Kontzamanis Graumann Smith MacMillan Inc.

KGS GROUP CONSULTING ENGINEERS

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July 8, 2016

File No. 16-0607-003

Manitoba Conservation and Water Stewardship
Department of Sustainable Development
Environmental Approvals Branch
Box 80, 123 Main Street
Winnipeg, Manitoba
R3C 1A5

ATTENTION: Ms. Tracy Braun, M.Sc.
Director

RE: Leachate Storage/Evaporation Ponds
Notice of Alteration – R.M. of St. Clements – Libau Landfill

Dear Ms. Braun:

On behalf of the R.M. of St. Clements, KGS Group is hereby submitting this Notice of Alteration request and enclosed $500 application fee are being submitted to the Department of Sustainable Development (DSD) for an amendment to the Class 1 Environmental Act Licence No. 2274 S2RR for the R.M. of St. Clements Libau Landfill. The amendment is to include the design and construction of leachate storage/evaporation ponds, in response to the Manitoba Conservation and Water Stewardship (MCWS) letters, dated September 19, 2014, with regards to improving the leachate management, and proposed method for final disposal of leachate at Libau Landfill (see Appendix A). Also, discussions during the meeting between the R.M, DSD and KGS Group representatives on April 18, 2016, at the MCWS office in Selkirk, concluded that building a leachate pond is the most cost-effective alternative to deal with the accumulated leachate at the Libau Landfill.

Based on conversations with Mr. Mike Baert, Regional Supervisor of DSD for the Central Region-Interlake, implementing leachate evaporation/storage ponds at the Libau Landfill is considered a Minor Alteration, subject to Director Approval.

Details of the design, construction and operation of the leachate ponds are given in the following sections, to obtain formal authorization from the DSD and for inclusion in the Client File No. 3967.

## 1.0 PROPOSED AMENDMENT

Authorization is required to include the following facility in Licence No. 2274 S2 RR:

A. Construction of two (2) 5,000 $m^3$ leachate storage/evaporation ponds to store impacted water and leachate, including:

- An enhanced evaporation/aeration system consisting of piping, sprinklers and pumps.
- Cell design to enable freeze/thaw treatment of leachate – ice in winter by transferring the leachate under the ice to the adjacent pond and leaving the clean ice to melt under ambient weather conditions in Spring.

B. Installing a Retrofitted Leachate Collection System (RLCS) in Cell 1 as per KGS Group design.

In 2015, KGS Group performed pump tests at the leachate collection systems in Cells 1 and 3, indicating that pumping recovery was adequate in Cell 3, but with very low recovery in Cell 1. This indicated potential clogging in the Cell 1 collection system, which compromises the ability to control the leachate head on the liner. Since the leachate head must be reduced in Cell 1, a RLCS system will be required.

## 2.0 LEACHATE STORAGE/EVAPORATION POND DESIGN

KGS Group (2016) estimated that suitable storage is required for 1,200 $m^3$ of impacted water and 3,600 $m^3$ of annual extractable leachate. The annual precipitation volume is assumed to be offset by the enhanced evaporation system to be implemented in the pond and freeze/thaw treatment over winter. Therefore, the total volume required for this pond is approximately 5,000 $m^3$. This new pond will allow for dewatering Cells 1 and 3 and the existing large pond south of Cell 1 (See Figure 1), and onsite storage/treatment of leachate by using enhanced evaporation and aeration during summer, and freeze/thaw leachate-ice separation during winter. The main purpose of constructing two (2) 5,000 $m^3$ ponds is to include storage capacity for future cells development, and to provide a second pond to allow leachate separation from the ice during winter. Depending on the leachate chemistry, the ultimate disposition of the leachate and thawed ice could be onsite irrigation or hauling to the North End Wastewater Pollution Control Centre (NEWPCC).

Figure 2 shows the design of the leachate ponds, each measuring 65 m x 63.5 m, with a 1 m compacted clay liner meeting $1x10^{-7}$ cm/sec permeability requirements and the soil sampling and soil laboratory data confirms the hydraulic conductivity is approximately $1x10^{-8}$ cm/sec and likely much lower (See Section 5). The design utilizes an inside slope of 4 to 1, with a berm width of 3 m for vehicle access, and a perimeter ditch with 3 to 1 slopes and a 1 m base. The maximum design leachate level is 2.5 m above the clay liner, with 0.5 m of freeboard, as shown in Figure 2.

## 3.0 SYSTEM OPERATION AND MAINTAINANCE

### 3.1 LEACHATE PUMPING

The pond operation is described as follows. Once the leachate ponds are constructed, leachate from the northwest and northeast manholes in Cell 3 (See Figure 1) and the existing large pond south of Cell 1 will be pumped to one of the leachate ponds. Leachate/impacted water will be discharged to the rip rap aprons in the ponds to prevent scouring. From Cell 3, leachate will be pumped out at low flow rates to prevent clogging of the collection system and impairing its long term performance.

After the existing large pond south of Cell 1 has been dewatered, the assessment of its physical state will be carried out to determine its potential future use as transitional pond for dewatering

Cell 1, using a RLCS. The advantage of using this existing large pond is its potential for accumulating extracted leachate at anticipated low flow rates, which would allow for the accumulated leachate to be pumped to the new leachate ponds at high flow rates.

