept 10, 2021 | ACR Env./ A2LA | Sept 10, 2022 |
| 140-Norsonic | Real Time Analyzer | 1406423 | Nov 8, 2021 | Scantek / NVLAP | Nov 8, 2022 |
| PC Program 1018 Norsonic | Calibration software | v.6.1T | Validated Nov 2014 | Scantek, Inc. | - |
| 4134-Brüel&Kjær | Microphone | 173368 | Nov 8, 2021 | Scantek, Inc. / NVLAP | Nov 8, 2022 |
| 1203-Norsonic | Preamplifier | 14059 | Mar 7, 2022 | Scantek, Inc./ NVLAP | Mar 7, 2023 |

**Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)**

| Calibrated by: | Bailey Partoza | Authorized signatory: | William Gallagher |
|---|---|---|---|
| Signature | [signature] | Signature | [signature] |
| Date | 9/6/22 | Date | 9/6/2022 |

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Page 1 of 2

## Appendix II THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

### Sound Pressure Level

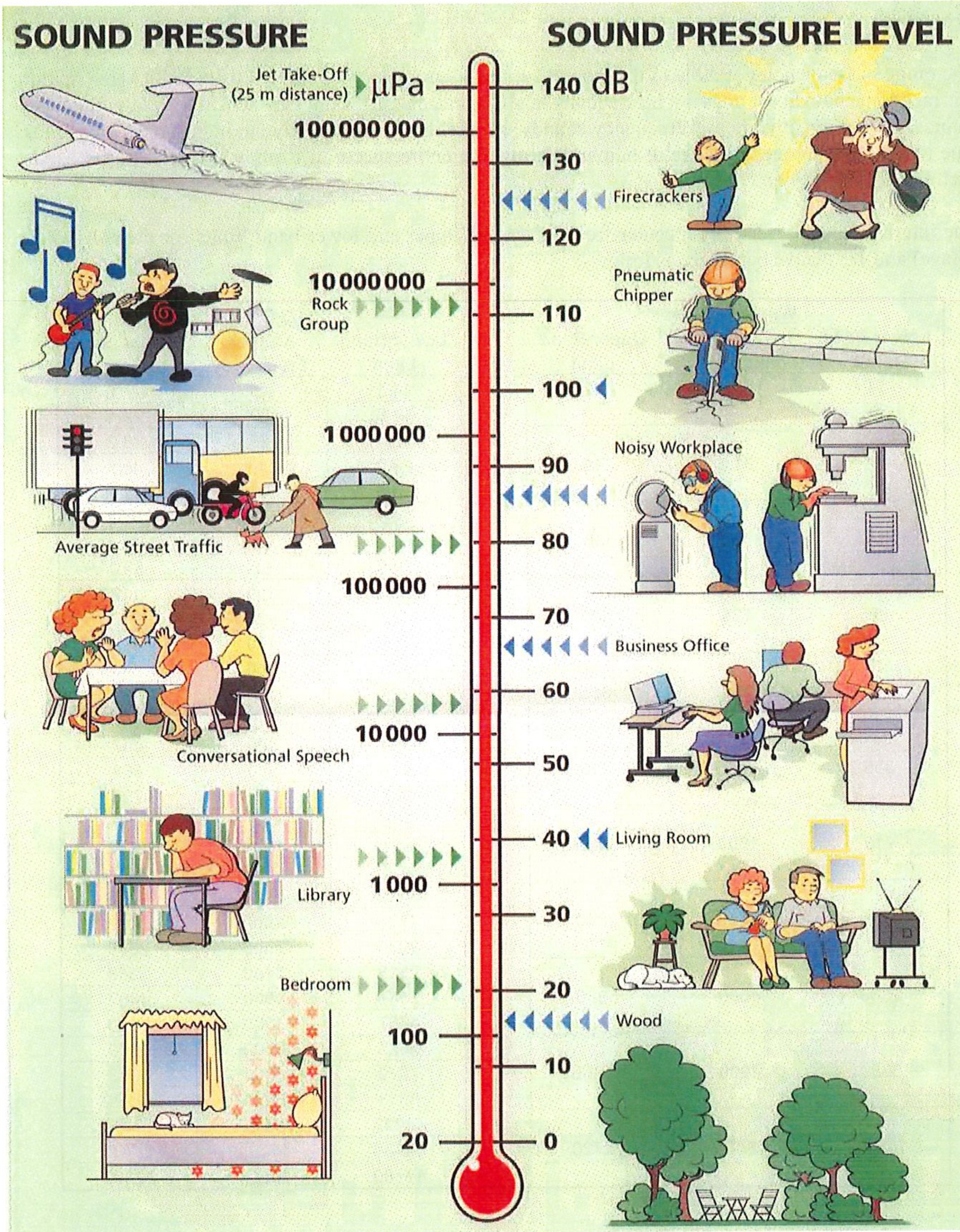
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we measure pressure we typically measure the RMS sound pressure.

$$SPL = 10\log_{10}\left[\frac{P_{RMS}^2}{P_{ref}^2}\right] = 20\log_{10}\left[\frac{P_{RMS}}{P_{ref}}\right]$$

Where: $SPL$ = Sound Pressure Level in dB
$P_{RMS}$ = Root Mean Square measured pressure (Pa)
$P_{ref}$ = Reference sound pressure level ($P_{ref} = 2\text{x}10^{-5}$ Pa $= 20$ μPa)

This reference sound pressure level is an internationally agreed upon value. It represents the threshold of human hearing for "typical" people based on numerous testing. It is possible to have a threshold which is lower than 20 μPa which will result in negative dB levels. As such, zero dB does not mean there is no sound!

In general, a difference of 1 – 2 dB is the threshold for humans to notice that there has been a change in sound level. A difference of 3 dB (factor of 2 in acoustical energy) is perceptible and a change of 5 dB is strongly perceptible. A change of 10 dB is typically considered a factor of 2. This is quite remarkable when considering that 10 dB is 10-times the acoustical energy!


SOUND PRESSURE
SOUND PRESSURE LEVEL
Jet Take-Off (25 m distance)
µPa
140 dB
100 000 000
130
Firecrackers
120
10 000 000
Rock Group
Pneumatic Chipper
110
100
1 000 000
Noisy Workplace
90
Average Street Traffic
80
100 000
70
Business Office
60
10 000
Conversational Speech
50
40
Living Room
Library
1 000
30
Bedroom
20
Wood
100
10
20
0

## Frequency

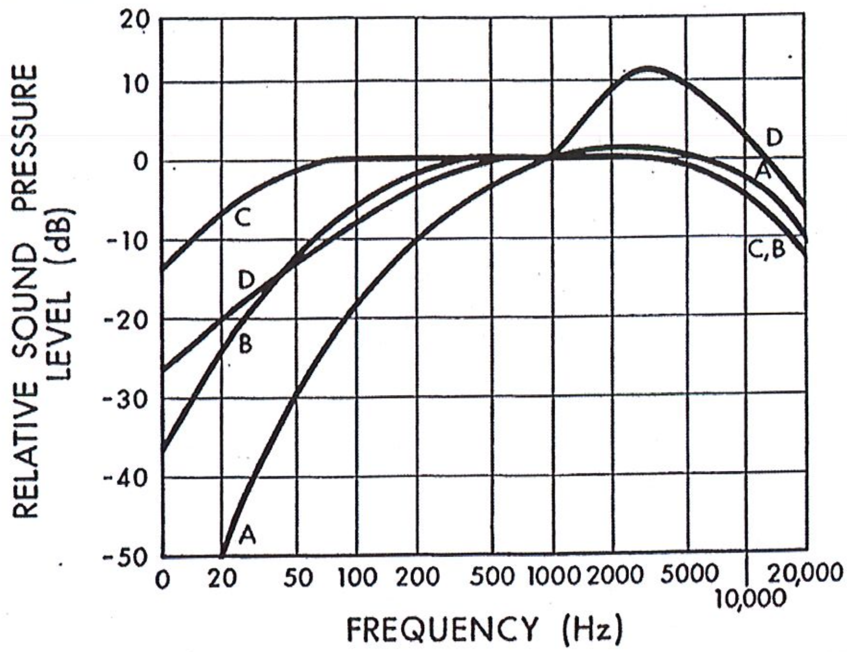
The range of frequencies audible to the human ear ranges from approximately 20 Hz to 20 kHz. Within this range, the human ear does not hear equally at all frequencies. It is not very sensitive to low frequency sounds, is very sensitive to mid frequency sounds and is slightly less sensitive to high frequency sounds. Due to the large frequency range of human hearing, the entire spectrum is often divided into 31 bands, each known as a 1/3 octave band.