If the physical state of the existing pond indicates that it cannot be used for transitional leachate storage, leachate from the RLCS will need to be pumped at anticipated low flow rates to the new ponds.

## 3.2 RETROFITTED LEACHATE COLLECTION SYSTEM (RLCS) IN CELL 1

The rehabilitation concept of the leachate collection system in Cell 1 involves installing a trench on each of the three (3) sides of the cell, preferably where leachate seepage has been observed, using a perforated pipe bedded in recycled glass as drainage medium, and covered with clay to minimize infiltration. The outer end of the pipe would have a valve to control the leachate flow. This system would help to lower the leachate up to prairie level by gravity. Initially, the concept is to construct a trench in the south side of Cell 1 that would drain towards the existing large pond, if determined to be suitable for transitional storage. After draining this side of Cell 1 to prairie level, other sides would be similarly drained.

The proposed Retrofitted Leachate Collection System (RLCS) consists of a 0.15 m diameter HDPE DR 11 perforated pipe of 5 to 10 m of length, embedded in recycled glass with a shut-off/control valve at the pipe-end for leachate flow control, as shown in Figure 03. After using a backhoe to dig up a 5 to 10 m trench within the landfill, the perforated pipe will be placed at 2% slope draining towards outside of the landfill. The trench will be filled with recycled glass, and prior to replacing the excavated cover, a geotextile will be placed as the boundary layer between the glass and clay, as shown in Figure 03.

The proposed RLCS would facilitate the drainage of the perched leachate to prairie level. Reducing leachate levels in Cell 1 below prairie level would then be carried out using large diameter extraction wells.

## 3.3 EVAPORATION/AERATION SYSTEM

For each pond, leachate will be pumped out using a submersible pump placed inside the submerged 0.15 M HDPE pipe on one corner of each lagoon. The submersible pump will be connected to a header pipe at the periphery of the ponds. Spray nozzles will be affixed to the header pipe to allow for spraying the leachate into the pond, providing aeration and evaporation.

## 3.4 FREEZE / THAW OPERATION / IRRIGATION

During winter, and after any snowstorm, landfill personnel will remove the snow from the leachate pond surface to maximize the ice formation. Before Spring, leachate will be pumped out from the full pond to the empty pond, while leaving the ice to melt during Spring. Once melted, the thawed ice water will be tested for suitability for irrigation on adjacent land.

Also, depending on the characteristics of the aerated leachate, the leachate itself could be irrigated on adjacent land. The irrigation could occur on grassed or forested areas east of the ponds. Any such areas irrigated would be tested to ensure containment and minimal vegetative stress.

### 3.5 NEW GROUNDWATER MONITORING WELLS

Three monitoring wells are proposed, 2 along the west property boundary and one monitoring well on the east side upstream of the site (groundwater direction is northwest). The monitoring wells will be installed adjacent to the leachate ponds to ensure the groundwater quality is not affected by the operation of the proposed ponds. The piezometer will be 5.5 m deep with 0.5 m stick-up and 4.5 m of 15 slot screen. The monitoring wells will be sampled every year following the Class 1 Environmental Act Licence No. 2274 S2RR requirements in conjunction with the yearly groundwater monitoring and sampling program for Libau Landfill and the four waste transfer stations in the R.M. The proposed location of the new monitoring wells is shown in Figure 03.

### 3.6 MAINTAINING THE LEACHATE PONDS

It is anticipated that every 5 to 10 years, organic and inorganic material will precipitate and accumulate as sludge at the bottom of the leachate ponds. Maintenance will be required involving removal and storage of this material to a future sludge drying bed near the proposed lagoon and then disposed at the current active landfill cell (5 years plus from now).

## 4.0 STEPS FOR IMPLEMENTING THE LEACHATE STORAGE/EVAPORATION PONDS

The scope of work to complete the design and construction of the leachate ponds is summarized as follows

1. ***Geotechnical Investigations*** **–** Figure 1 shows the area where the leachate ponds would be constructed. KGS Group (2000) monitoring report indicates thin layers of peat (0.3 m) and sand (0.5 m), over approximately 8 m of silty clay. The clay is suitable for a compacted clay liner. Based on subsurface investigations and soil tests data confirm the quality/suitability as good liner material. This work involved a survey of the proposed area, and test pits for soil sampling and laboratory, and focused analysis on the upper 3 m of the soil profile.

2. ***Preliminary Design*** **–** The preliminary design will be based on the soil and groundwater conditions encountered onsite, and will include leachate ponds with compacted clay, dikes and ditches around the pond, and monitoring wells to assess groundwater elevation and quality. Upon review by the R.M. of St. Clements the proposed preliminary design will be submitted to the DSD for comments.

3. ***Final Design*** **–** After receiving comments from the DSD regarding the proposed preliminary design of the leachate pond, the final design will be prepared.

4. ***Tender Documents*** **–** Tender documents will include Drawings and Specifications for the construction of the engineered leachate evaporation/storage pond. KGS Group will prepare a Tender Package according to R.M. of St. Clements format and will provide support services for the tendering and review of bids.

5. ***Construction Supervision*** **–** KGS Group will provide site supervision as required during the construction of the works. KGS Group will ensure the contractor completes the work as set out in the Tender Documents. Quality control of the liner installation will be overseen by KGS Group. Testing for the installed liner including drilling, clay sampling and laboratory tests, was carried out under KGS Group supervision.

## 5.0 Geotechnical Investigations

KGS Group staff visited the Libau Landfill on May 20th of 2016, excavating 9 test pits where the location of the evaporation ponds have been proposed, as indicated in Figures 01 and 04. The drilling logs from the test pits have been included in Appendix B, and soil testing results for Atterberg Limits, maximum dry density and hydraulic conductivity have been included in Appendix C.

The general stratigraphy at the proposed leachate evaporation ponds location consists of the following units based on 9 test pits excavated and sampled within the 2 cell lagoon footprint.

**Top Soil** – Typical thickness of 0.3 to 0.6 m in lagoon footprint

**Silt –** Found only in the southeast corner at a depth of 0.6 to 0.9 m.

**Silt Clay and Clay –** Found in all test pits under the silt or top soil as if typical for Agassis sedimentary deposits regionally.

Laboroatory soil testing results for the existent clay/silty-clay deposit (Appendix B) showed that it is mainly a intermediate to high plastic clay with a Liquid Limit range of 92% to 96%, a Plastic Limit range of 26 to 28% and a Plastic Index range of 64 to 68%.A moisture-density relationship test (Standard Proctor Maximum Dry Density) conducted on the clay yielded a maximum Dry Density of 1,389 kg/$m^3$ and an optimum moisture content of 28%. The target moisture content during construction will be about 30% or 2% wet of optimum. A laboratory hydraulic conductivity test was conducted on one composite recompacted sample and the results demonstrated a hydraulic conductivity of 1x10-$^8$ cm/sec. Based on the liquid limits over 90% suggests strongly that the actual hydraulic conductivity would be an order of magnitude and possibly lower. The results indicate that suitable clay for leachate evaporation ponds is available across the whole proposed lagoon area.

## 6.0 LEACHATE POND – ADDITIONAL INFRASTRUCTURE

The leachate ponds will have the following associated infrastructure:

- **Access Road**

  The facility access will be connected to the main road.

- **Fencing**

  The leachate pond will be surrounded by a 3 strand barb wire fence with a locked single access gate. The fence is intended to discourage trespassing and prevent wildlife from entering the facility.

## 7.0 SCHEDULE

Time is of the essence in order to complete this project in 2016 during acceptable weather conditions and to begin transferring the existing ponded and stored leachate to an acceptable holding facility.

We trust the above information is adequate for an alteration to the Licence and inclusion in the Client File. Should you have any questions or wish to discuss this letter further, please do not hesitate to contact the undersigned.

Prepared By:

Stan Lozecznik, Ph.D., P.Eng.
Environmental Engineer

Approved By:

Rob Sinclair, P.Eng.
Environmental Services Specialist

AB/nf/jr
Attachments

cc: Donna Smiley
Mike Baert
DJ Sigmundson
Greg Elson
Dick Mennon
Kris Innes
Tony Kuluk
Rob Sinclair

# FIGURES

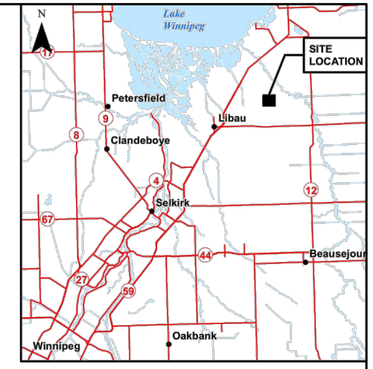
11x17

671250 671500 671750 672000

5575750 5575500 5575250

N

Site Gate
North Ditch
Northwest Pumpout
MW22-98
MW21-98
Northwest Manhole
Northeast Manhole
Clay Borrow
MW23-98
Cell 1
Cell 3
Clay Pile
MW10-98
Southwest Cleanout
MW24-98
Large Pond
Gypsum Pile
Wood Waste
POND 1
POND 2
MW20-98
Tires
Culverts
New Recycling Bin & Household Waste Drop Off
South Ditch
Site Gate
Weigh Scale & Maintenance Facility
Fridge Stockpile Area




LEGEND:

Monitoring Well

Landfill Boundary

25 0 25 50 75 100m

SCALE: 1:2500

| NO. | YY/MM/DD | DESCRIPTION | ISSUED BY | CHECK BY |
|---|---|---|---|---|
| A | 16/05/ | | SAL | RDS |

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

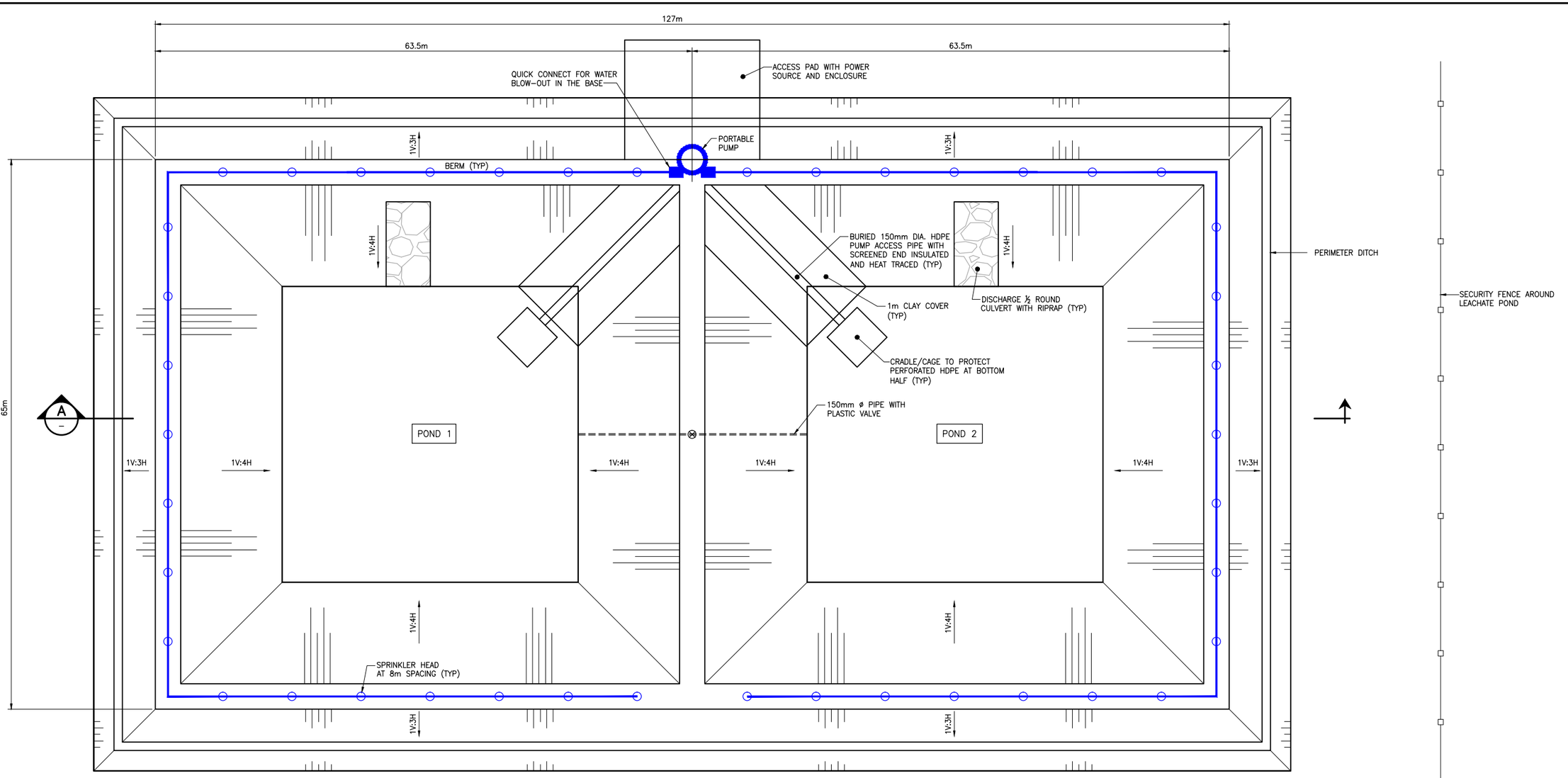
St.Clements The place to be

LEACHATE STORAGE/EVAPORATION PONDS
LIBAU LANDFILL, MB

SITE PLAN

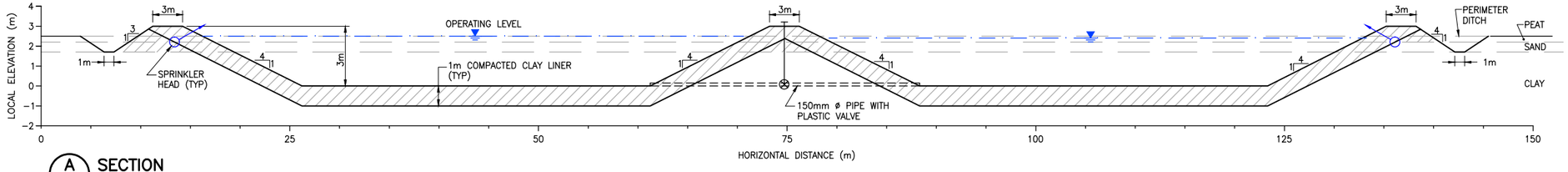
MAY 2016 | FIGURE 01 | REV: A

FileName: U:\PMS\16-0607-003\16-0607-003_Fig01.dwg — Tab: FIG01 Plotted By: rreyes 16/05/19 [Thu 11:19am]
11"x17" PLOT SCALE: 1"=2"




**PLAN**
SCALE: 1:500

5 0 5 10 15 20m
SCALE: 1:500




**A SECTION**
SCALE: 1:500
EXAGGERATION x2

| NO. | YY/MM/DD | DESCRIPTION | ISSUED BY | CHECK BY |
|---|---|---|---|---|
| A | 16/05/ | I | SAL | RDS |

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KGS GROUP CONSULTING ENGINEERS