The internationally agreed upon center frequencies and upper and lower band limits for the 1/1 (whole octave) and 1/3 octave bands are as follows:

| Lower Band Limit | Whole Octave Center Frequency | Upper Band Limit |
|---|---|---|
| 11 | **16** | 22 |
| 22 | **31.5** | 44 |
| 44 | **63** | 88 |
| 88 | **125** | 177 |
| 177 | **250** | 355 |
| 355 | **500** | 710 |
| 710 | **1000** | 1420 |
| 1420 | **2000** | 2840 |
| 2840 | **4000** | 5680 |
| 5680 | **8000** | 11360 |
| 11360 | **16000** | 22720 |

| Lower Band Limit | 1/3 Octave Center Frequency | Upper Band Limit |
|---|---|---|
| 14.1 | **16** | 17.8 |
| 17.8 | **20** | 22.4 |
| 22.4 | **25** | 28.2 |
| 28.2 | **31.5** | 35.5 |
| 35.5 | **40** | 44.7 |
| 44.7 | **50** | 56.2 |
| 56.2 | **63** | 70.8 |
| 70.8 | **80** | 89.1 |
| 89.1 | **100** | 112 |
| 112 | **125** | 141 |
| 141 | **160** | 178 |
| 178 | **200** | 224 |
| 224 | **250** | 282 |
| 282 | **315** | 355 |
| 355 | **400** | 447 |
| 447 | **500** | 562 |
| 562 | **630** | 708 |
| 708 | **800** | 891 |
| 891 | **1000** | 1122 |
| 1122 | **1250** | 1413 |
| 1413 | **1600** | 1778 |
| 1778 | **2000** | 2239 |
| 2239 | **2500** | 2818 |
| 2818 | **3150** | 3548 |
| 3548 | **4000** | 4467 |
| 4467 | **5000** | 5623 |
| 5623 | **6300** | 7079 |
| 7079 | **8000** | 8913 |
| 8913 | **10000** | 11220 |
| 11220 | **12500** | 14130 |
| 14130 | **16000** | 17780 |
| 17780 | **20000** | 22390 |

Human hearing is most sensitive at approximately 3500 Hz which corresponds to the ¼ wavelength of the ear canal (approximately 2.5 cm). Because of this range of sensitivity to various frequencies, we typically apply various weighting networks to the broadband measured sound to more appropriately account for the way humans hear. By default, the most common weighting network used is the so-called "A-weighting". It can be seen in the figure that the low frequency sounds are reduced significantly with the A-weighting.




## Combination of Sounds

When combining multiple sound sources the general equation is:

$$\Sigma SPL_n = 10\log_{10}\left[\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}\right]$$

Examples:

- Two sources of 50 dB each add together to result in 53 dB.
- Three sources of 50 dB each add together to result in 55 dB.
- Ten sources of 50 dB each add together to result in 60 dB.
- One source of 50 dB added to another source of 40 dB results in 50.4 dB

It can be seen that, if multiple similar sources exist, removing or reducing only one source will have little effect.

**Sound Level Measurements**

Over the years a number of methods for measuring and describing environmental noise have been developed. The most widely used and accepted is the concept of the Energy Equivalent Sound Level ($L_{eq}$) which was developed in the US (1970's) to characterize noise levels near US Air-force bases. This is the level of a steady state sound which, for a given period of time, would contain the same energy as the time varying sound. The concept is that the same amount of annoyance occurs from a sound having a high level for a short period of time as from a sound at a lower level for a longer period of time.
The $L_{eq}$ is defined as:

$$L_{eq} = 10\log_{10}\left[\frac{1}{T}\int_0^T 10^{\frac{dB}{10}}\,dT\right] = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{P^2}{P_{ref}^2}\,dT\right]$$

We must specify the time period over which to measure the sound. i.e. 1-second, 10-seconds, 15-seconds, 1-minute, 1-day, etc. **An $L_{eq}$ is meaningless if there is no time period associated.**

In general there a few very common $L_{eq}$ sample durations which are used in describing environmental noise measurements. These include:

- $L_{eq}$24 - Measured over a 24-hour period
- $L_{eq}$Night - Measured over the night-time (typically 22:00 – 07:00)
- $L_{eq}$Day - Measured over the day-time (typically 07:00 – 22:00)
- $L_{DN}$ - Same as $L_{eq}$24 with a 10 dB penalty added to the night-time

**Statistical Descriptor**

Another method of conveying long term noise levels utilizes statistical descriptors. These are calculated from a cumulative distribution of the sound levels over the entire measurement duration and then determining the sound level at xx % of the time.

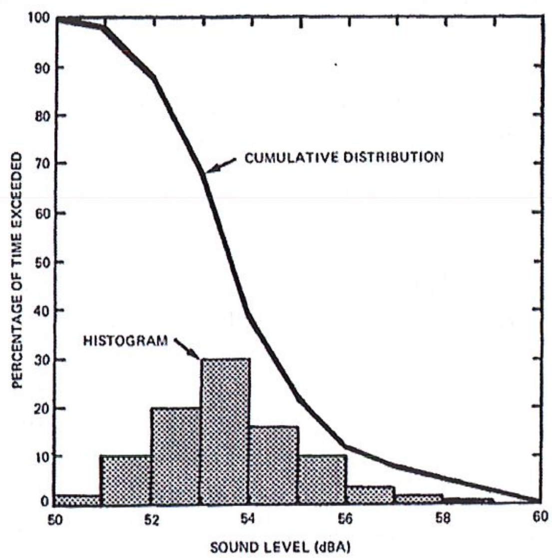



**Figure 16.6** Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

*Industrial Noise Control, Lewis Bell, Marcel Dekker, Inc. 1994*

The most common statistical descriptors are:

$L_{min}$ - minimum sound level measured
$L_{01}$ - sound level that was exceeded only 1% of the time
$L_{10}$ - sound level that was exceeded only 10% of the time.
- Good measure of intermittent or intrusive noise
- Good measure of Traffic Noise

$L_{50}$ - sound level that was exceeded 50% of the time (arithmetic average)
- Good to compare to $L_{eq}$ to determine steadiness of noise

$L_{90}$ - sound level that was exceeded 90% of the time
- Good indicator of typical "ambient" noise levels

$L_{99}$ - sound level that was exceeded 99% of the time
$L_{max}$ - maximum sound level measured

These descriptors can be used to provide a more detailed analysis of the varying noise climate:

- If there is a large difference between the $L_{eq}$ and the $L_{50}$ ($L_{eq}$ can never be any lower than the $L_{50}$) then it can be surmised that one or more short duration, high level sound(s) occurred during the time period.
- If the gap between the $L_{10}$ and $L_{90}$ is relatively small (less than 15 – 20 dBA) then it can be surmised that the noise climate was relatively steady.

**Sound Propagation**

In order to understand sound propagation, the nature of the source must first be discussed. In general, there are three types of sources. These are known as 'point', 'line', and 'area'. This discussion will concentrate on point and line sources since area sources are much more complex and can usually be approximated by point sources at large distances.

Point Source

As sound radiates from a point source, it dissipates through geometric spreading. The basic relationship between the sound levels at two distances from a point source is:

$$\therefore SPL_1 - SPL_2 = 20\log_{10}\left(\frac{r_2}{r_1}\right)$$

Where: $SPL_1$ = sound pressure level at location 1, $SPL_2$ = sound pressure level at location 2
$r_1$ = distance from source to location 1, $r_2$ = distance from source to location 2

Thus, the reduction in sound pressure level for a point source radiating in a free field is **6 dB per doubling of distance**. This relationship is independent of reflectivity factors provided they are always present. Note that this only considers geometric spreading and does not take into account atmospheric effects. Point sources still have some physical dimension associated with them, and typically do not radiate sound equally in all directions in all frequencies. The directionality of a source is also highly dependent on frequency. As frequency increases, directionality increases.

Examples (note no atmospheric absorption):

- A point source measuring 50 dB at 100m will be 44 dB at 200m.
- A point source measuring 50 dB at 100m will be 40.5 dB at 300m.
- A point source measuring 50 dB at 100m will be 38 dB at 400m.
- A point source measuring 50 dB at 100m will be 30 dB at 1000m.

Line Source

A line source is similar to a point source in that it dissipates through geometric spreading. The difference is that a line source is equivalent to a long line of many point sources. The basic relationship between the sound levels at two distances from a line source is:

$$SPL_1 - SPL_2 = 10\log_{10}\left(\frac{r_2}{r_1}\right)$$

The difference from the point source is that the '20' term in front of the 'log' is now only 10. Thus, the reduction in sound pressure level for a line source radiating in a free field is **3 dB per doubling of distance**.

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100m will be 47 dB at 200m.
- A line source measuring 50 dB at 100m will be 45 dB at 300m.
- A line source measuring 50 dB at 100m will be 44 dB at 400m.
- A line source measuring 50 dB at 100m will be 40 dB at 1000m.

## Atmospheric Absorption

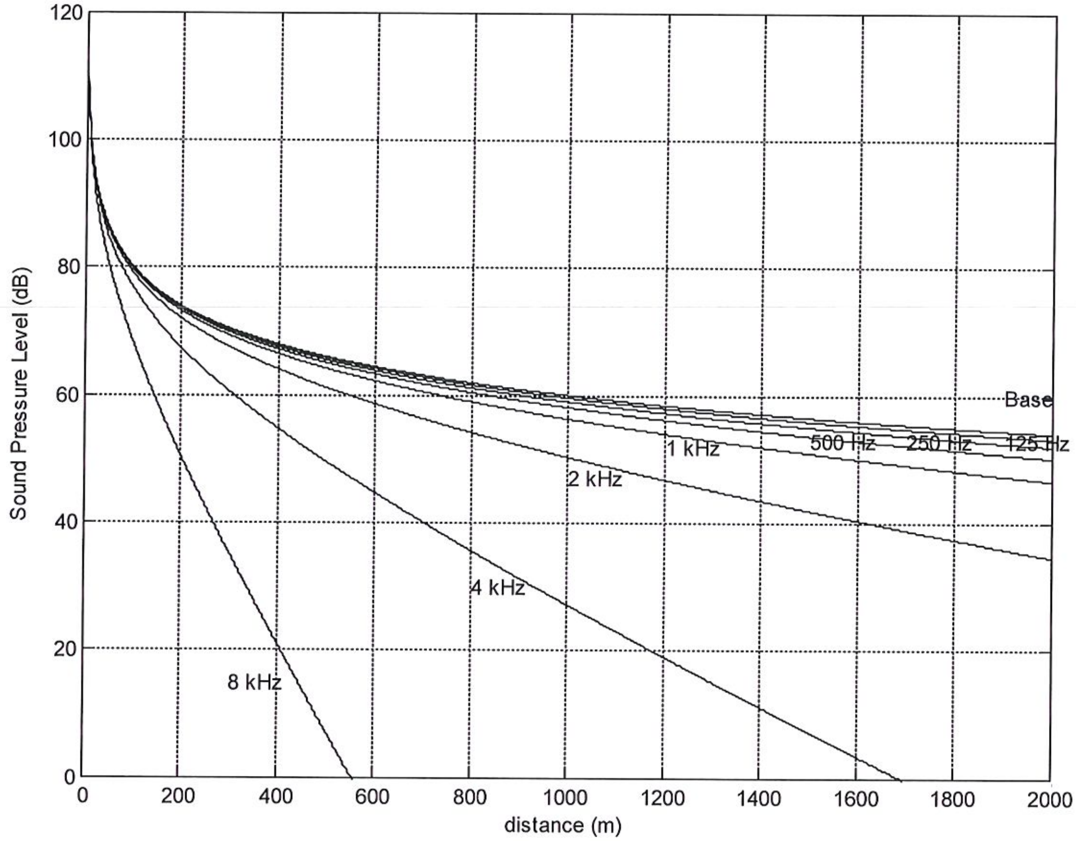
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

1) **Viscous Effects** - Dissipation of acoustic energy due to fluid friction which results in thermodynamically irreversible propagation of sound.
2) **Heat Conduction Effects** - Heat transfer between high and low temperature regions in the wave which result in non-adiabatic propagation of the sound.
3) **Inter Molecular Energy Interchanges** - Molecular energy relaxation effects which result in a time lag between changes in translational kinetic energy and the energy associated with rotation and vibration of the molecules.

The following table illustrates the attenuation coefficient of sound at standard pressure (101.325 kPa) in units of dB/100m.

| Temperature °C | Relative Humidity (%) | Frequency (Hz) 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|---|
| 30 | 20 | 0.06 | 0.18 | 0.37 | 0.64 | 1.40 | 4.40 |
| | 50 | 0.03 | 0.10 | 0.33 | 0.75 | 1.30 | 2.50 |
| | 90 | 0.02 | 0.06 | 0.24 | 0.70 | 1.50 | 2.60 |
| 20 | 20 | 0.07 | 0.15 | 0.27 | 0.62 | 1.90 | 6.70 |
| | 50 | 0.04 | 0.12 | 0.28 | 0.50 | 1.00 | 2.80 |
| | 90 | 0.02 | 0.08 | 0.26 | 0.56 | 0.99 | 2.10 |
| 10 | 20 | 0.06 | 0.11 | 0.29 | 0.94 | 3.20 | 9.00 |
| | 50 | 0.04 | 0.11 | 0.20 | 0.41 | 1.20 | 4.20 |
| | 90 | 0.03 | 0.10 | 0.21 | 0.38 | 0.81 | 2.50 |
| 0 | 20 | 0.05 | 0.15 | 0.50 | 1.60 | 3.70 | 5.70 |
| | 50 | 0.04 | 0.08 | 0.19 | 0.60 | 2.10 | 6.70 |
| | 90 | 0.03 | 0.08 | 0.15 | 0.36 | 1.10 | 4.10 |

- As frequency increases, absorption tends to increase
- As Relative Humidity increases, absorption tends to decrease
- There is no direct relationship between absorption and temperature
- **The net result of atmospheric absorption is to modify the sound propagation of a point source from 6 dB/doubling-of-distance to approximately 7 – 8 dB/doubling-of-distance (based on anecdotal experience)**




**Atmospheric Absorption at 10°C and 70% RH**

**Meteorological Effects**

There are many meteorological factors which can affect how sound propagates over large distances. These various phenomena must be considered when trying to determine the relative impact of a noise source either after installation or during the design stage.

Wind
- Can greatly alter the noise climate away from a source depending on direction
- Sound levels downwind from a source can be increased due to refraction of sound back down towards the surface. This is due to the generally higher velocities as altitude increases.
- Sound levels upwind from a source can be decreased due to a "bending" of the sound away from the earth's surface.
- Sound level differences of ±10dB are possible depending on severity of wind and distance from source.
- Sound levels crosswind are generally not disturbed by an appreciable amount
- Wind tends to generate its own noise, however, and can provide a high degree of masking relative to a noise source of particular interest.

Temperature
- Temperature effects can be similar to wind effects
- Typically, the temperature is warmer at ground level than it is at higher elevations.
- If there is a very large difference between the ground temperature (very warm) and the air aloft (only a few hundred meters) then the transmitted sound refracts upward due to the changing speed of sound.
- If the air aloft is warmer than the ground temperature (known as an *inversion*) the resulting higher speed of sound aloft tends to refract the transmitted sound back down towards the ground. This essentially works on Snell's law of reflection and refraction.
- Temperature inversions typically happen early in the morning and are most common over large bodies of water or across river valleys.
- Sound level differences of ±10dB are possible depending on gradient of temperature and distance from source.

Rain
- Rain does not affect sound propagation by an appreciable amount unless it is very heavy
- The larger concern is the noise generated by the rain itself. A heavy rain striking the ground can cause a significant amount of highly broadband noise. The amount of noise generated is difficult to predict.
- Rain can also affect the output of various noise sources such as vehicle traffic.

Summary
- In general, these wind and temperature effects are difficult to predict
- Empirical models (based on measured data) have been generated to attempt to account for these effects.
- Environmental noise measurements must be conducted with these effects in mind. Sometimes it is desired to have completely calm conditions, other times a "worst case" of downwind noise levels are desired.

## Topographical Effects

Similar to the various atmospheric effects outlined in the previous section, the effect of various geographical and vegetative factors must also be considered when examining the propagation of noise over large distances.

Topography

- One of the most important factors in sound propagation.
- Can provide a natural barrier between source and receiver (i.e. if berm or hill in between).
- Can provide a natural amplifier between source and receiver (i.e. large valley in between or hard reflective surface in between).
- Must look at location of topographical features relative to source and receiver to determine importance (i.e. small berm 1km away from source and 1km away from receiver will make negligible impact).

Grass

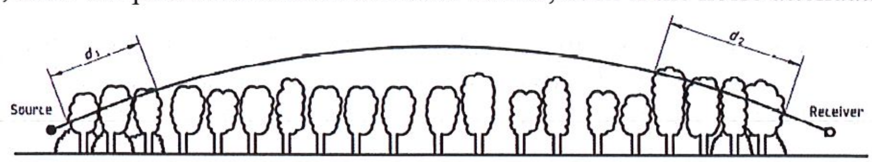
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of thumb based on empirical data is:

$$A_g = 18\log_{10}(f) - 31 \qquad (dB/100m)$$

Where: $A_g$ is the absorption amount

Trees

- Provide absorption due to foliage
- Deciduous trees are essentially ineffective in the winter
- Absorption depends heavily on density and height of trees
- No data found on absorption of various kinds of trees
- Large spans of trees are required to obtain even minor amounts of sound reduction
- In many cases, trees can provide an effective visual barrier, even if the noise attenuation is negligible.




NOTE — $d_f = d_1 + d_2$

For calculating $d_1$ and $d_2$, the curved path radius may be assumed to be 5 km.

**Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance $d_f$ through the foliage**

**Table A.1 — Attenuation of an octave band of noise due to propagation a distance $d_f$ through dense foliage**

| Propagation distance $d_f$ m | Nominal midband frequency Hz | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1 000 | 2 000 | 4 000 | 8 000 |
| $10 \le d_f \le 20$ | Attenuation, dB: 0 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| $20 \le d_f \le 200$ | Attenuation, dB/m: 0,02 | 0,03 | 0,04 | 0,05 | 0,06 | 0,08 | 0,09 | 0,12 |

*Tree/Foliage attenuation from ISO 9613-2:1996*

Bodies of Water

- Large bodies of water can provide the opposite effect to grass and trees.
- Reflections caused by small incidence angles (grazing) can result in larger sound levels at great distances (increased reflectivity, Q).
- Typically air temperatures are warmer high aloft since air temperatures near water surface tend to be more constant. Result is a high probability of temperature inversion.
- Sound levels can "carry" much further.

Snow

- Covers the ground for approximately 1/2 of the year in northern climates.
- Can act as an absorber or reflector (and varying degrees in between).
- Freshly fallen snow can be quite absorptive.
- Snow which has been sitting for a while and hard packed due to wind can be quite reflective.
- Falling snow can be more absorptive than rain, but does not tend to produce its own noise.
- Snow can cover grass which might have provided some means of absorption.
- Typically sound propagates with less impedance in winter due to hard snow on ground and no foliage on trees/shrubs.

## Appendix III SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from the Alberta Energy Regulator Directive 038 (February, 2007)

| Source[1] | Sound Level ( dBA) |
|---|---|
| Bedroom of a country home | 30 |
| Soft whisper at 1.5 m | 30 |
| Quiet office or living room | 40 |
| Moderate rainfall | 50 |
| Inside average urban home | 50 |
| Quiet street | 50 |
| Normal conversation at 1 m | 60 |
| Noisy office | 60 |
| Noisy restaurant | 70 |
| Highway traffic at 15 m | 75 |
| Loud singing at 1 m | 75 |
| Tractor at 15 m | 78-95 |
| Busy traffic intersection | 80 |
| Electric typewriter | 80 |
| Bus or heavy truck at 15 m | 88-94 |
| Jackhammer | 88-98 |
| Loud shout | 90 |
| Freight train at 15 m | 95 |
| Modified motorcycle | 95 |
| Jet taking off at 600 m | 100 |
| Amplified rock music | 110 |
| Jet taking off at 60 m | 120 |
| Air-raid siren | 130 |

[1] Cottrell, Tom, 1980, *Noise in Alberta*, Table 1, p.8, ECA80 - 16/1B4 (Edmonton: Environment Council of Alberta).

## SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from the Alberta Energy Regulator Directive 038 (February, 2007)

| Source[1] | Sound level at 3 feet (dBA) |
|---|---|
| Freezer | 38-45 |
| Refrigerator | 34-53 |
| Electric heater | 47 |
| Hair clipper | 50 |
| Electric toothbrush | 48-57 |
| Humidifier | 41-54 |
| Clothes dryer | 51-65 |
| Air conditioner | 50-67 |
| Electric shaver | 47-68 |
| Water faucet | 62 |
| Hair dryer | 58-64 |
| Clothes washer | 48-73 |
| Dishwasher | 59-71 |
| Electric can opener | 60-70 |
| Food mixer | 59-75 |
| Electric knife | 65-75 |
| Electric knife sharpener | 72 |
| Sewing machine | 70-74 |
| Vacuum cleaner | 65-80 |
| Food blender | 65-85 |
| Coffee mill | 75-79 |
| Food waste disposer | 69-90 |
| Edger and trimmer | 81 |
| Home shop tools | 64-95 |
| Hedge clippers | 85 |
| Electric lawn mower | 80-90 |

[1] Reif, Z. F., and Vermeulen, P. J., 1979, "Noise from domestic appliances, construction, and industry," Table 1, p.166, in Jones, H. W., ed., *Noise in the Human Environment*, vol. 2, ECA79-SP/1 (Edmonton: Environment Council of Alberta).

# Appendix IV NOISE MODELING PARAMETERS

## Project Equipment Noise Levels (Current Case & Processing/Washing)

| Item | Noise Source Type[1] | Qty | Source Height (m) | SWL (dBA) | 32 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Generator | SPS | 1 | 2.0 | 105 | 108 | 105 | 109 | 107 | 101 | 99 | 97 | 95 | 88 |
| Generator (No Silencer) | SPS | 2 | 2.0 | 121 | 111 | 124 | 127 | 118 | 116 | 116 | 113 | 108 | 101 |
| Cone Crusher | SPS | 2 | 4.5 | 113 | 106 | 112 | 115 | 109 | 107 | 109 | 105 | 99 | 98 |
| Shakers (North) | SPS | 1 | 4.0 | 119 | 116 | 116 | 117 | 110 | 116 | 115 | 111 | 110 | 103 |
| Shaker (South) | SPS | 1 | 4.0 | 107 | 115 | 104 | 106 | 104 | 107 | 101 | 97 | 93 | 86 |
| Feeder | TPS | 3 | 1.5 | 107 | 92 | 101 | 100 | 97 | 102 | 97 | 102 | 101 | 96 |
| Loader | TPS | 3 | 1.5 | 102 | 99 | 106 | 102 | 98 | 99 | 99 | 94 | 89 | 83 |
| Rock Truck | SPS | 1 | 1.5 | 105 | 97 | 108 | 111 | 105 | 102 | 99 | 96 | 93 | 87 |
| Water Pump | SPS | 1 | 2.0 | 104 | 104 | 119 | 103 | 91 | 91 | 94 | 92 | 98 | 100 |
| Small Generator | SPS | 1 | 1.5 | 71 | 89 | 76 | 79 | 74 | 69 | 60 | 59 | 48 | 43 |

## Project Equipment Noise Levels (Pit Operations)

| Item | Noise Source Type[1] | Qty | Source Height (m) | SWL (dBA) | 32 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scraper | TPS | 6 | 1.5 | 114 | 113 | 104 | 115 | 114 | 111 | 109 | 107 | 100 | 92 |
| Grader | TPS | 1 | 1.5 | 112 | 102 | 105 | 116 | 116 | 109 | 106 | 103 | 96 | 87 |
| Dozer (D8) | TPS | 1 | 1.5 | 112 | 100 | 108 | 107 | 109 | 108 | 107 | 104 | 105 | 99 |
| Dozer (D6) | TPS | 2 | 1.5 | 105 | 102 | 110 | 106 | 100 | 98 | 101 | 97 | 93 | 85 |
| Excavator | SPS | 3 | 2.0 | 107 | 105 | 105 | 106 | 105 | 101 | 101 | 100 | 97 | 96 |
| Rock Trucks | TPS | 6 | 1.5 | 105 | 92 | 101 | 100 | 97 | 102 | 97 | 102 | 101 | 96 |

## Project Equipment Noise Levels (Hauling Operations)

| Item | Noise Source Type[1] | Qty | Source Height (m) | SWL (dBA) | 32 Hz | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Loader | TPS | 1 | 1.5 | 102 | 99 | 106 | 102 | 98 | 99 | 99 | 94 | 89 | 83 |

## Haul Road

| Road | (Vehicles Per Hour) | % Heavy Vehicles | Speed (km/hr) |
|---|---|---|---|
| Haul Road | 10 | 100 | 30 |

[1] SPS = Stationary Point Source, TPS=Traveling Point Source

## General Modeling Parameters

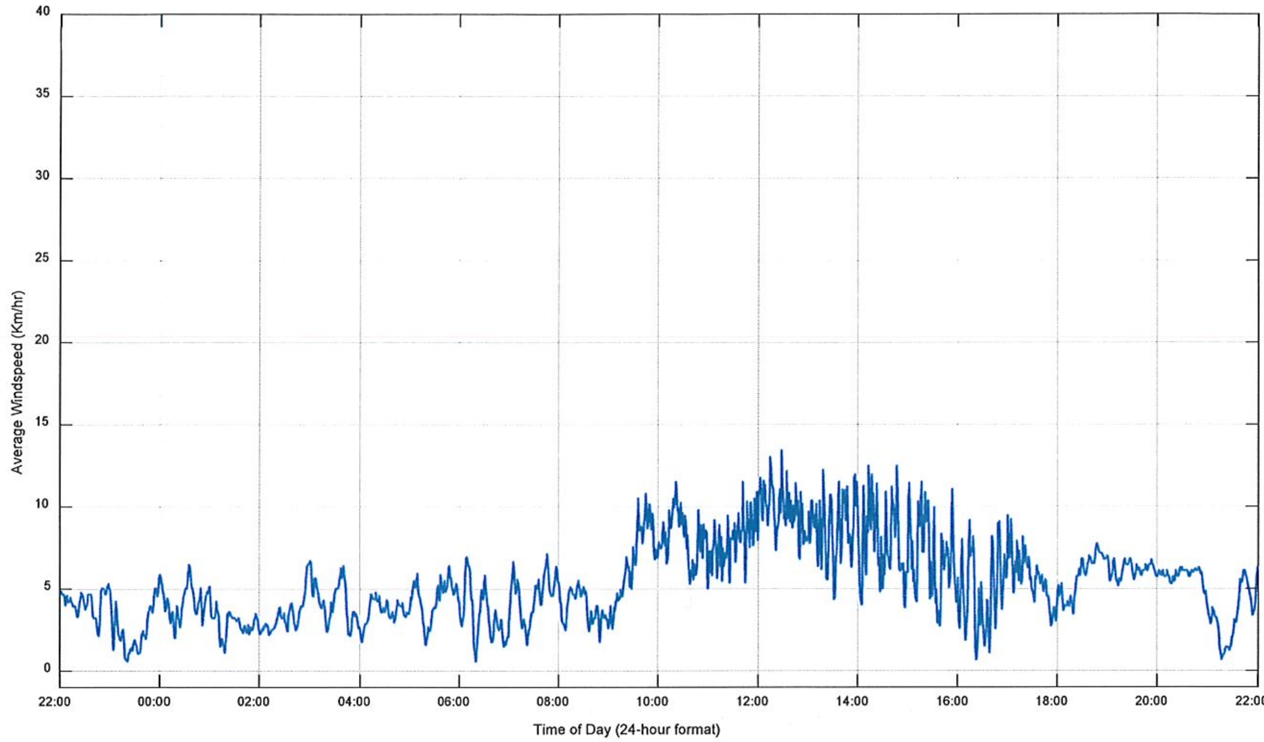
| Parameter | Value |
|---|---|
| **Modeling Software** | CADNA/A (Version 2022 MR1, Build 183.5110) |
| **Standard Followed** | ISO 9613-2 |
| **Ground Sound Absorption Coefficient** | 0.8 |
| **Wind Speed** | 1 - 5 m/s (3.6 - 18 km/hr) |
| **Wind Direction** | Downwind from all sources to all receptors |
| **Temperature** | 10 °C |
| **Humidity** | 70% |
| **Topography** | 1.0 m increments From LiDAR15 from AltaLIS |