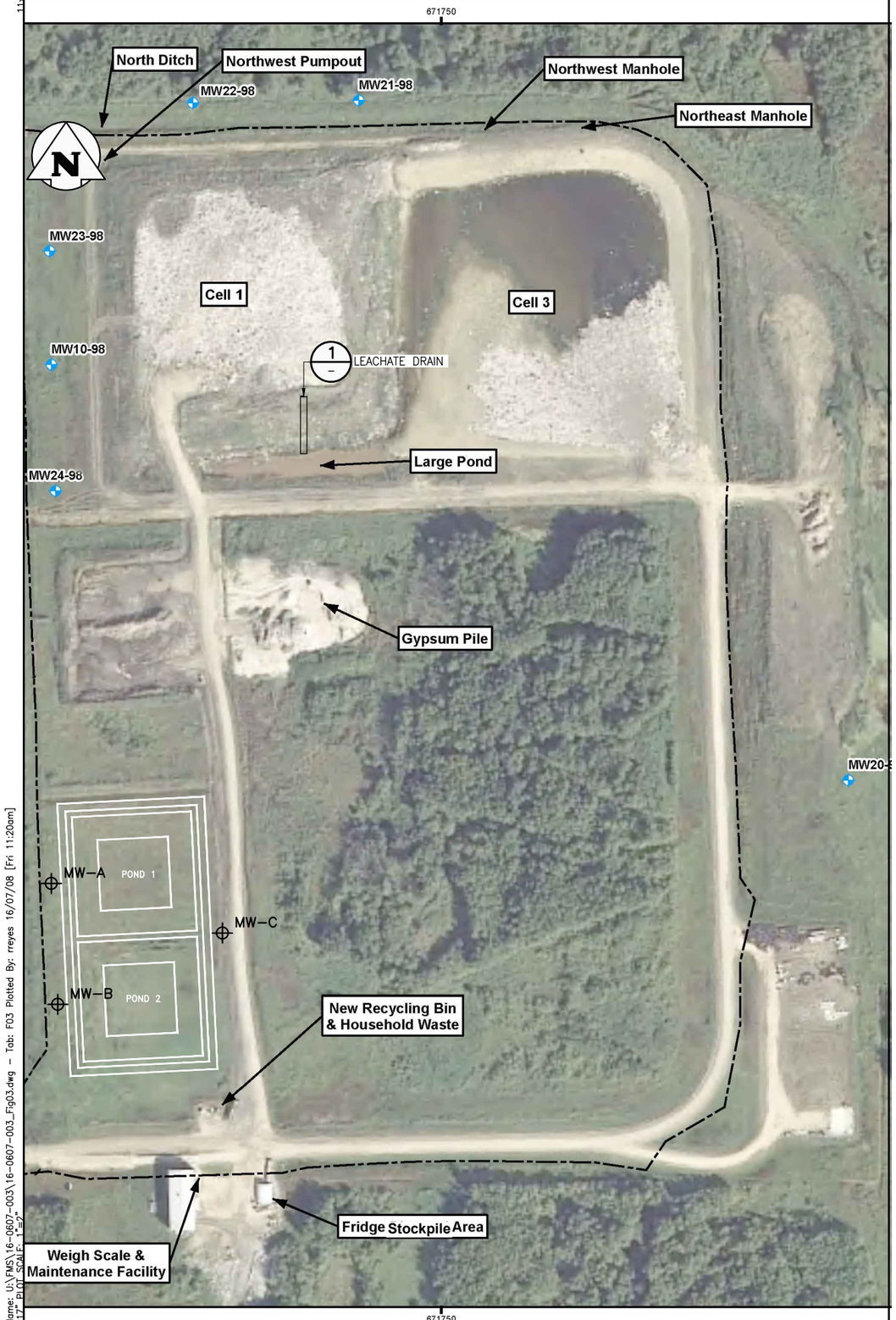
St. Clements The place to be

LEACHATE STORAGE/EVAPORATION PONDS
LIBAU LANDFILL, MB

PLAN AND SECTION

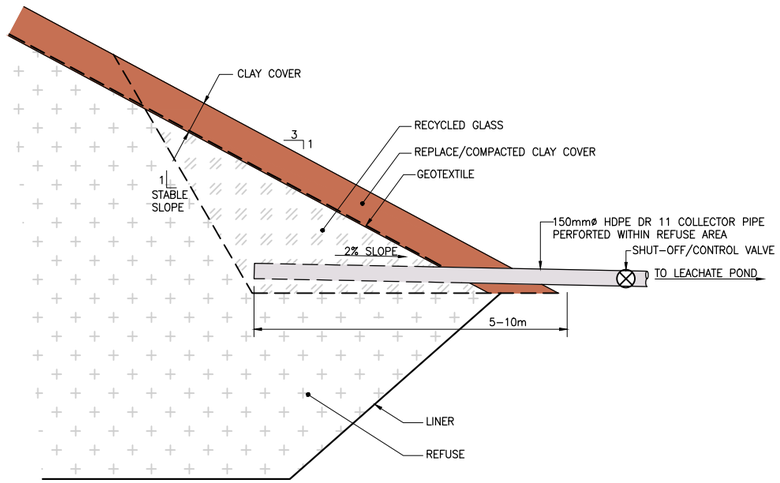
MAY 2016 | FIGURE 02 | REV: A

11x17

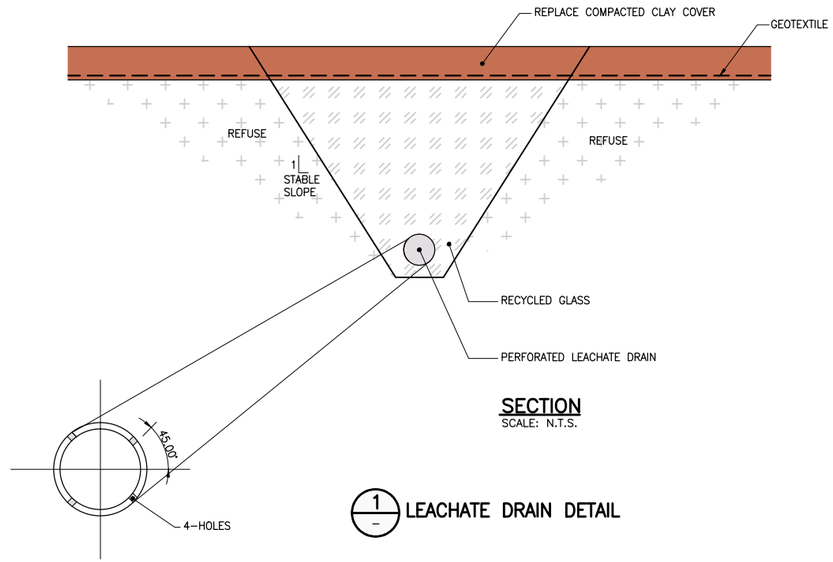



LEGEND:

MW–A ⊕ PROPOSED MONITORING WELLS (3 REQUIRED)




PROFILE
SCALE: N.T.S.




SECTION
SCALE: N.T.S.

1 – LEACHATE DRAIN DETAIL

25 0 25 50 75 100m
SCALE: 1:2500 METRIC (11x17)

| NO. | YY/MM/DD | DESCRIPTION | ISSUED BY | CHECK BY |
|---|---|---|---|---|
| 0 | 16/07/08 | ISSUED WITH FINAL LETTER | SAL | RDS |

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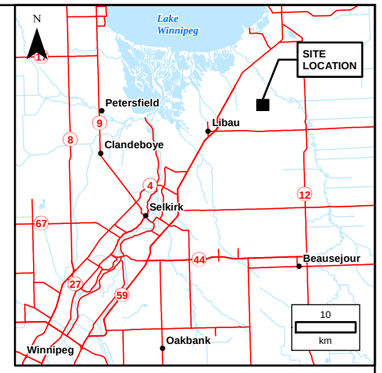
LEACHATE STORAGE/EVAPORATION PONDS
LIBAU LANDFILL, MB

CONCEPTUAL LEACHATE GRAVITY DRAIN

JULY 2016 | FIGURE 03 | REV: 0

FileName: I:\FMS\16-0607-003\16-0607-003_Fig03.dwg - Tab: F03 Plotted By: rreyes 16/07/08 [Fri 11:20am]
11"x17" PLOT SCALE: 1=2"


LEGEND:

- (KGS Survey, May 20, 2016)
- 1m Index LiDAR Contour
- 0.25 LiDAR Contour

NOTES:

1. KGS surveyed the site on May 20, 2016.
2. LiDAR provided by R.M. of St. Clements and captured by Atlis Geomatics in 2010.
3. Imagery is supplied by the Province of Manitoba, (MLI) Manitoba Land Initiative website and dated 2008 – 2010.
4. All units are metric and in metres unless otherwise specified.
   Transverse Mercator Projection, NAD 1983, Zone 14
   Elevations are in metres above sea level (MSL)

DRAFT

20 0 20 40 60 80 100
Metres

SCALE: 1:2,505 METRIC 11"x17"

| NO. | YY/MM/DD | DESCRIPTION | ISSUED BY | CHECK BY |