# Appendix V NOISE MONITOR ISOLATED DATA

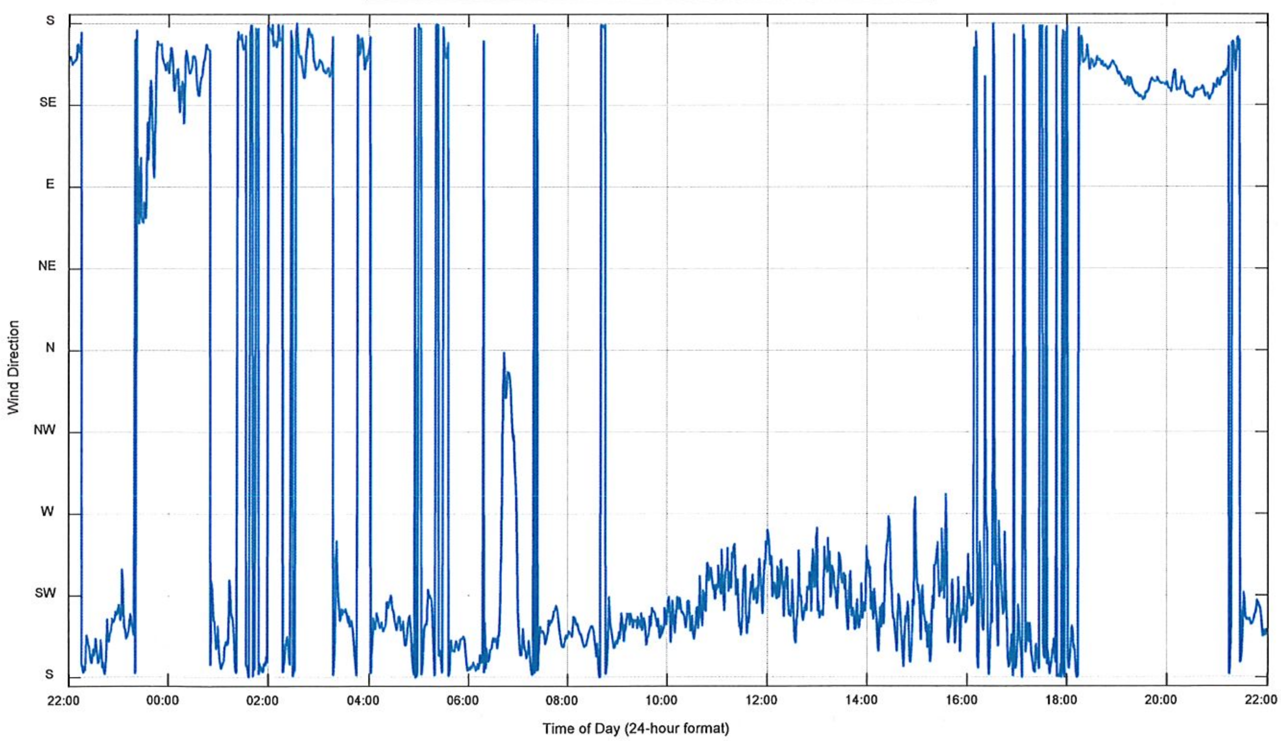
## Northern Monitor (October 17 – 18, 2022)

| Start Time | End Time | SPL (dBA) | Duration (min) | Reason |
|---|---|---|---|---|
| 10/17/22 08:45 | 10/17/22 08:46 | 62.1 | 0.75 | Train Passby |
| 10/17/22 08:47 | 10/17/22 08:48 | 63.8 | 1.25 | Train Passby |
| 10/17/22 11:13 | 10/17/22 11:13 | 54.0 | 0.5 | Misc. |
| 10/17/22 12:03 | 10/17/22 12:04 | 61.5 | 1.25 | Aircraft Flyover |
| 10/17/22 13:34 | 10/17/22 13:35 | 57.7 | 0.5 | Misc. |
| 10/17/22 14:09 | 10/17/22 14:10 | 70.7 | 0.25 | Animal Noise |
| 10/17/22 14:10 | 10/17/22 14:11 | 58.3 | 1.25 | Aircraft Flyover |
| 10/17/22 15:55 | 10/17/22 15:55 | 70.1 | 0.25 | Animal Noise |
| 10/17/22 17:49 | 10/17/22 17:50 | 55.4 | 1.25 | Aircraft Flyover |
| 10/17/22 17:52 | 10/17/22 17:53 | 54.3 | 0.75 | Aircraft Flyover |
| 10/17/22 18:06 | 10/17/22 18:06 | 52.8 | 0.5 | Animal Noise |
| 10/17/22 18:12 | 10/17/22 18:13 | 52.3 | 0.75 | Animal Noise |
| 10/17/22 18:22 | 10/17/22 18:23 | 59.3 | 1.25 | Aircraft Flyover |
| | Total Isolated Time | | 10.5 | |

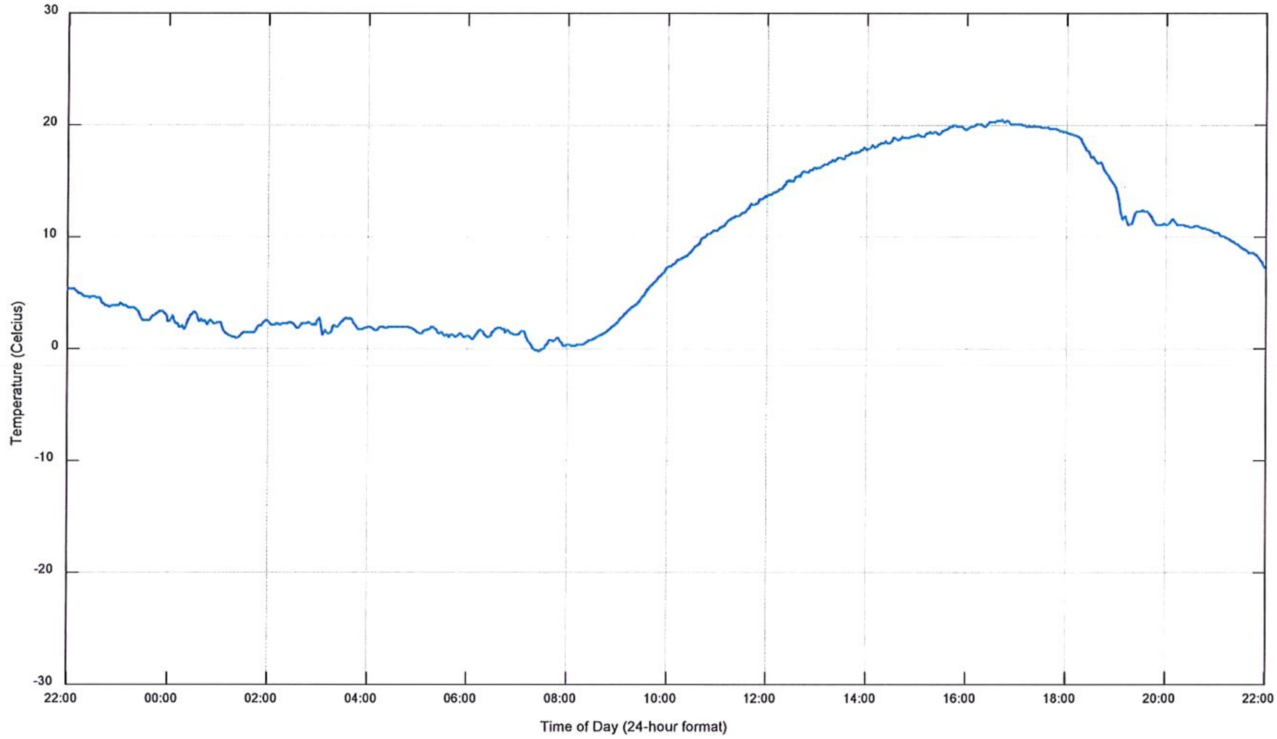
# Appendix VI WEATHER DATA



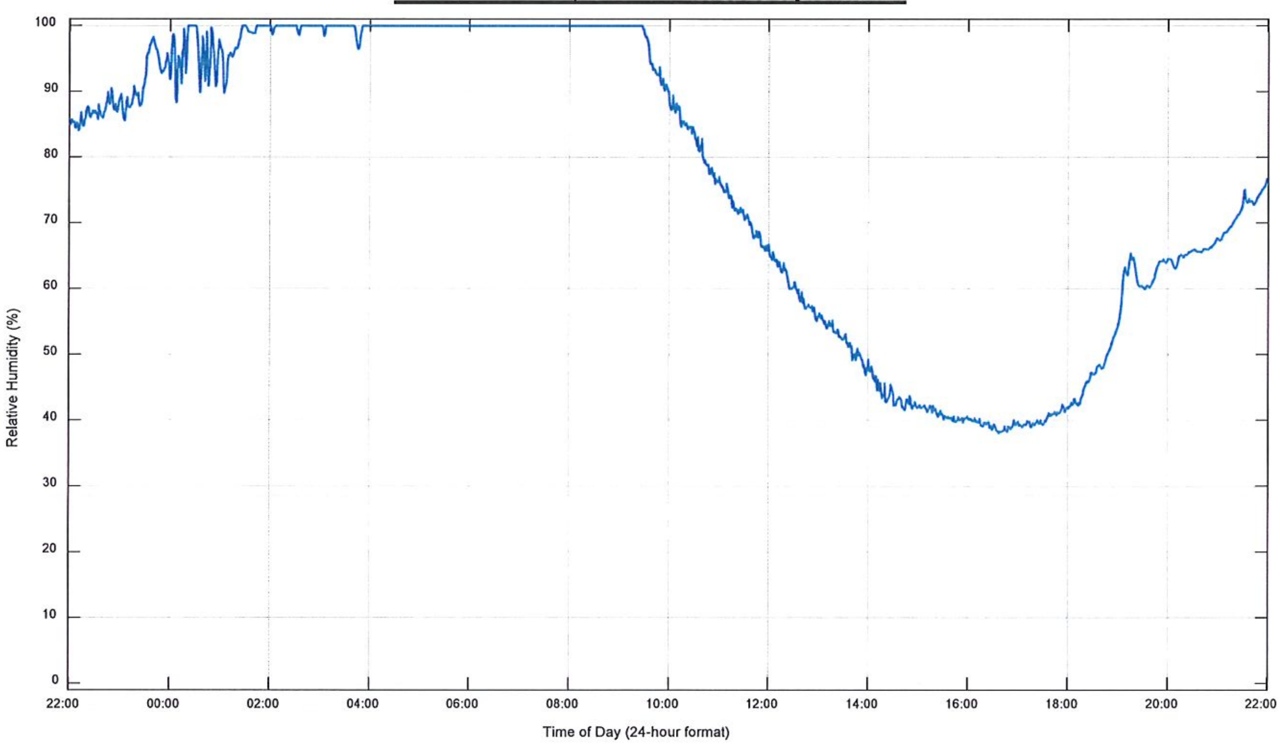

**October 6 – 7, 2022 Monitored Wind Speed**



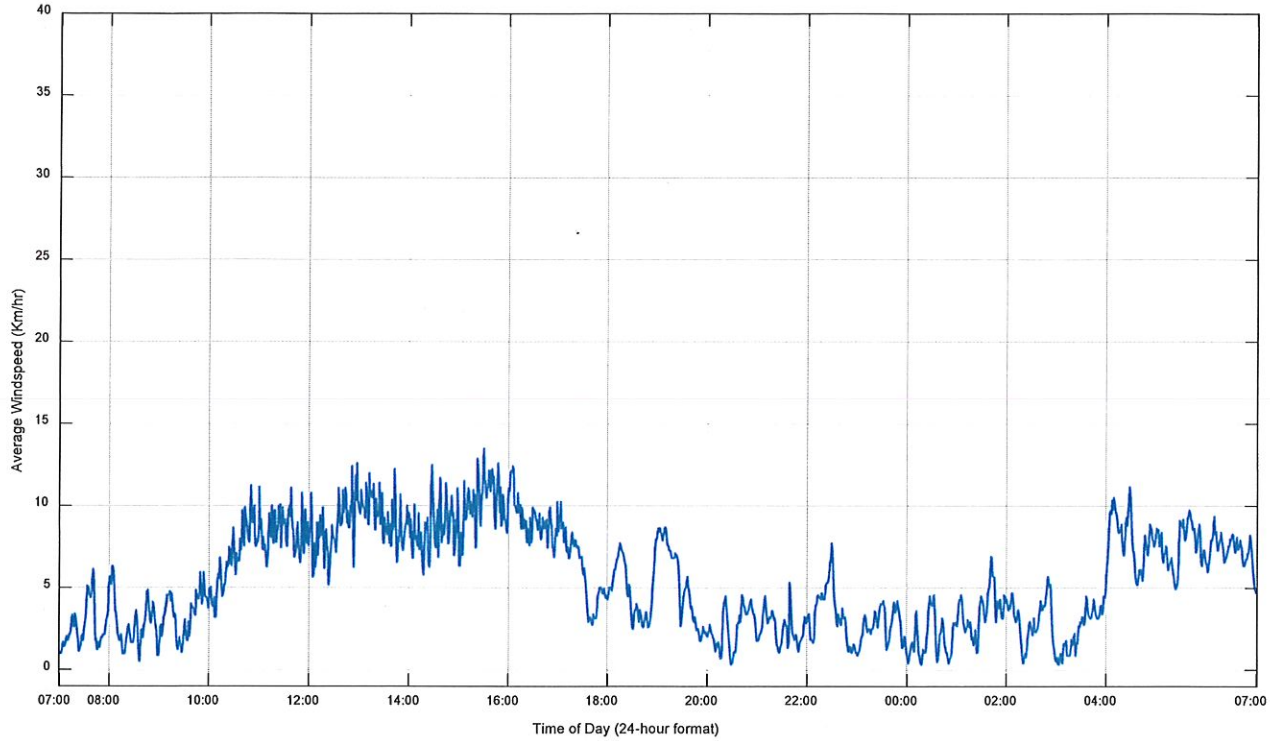

**October 6 – 7, Monitored Wind Direction**



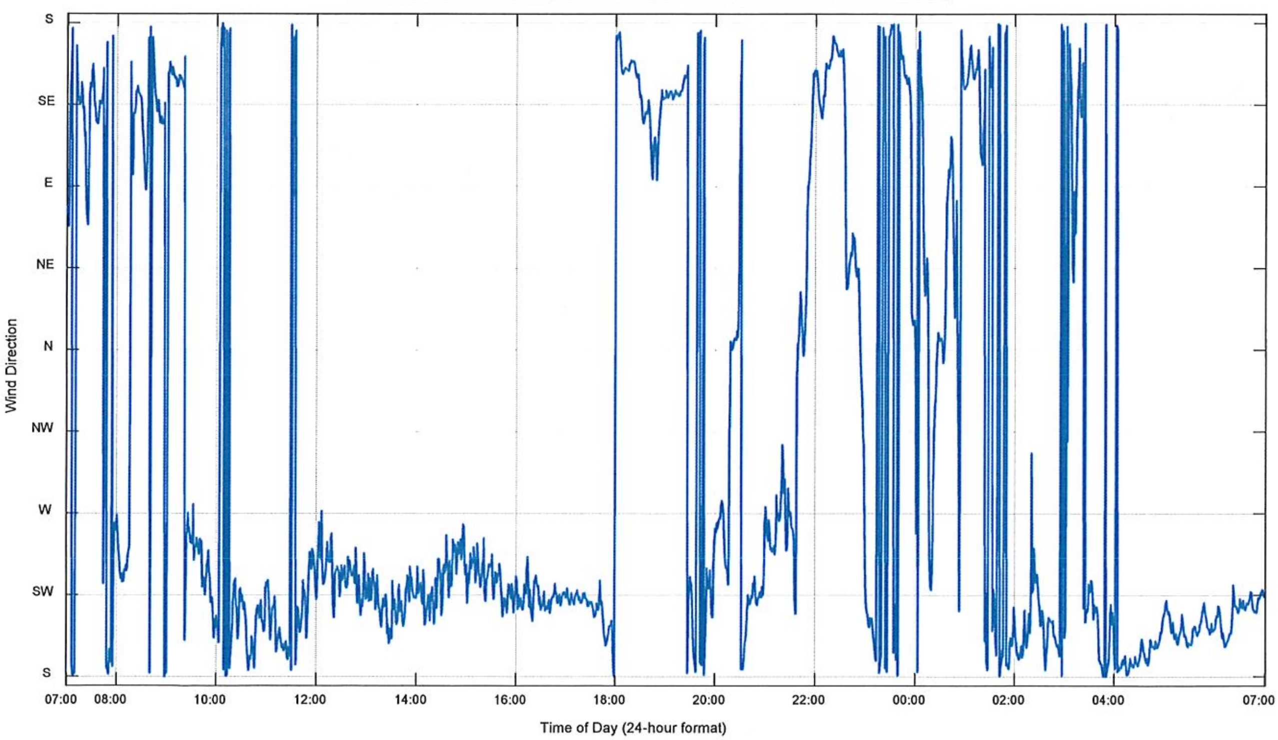

**October 6 – 7, Monitored Temperature**



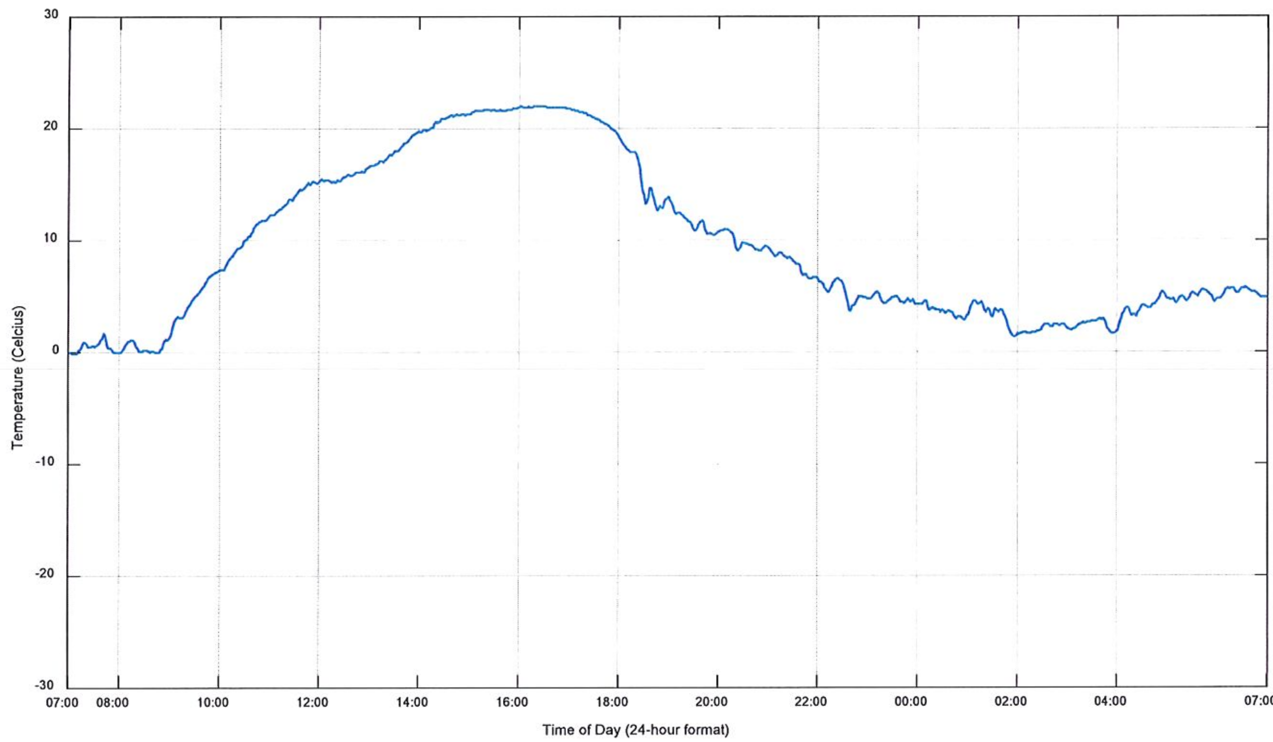

**October 6 – 7, Monitored Relative Humidity**



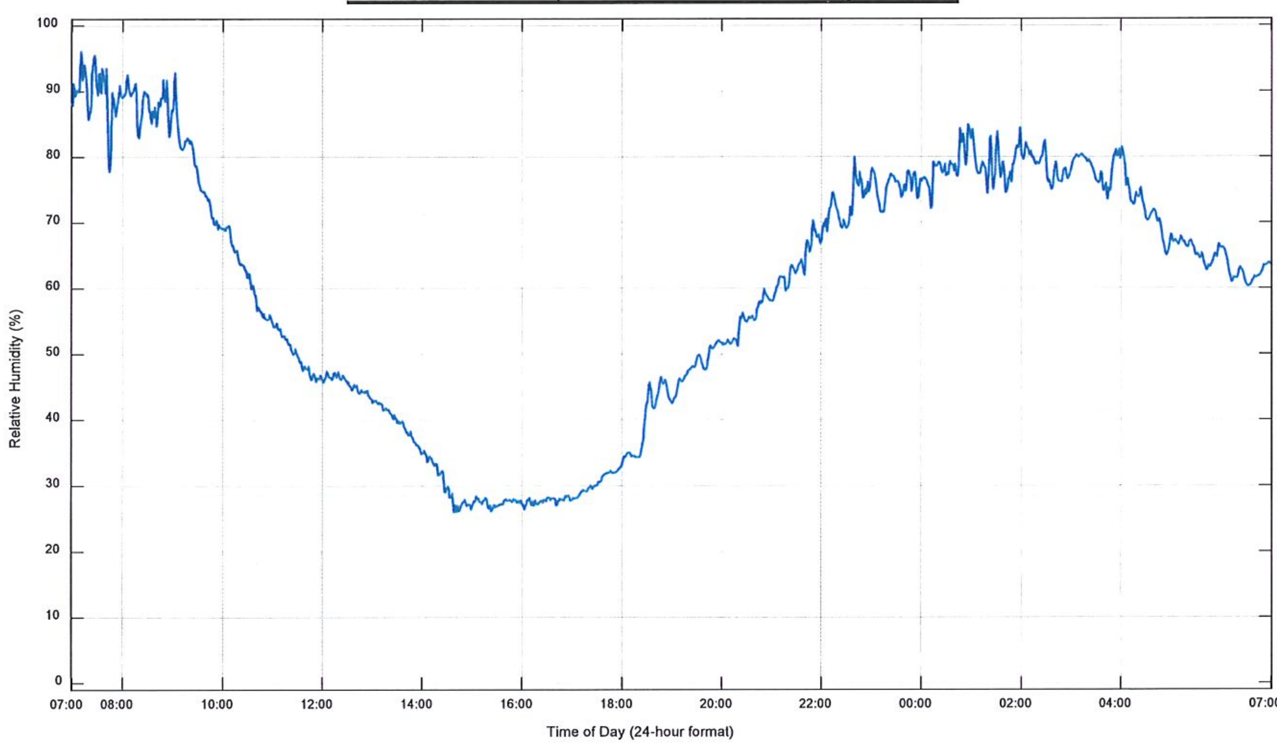

**October 17 – 18, 2022 Monitored Wind Speed**




**October 17 – 18, 2022 Monitored Wind Direction**




**October 17 – 18, 2022 Monitored Temperature**




**October 17 – 18, 2022 Monitored Relative Humidity**

## Lana Dyrland

**From:** Lana Dyrland
**Sent:** Monday, January 23, 2023 3:37 PM
**To:** Janice Agrios; Wachowicz, Ian; Chris Gow; developmentpermitting; Jana Jedlic; Kendra Andrew
**Cc:** Sara McKerry; Thomas Kassian; Susanne Semchuk; SDAB
**Subject:** SDAB Appeals 2023-01 and 2023-02 [PRELIMINARY MATTER]

**Importance:** High

Good afternoon,

A matter of jurisdiction has been raised with the Board.

The Board advises that the hearing on February 9, 2023 will be a preliminary hearing, the sole issue for which will be whether this appeal should be referred to the Land and Property Rights Tribunal or heard by the SDAB.

**The SDAB requests:**

1. The parties to submit their position on the matter of jurisdiction
2. The parties to submit their positions on whether the preliminary hearing should be oral or written

The Board asks that submissions be made in accordance with the deadlines set out in the Notice of Hearing, **that being end of day February 1, 2023**. The hearing package will then be circulated to the parties by end of day February 3, 2023.

Thank you,
Lana

**Lana Dyrland**
Clerk, Subdivision and Development Appeal Board
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca
**www.strathcona.ca**

## Lana Dyrland

**From:** Janice Agrios <JAgrios@kaolawyers.com>
**Sent:** Friday, January 20, 2023 3:32 PM
**To:** Lana Dyrland
**Cc:** Wachowicz, Ian
**Subject:** Subdivision and Development Appeal Board - Appeal #2023-01 and 2023-02
**Attachments:** Approval Environment and Parks.pdf

**Importance:** High



Hi Lana – Ian Wachowicz (Joburg's lawyer) has brought the attached registration from AEP to my attention. In light of this, both Mr. Wachowicz and I are of the view that this appeal should be referred to the LPRT as it falls under Section 685(2.1)(a)(i)(D) of the MGA.

*(2.1) An appeal referred to in subsection (1) [from the developer] or (2) [from an interested party] may be made*

***(a) to the Land and Property Rights Tribunal***

***(i) unless otherwise provided in the regulations under section 694(1)(h.2)(i), where the land that is the subject of the application***

*(A) is within the Green Area as classified by the Minister responsible for the Public Lands Act,*

*(B) contains, is adjacent to or is within the prescribed distance of a highway, a body of water, a sewage treatment or waste management facility or a historical site,*

*(C) is the subject of a licence, permit, approval or other authorization granted by the Natural Resources Conservation Board, Energy Resources Conservation Board, Alberta Energy Regulator, Alberta Energy and Utilities Board or Alberta Utilities Commission, or*

***(D) is the subject of a licence, permit, approval or other authorization granted by the Minister of Environment and Parks,***

*or*

*(ii) in any other circumstances described in the regulations under section 694(1)(h.2)(ii),*

*or*