|---|---|---|---|---|
| A | 16/07/05 | ISSUED WITH REPORT | SAL | BAT |

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

RM OF ST. CLEMENTS

LEACHATE STORAGE/EVAPORATION PONDS – LIBAU LANDFILL, MB

SUBSURFACE SOIL INVESTIGATION

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

JULY 2016 | FIGURE 04 | REV: A

FileName: P:\Projects\2016\16-0607-003\Dwg\GIS\MXD\RevA\16-0607-003-Fig04_RevA.mxd
11"x17" PLOT SCALE 1:1

# APPENDIX A

# MANITOBA CONSERVATION AND WATER STEWARDSHIP LETTERS SEPTEMBER 19, 2014

Manitoba
Conservation and Water Stewardship
Climate Change and Environmental Protection Division
Environmental Compliance and Enforcement
Lower Level,446 Main St, Selkirk, Manitoba, Canada R1A 1V7
T 204-785-5030 F 204-785-5024
www.manitoba.ca

SEP 24 2014

File No.: 3967.00
License No.: 2274 S2 RR

September 19, 2014

Rural Municipality of St Clements
1043 Kittson Road, Box 2 Grp 35 RR1
East Selkirk, Manitoba R0E 0M0

Attention: D.J. Sigmundson, Chief Administrative Officer

Dear Mr. Sigmundson:

**Re: St Clements Regional Landfill – Environment Act Licence No. 2274 S2 RR**

Manitoba Conservation and Water Stewardship (CWS) conducted a site inspection of the St Clements Regional Landfill on July 15, 2014. Mr. Andrew Sprunt of the RM of St. Clements was in attendance. CWS wishes to draw your attention to the following deficiencies:

1. Daily cover on active areas
   Waste deposited into the active cell is not covered with suitable cover material on a daily basis as required by Clause 12 of the Licence.