***(b) in all other cases, to the subdivision and development appeal board.***

Accordingly, we are requesting that the SDAB refer this appeal to the LPRT pursuant to section 686(1.1) of the MGA:

*686 (1.1) Where a person files a notice of appeal with the wrong board, that board must refer the appeal to the appropriate board and the appropriate board must hear the appeal as if the notice of appeal had been filed with it and it is deemed to have received the notice of appeal from the applicant on the date it receives the notice of appeal from the first board, if*

*(a) in the case of a person referred to in subsection (1), the person files the notice with the wrong board within 21 days after receipt of the written decision or the deemed refusal, or*

*(b) in the case of a person referred to in subsection (2), the person files the notice with the wrong board within 21 days after the date on which the notice of the issuance of the permit was given in accordance with the land use bylaw.*

If you require anything further from us, please let us know. Thank you for your assistance.

Janice Agrios

Alberta Environment and Parks

Provincial Programs
Regulatory Approvals Centre
5th Floor, South Petroleum Plaza
9915 – 108 Street
Edmonton, Alberta T5K 2G8
Canada
Telephone: (780) 427-6311
Fax: (780) 422-0154
www.aep.alberta.ca

December 13, 2017

Joburg Aggregates Ltd.
11610 151 Street
Edmonton AB T5M 4W9

Attention: Peter Wall

Dear Mr. Wall:

**RE: Code of Practice for Pits**
**Joburg Pit W 25 & SW 36-54-22-W4M**
**Application No. 001-395081**

We have completed our review of your application for registration under the above Code of Practice. Attached is the original registration No. 395081-00-00 signed by the designated Director

It is your responsibility to obtain any approvals, permits or licences that are required from other agencies.

The holder of a registration for a Pit must meet all the requirements of the applicable Code of Practice. It is recommended that you and operating staff regularly review the code requirements and keep a copy of the Code of Practice available for staff use.

In addition, a registration holder and any staff involved in operating a pit must comply with all requirements of the *Environmental Protection and Enhancement Act*, associated Regulations, and any other applicable laws.

All licences, authorizations, registrations and approvals issued by Environment and Parks under the Alberta *Environmental Protection and Enhancement Act* or the *Water Act* should not be taken to mean the proponent (applicant) has complied with federal legislation. Proponents should contact Fisheries and Oceans, Habitat Management, Whitemud Business Park, 4253 - 97 Street, Edmonton, Alberta, T6E 5Y7, telephone (780) 495-4220, fax number (780) 495-8606 in relation to the application of federal laws relating to the *Fisheries Act (Canada)* and the Navigable Water Protection Program, Transport Canada, Canada Place, 1100, 9700 Jasper Avenue, Edmonton, Alberta, T5J 4E6 telephone (780) 495-8215, relating to the *Navigable Waters Protection Act*.

../2

Questions or concerns regarding the contents of the Code of Practice can be made to the:

Red Deer-North Saskatchewan Region
Alberta Environment and Parks
Twin Atria Building
111 4999 98 Avenue
Edmonton AB T6B 2X3
Telephone: (780) 427-7617
Fax: (780) 427-7824

If any changes to the operation (activities plan) of the pit are contemplated, the person responsible shall provide the Director with additional information about these proposed modifications by completing and submitting the applicable portions of Section 9 of the Guide to the Code of Practice for Pits, October, 2004.

Yours truly,

A Vawter

Annette Vawter
Application Coordinator

Attachment

cc: Elise Neumann – Red Deer-North Saskatchewan Region – Edmonton
cc: Sameng Inc.
Attention: Allisson Lefebvre
cc: Chris A McEachern
cc: 1415692 Alberta Ltd.
cc: 1415654 Alberta Ltd.
cc: Strathcona County

Alberta Environment and Parks

# REGISTRATION
## PROVINCE OF ALBERTA

## ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT
## R.S.A. 2000, c.E-12, as amended

REGISTRATION NO.: **395081-00-00**

APPLICATION NO.: **001-395081**

EFFECTIVE DATE: **December 5, 2017**

REGISTRATION HOLDER: **Joburg Aggregates Ltd.**

**Registration is issued for the following activity:**

The construction, operation and reclamation of a pit located in the NW 25-54-22-W4, SW 36-54-22-W4 and SW 25-054-22 W4M as described in the Activities Plan submitted with the registration application.

Designated Director under the Act ............................
Mohammad Habib, P.Eng

Date Signed December 5, 2017

## Lana Dyrland

**From:** Janice Agrios <JAgrios@kaolawyers.com>
**Sent:** Monday, January 23, 2023 6:08 PM
**To:** Lana Dyrland; Wachowicz, Ian; Chris Gow; developmentpermitting; Jana Jedlic; Kendra Andrew
**Cc:** Sara McKerry; Thomas Kassian; Susanne Semchuk; SDAB
**Subject:** RE: SDAB Appeals 2023-01 and 2023-02 [PRELIMINARY MATTER]

**CAUTION:** This email originated from outside the organization.

Hi Lana – I am fine with written submissions and do not have any further submissions beyond the email that I sent regarding the issue. The application also references Water Act authorizations from AEP, which provide a further basis on which this appeal should be heard by the LPRT. Mr. Wachowicz can confirm.

Janice Agrios

---

**From:** Lana Dyrland <Lana.Dyrland@strathcona.ca>
**Sent:** January 23, 2023 3:37 PM
**To:** Janice Agrios <JAgrios@kaolawyers.com>; Wachowicz, Ian <ian.wachowicz@dentons.com>; Chris Gow <Chris.Gow@strathcona.ca>; developmentpermitting <developmentpermitting@strathcona.ca>; Jana Jedlic <Jana.Jedlic@strathcona.ca>; Kendra Andrew <Kendra.Andrew@strathcona.ca>
**Cc:** Sara McKerry <Sara.McKerry@strathcona.ca>; Thomas Kassian <Thomas.Kassian@strathcona.ca>; Susanne Semchuk <Susanne.Semchuk@strathcona.ca>; SDAB <SDAB@strathcona.ca>
**Subject:** SDAB Appeals 2023-01 and 2023-02 [PRELIMINARY MATTER]
**Importance:** High

Good afternoon,

A matter of jurisdiction has been raised with the Board.

The Board advises that the hearing on February 9, 2023 will be a preliminary hearing, the sole issue for which will be whether this appeal should be referred to the Land and Property Rights Tribunal or heard by the SDAB.

**The SDAB requests:**
1. The parties to submit their position on the matter of jurisdiction
2. The parties to submit their positions on whether the preliminary hearing should be oral or written

The Board asks that submissions be made in accordance with the deadlines set out in the Notice of Hearing, **that being end of day February 1, 2023**. The hearing package will then be circulated to the parties by end of day February 3, 2023.

Thank you,
Lana

**Lana Dyrland**
Clerk, Subdivision and Development Appeal Board
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8140
Fax: 780-464-8194
lana.dyrland@strathcona.ca
**www.strathcona.ca**

## Lana Dyrland

**From:** Jana Jedlic
**Sent:** Monday, January 30, 2023 2:58 PM
**To:** SDAB
**Cc:** Lana Dyrland; Chris Gow; Meghan Thompson
**Subject:** Appeals 2023-01 and 2023-02 Preliminary Matter
**Attachments:** SDAB LPRT Letter.pdf

Good afternoon,

Attached please find the Development Authority's requested submission relating to the preliminary matter of jurisdiction.

Thank you,

Jana

**Jana Jedlic M.U.P., B.A., RPP, MCIP** (she/her)
Manager, Permitting, Inspections & Customer Service
Planning & Development Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB T8A 3W7
Phone: 780-464-8159
jana.jedlic@strathcona.ca
**www.strathcona.ca**

STRATHCONA COUNTY

Find us on:

STRATHCONA COUNTY

January 27, 2023

Subdivision and Development Appeal Board (SDAB)
c/o Lana Dyrland, Clerk
Legislative & Legal Services
Strathcona County
2001 Sherwood Drive
Sherwood Park, AB
T8A 3W7

**SDAB Appeals 2023-01 and 2023-02 PRELIMINARY MATTER**
**Re: Development Permit #2022-0589-DP for Aggregate Extraction Use**
**SW 25-54-22-W4, NW 25-54-22-W4 and SW 36-54-22-W4**

In an email dated January 23, 2023, the Clerk of the SDAB notified the parties to the appeal that a matter of jurisdiction had been raised. The Clerk requested that the parties submit "their position on the matter of jurisdiction" and "their positions on whether the preliminary hearing should be oral or written." This letter is the Development Authority's submission for both requests.

**Matter of Jurisdiction**

In the decision letter for Development Permit number 2022-0589-DP, on page 5, the Development Authority incorrectly referenced the SDAB. Rather, an appeal should be directed to the Land and Property Rights Tribunal (LPRT) in accordance with sub-clause 685(2.1)(a)(i)(D) of the Municipal Government Act, which indicates:

> 685(2.1) An appeal referred to in subsection (1) or (2) may be made
> (a) to the Land and Property Rights Tribunal
> (i) unless otherwise provided in the regulations under section 694(1)(h.2)(i), where the land that is the subject of the application
> …
> (D) is the subject of a licence, permit, approval or other authorization granted by the Minister of Environment and Protected Areas or the Minister of Forestry, Parks and Tourism…

The proposed aggregate extraction operation on the above-refenced lands is subject to authorization by the Minister of Environment and Protected Areas.

There is no prejudice or harm from the mistaken reference and the SDAB should refer the appeal to the LPRT in accordance with Municipal Government Act sub-section 686(1.1).

**Oral or Written Hearing**

The Development Authority takes no position on whether the hearing on the preliminary matter of jurisdiction is considered based on an oral or written hearing. If the hearing is carried out orally, the Development Authority is available to attend on February 9th, 2023.

Should you have any questions about this letter, please contact me at 780-464-8159.

Sincerely,

STRATHCONA COUNTY

Jana Jedlic

Jana Jedlic, Development Officer
Permitting, Inspections & Customer Service
PLANNING & DEVELOPMENT SERVICES

2001 Sherwood Drive
Sherwood Park, Alberta T8A 3W7

780-464-8080
**www.strathcona.ca**

## Lana Dyrland

**From:** Wachowicz, Ian <ian.wachowicz@dentons.com>
**Sent:** Wednesday, February 1, 2023 2:06 PM
**To:** Janice Agrios; Lana Dyrland; Chris Gow; developmentpermitting; Jana Jedlic; Kendra Andrew
**Cc:** Sara McKerry; Thomas Kassian; Susanne Semchuk; SDAB
**Subject:** RE: SDAB Appeals 2023-01 and 2023-02 [PRELIMINARY MATTER]
**Attachments:** Approval Environment and Parks.pdf



I do not have anything substantive to add to the jurisdictional points that Ms. Agrios set out in her last email. I am attaching to this email the Approval from Environment and Parks that causes this matter to be removed from the jurisdiction of the SDAB and placed in the jurisdiction of the LPRT.

685(2.1) of the MGA states:

(2.1) An appeal referred to in subsection (1) [from the developer] or (2) [from an interested party] may be made

(a) to the Land and Property Rights Tribunal

(i) unless otherwise provided in the regulations under section 694(1)(h.2)(i), where the land that is the subject of the application

(A) is within the Green Area as classified by the Minister responsible for the Public Lands Act,

(B) contains, is adjacent to or is within the prescribed distance of a highway, a body of water, a sewage treatment or waste management facility or a historical site,

(C) is the subject of a licence, permit, approval or other authorization granted by the Natural Resources Conservation Board, Energy Resources Conservation Board, Alberta Energy Regulator, Alberta Energy and Utilities Board or Alberta Utilities Commission, or

(D) is the subject of a licence, permit, approval or other authorization granted by the Minister of Environment and Parks,

or

(ii) in any other circumstances described in the regulations under section 694(1)(h.2)(ii),

or

(b) in all other cases, to the subdivision and development appeal board.

The matter is straightforward. Section 685(2.1)(a)(i)(D) requires this appeal to be heard by the LPRT. The SDAB does not have jurisdiction to hear it.

When that happens, and an appeal was filed in time to the SDAB, the SDAB has a positive duty to transfer the matter to the LPRT:

*686 (1.1) Where a person files a notice of appeal with the wrong board, that board must refer the appeal to the appropriate board and the appropriate board must hear the appeal as if the notice of appeal had been filed with it and it is deemed to have received the notice of appeal from the applicant on the date it receives the notice of appeal from the first board, if* *(a) in the case of a person referred to in subsection (1), the person files the notice with the wrong board within 21 days after receipt of the written decision or the deemed refusal, or*

*(b) in the case of a person referred to in subsection (2), the person files the notice with the wrong board within 21 days after the date on which the notice of the issuance of the permit was given in accordance with the land use bylaw.*

There is agreement between both myself and Ms. Agrios that this transfer must be made.

My only added submission is with regard to timing. Given that Development Appeals are supposed to be heard within 30 days of filing, and given that my client agreed, albeit reluctantly, to an adjournment of the matter once, and given that this transfer will inevitably cause a second delay in the scheduling of the hearing, and given that there is agreement between the two parties that adverse in interest on this matter, we request that a quorum of the SDAB meet via telephone or even via email to refer this matter to the LPRT as soon as possible. We cannot contact the LPRT for dates for a hearing until the s. 686(1.1) referral is made.

Thank you.


Ian L. Wachowicz
Partner

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