2. Portable litter fence
   Positioning of the portable litter fence is found to be ineffective and as such, litter is scattered around the surrounding area of the active cell which is contrary to the intention of Section16 of the Licence. This is aggravated by the practice of allowing dumping of garbage all over the active cell.

3. Submission of burn records
   Records of all controlled burns have not been submitted for several years, contrary to Section 9(j) of the Licence.

4. Record keeping at the Facility
   The records as required in Clause 33 of the Licence were not available at the site for inspection. Please forward records for the past three calendar years to CWS for review by the date specified in this letter.

5. Submission of analytical results of the monitoring wells
   The records as required in Clause 34 of the Licence have not been received for several years. Please forward the report for the 2013 calendar year.

6. Performance Monitoring plan and Contingency plan
   The performance-monitoring program that was previously submitted pursuant to Clause 27 of this Licence and the Contingency Plan previously submitted pursuant to Clause 36 of this Licence are not being followed and are not current. Please forward these documents by the date requested below.

Please provide the requested documentation to Manitoba Conservation and Water Stewardship in writing on or before **December 1, 2014**. If you feel you need additional time for the submission of any of the requested records in items numbered 2 through 6 above, you must request an extension in writing.

If you have any questions, please do not hesitate to contact Nada Suresh, Environment Officer, Selkirk District Office, at 204-785-5367.

Sincerely,

Nada Suresh
Environment Officer
Environmental Compliance and Enforcement

c: ✓ Andrew Sprunt, Director Public Works, RM of St Clements
Tracey Braun, Director, Environmental Approvals
Don Labossiere, Director, Environmental Compliance and Enforcement
Donna Smiley/Mike Baert, Environmental Compliance and Enforcement

Manitoba
Conservation and Water Stewardship
Climate Change and Environmental Protection Division
Environmental Compliance and Enforcement
Lower Level,446 Main St, Selkirk, Manitoba, Canada R1A 1V7
T 204-785-5030 F 204-785-5024
www.manitoba.ca



File No.: 3967.00
License No.: 2274 S2 RR

September 19, 2014

Rural Municipality of St Clements
1043 Kittson Road, Box 2 Grp 35 RR1
East Selkirk, Manitoba R0E 0M0

Attention: D.J. Sigmundson, Chief Administrative Officer

Dear Mr. Sigmundson:

Re: **St Clements Regional Landfill**
**Environment Act Licence No. 2274 S2 RR-Leachate Management**

On July 15, 2014 Manitoba Conservation and Water Stewardship (CWS) conducted a site inspection of the St Clements Regional landfill site in conjunction with Mr. Andrew Sprunt of the Rural Municipality of St. Clements (the Licensee).

During the site inspection it was observed that leachate was draining outside the active cell. The Licensee notified the Department that a temporary barrier was constructed to prevent any leachate from escaping the cell. CWS was made aware that the facility's leachate collection system does not receive any leachate at present. These observations indicate that the facility's leachate collection system may not be functioning properly.

Reviewing the past leachate management practices at the above landfill, the following were noted:

- In a letter dated March 22, 2001 the Director of Environmental Approvals granted approval to the Licensee to treat the leachate generated at the St. Clements Regional landfill at the City of Winnipeg North End Water Pollution Control Centre. (Copy attached).
- In May 2006, approximately 100 liters of leachate was disposed at the Grand Marais Wastewater Treatment Lagoon. This action was not approved by the Director and a warning was issued.
- In December 2007, approval was granted in response to a request to dispose the leachate collected in drums at the City of Selkirk Sewage Treatment Plant.
- In October 2010 leachate was pumped to a ditch at the landfill and upon instructions from CWS was pumped backed to where it originated.

- At a meeting held on February 15, 2013 between the Director of Public Works and departmental staff, CWS was informed that the Licensee has initiated a study to determine the most suitable option to dispose of the leachate.

During a follow up inspection on September 11, 2014, it was observed that leachate was seeping out from the bottom of Cell #1 indicating that this cell has not been properly capped and sealed. Additionally, standing water was observed at several areas within the facility suggesting problems exist with surface water management.

It is evident that the Licensee currently has no viable leachate management practice for this facility or permanent solution for the disposal of leachate generated from the landfill.

Please advise this office in writing on or before **October 31, 2014** as to how the licensee plans to address the following:

1. How leachate collection will be managed through the landfill cells and the proposed method for final disposal of leachate.
2. Leachate seepage from Cell # 1.
3. Surface water management on the grounds of the facility.

If you have any questions, please do not hesitate to contact Nada Suresh, Environment Officer, Selkirk District Office, at 204-785-5367.

Sincerely

Nada Suresh
Environment Officer
Environmental Compliance and Enforcement

c: Andrew Sprunt, Director Public Works, RM of St. Clements
Tracey Braun/Cory Switzer, Environmental Approvals
Don Labossiere, Director, Environmental Compliance and Enforcement
Donna Smiley/Mike Baert, Environmental Compliance and Enforcement

# APPENDIX B

# DRILLING LOGS

KGS GROUP

# SUMMARY LOG

HOLE NO. **TP-1**



| | |
|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** |
| **SITE** | **R.M. of Clements** |
| **LOCATION** | **East side of proposed storage pond** |
| **DRILLING METHOD** | **Excavator** |

JOB NO. **16-0607-003**
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED **20/05/2016**
UTMs (NAD83) N **5,575,301** E **671,631**

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER |
|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets, organics. | | |
| | 0.5 | | **SILT** - Grey, damp, soft. | | |
| | 1.0 | | **CLAY** - Grey, damp, stiff, intermediate to high plasticity. | | S1 |
| | 1.5 | | | | |
| | 2.0 | | | | |
| | 2.5 | | | | S2 |
| | 3.0 | | | | S3 |
| | 3.5 | | **END OF TEST PIT AT 3.51 m.** | | |
| | 4.0 | | | | |
| | 4.5 | | | | |
| | 5.0 | | | | |
| | 5.5 | | | | |
| | 6.0 | | | | |
| | 6.5 | | | | |
| | 7.0 | | | | |
| | 7.5 | | | | |
| | 8.0 | | | | |
| | 8.5 | | | | |
| | 9.0 | | | | |
| | 9.5 | | | | |

**FIELD HEADSPACE TEST**
**Photoionizable Vapours (ppm)** ●
50 100 150 200

SAMPLE TYPE ⧓ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| **R.M. of St. Clements** | **A. SINCLAIR/R. BOWER** | Draft | 30/6/16 |

ENVIRO (VAPOUR) U:\FMS\16-0607-003\R.M. OF ST. CLEMENTS_16-0607-003.GPJ

Prepared By: on

KGS GROUP

# SUMMARY LOG

HOLE NO. **TP-2**



| | | | |
|---|---|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** | JOB NO. | **16-0607-003** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** | GROUND ELEV. | |
| | | TOP OF CASING ELEV. | |
| **SITE** | **R.M. of Clements** | WATER ELEV. | |
| **LOCATION** | **East side of proposed storage pond** | DATE DRILLED | **20/05/2016** |
| **DRILLING METHOD** | **Excavator** | UTMs (NAD83) | N **5,575,338**<br>E **671,623** |

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | FIELD HEADSPACE TEST Photoionizable Vapours (ppm) 50 100 150 200 |
|---|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | | | |
| | | | **CLAY** - Greyish brown, damp, stiff, intermediate to high plasticity. | | | |
| | 0.5 | | | | | |
| | 1.0 | | | | S1 | |
| | 1.5 | | | | | |
| | 2.0 | | | | S2 | |
| | 2.5 | | - Very moist, high plasticity below 2.44 m. | | | |
| | 3.0 | | | | | |
| | | | **END OF TEST PIT AT 3.20 m.** | | | |
| | 3.5 | | | | | |
| | 4.0 | | | | | |
| | 4.5 | | | | | |
| | 5.0 | | | | | |
| | 5.5 | | | | | |
| | 6.0 | | | | | |
| | 6.5 | | | | | |
| | 7.0 | | | | | |
| | 7.5 | | | | | |
| | 8.0 | | | | | |
| | 8.5 | | | | | |
| | 9.0 | | | | | |
| | 9.5 | | | | | |

SAMPLE TYPE ⋈ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| **R.M. of St. Clements** | **A. SINCLAIR/R. BOWER** | Draft | 30/6/16 |

KGS GROUP

# SUMMARY LOG

HOLE NO. **TP-3**



| | |
|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** |
| **SITE** | **R.M. of Clements** |
| **LOCATION** | **East side of proposed storage pond** |
| **DRILLING METHOD** | **Excavator** |

JOB NO. **16-0607-003**
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED **20/05/2016**
UTMs (NAD83) N **5,575,384** E **671,625**

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER |
|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets, organics. | | |
| | | | **SILTY CLAY** - Tan to brown, damp, stiff, low to intermediate plasticity. | | |
| | 0.5 | | | | |
| | 1.0 | | | | S1 |
| | 1.5 | | | | |
| | 2.0 | | | | S2 |
| | 2.5 | | | | |
| | 3.0 | | - Grey, high plasticity at 3.05 m. | | |
| | 3.5 | | | | |
| | 4.0 | | **END OF TEST PIT AT 3.96 m.** | | |
| | 4.5 | | | | |
| | 5.0 | | | | |
| | 5.5 | | | | |
| | 6.0 | | | | |
| | 6.5 | | | | |
| | 7.0 | | | | |
| | 7.5 | | | | |
| | 8.0 | | | | |
| | 8.5 | | | | |
| | 9.0 | | | | |
| | 9.5 | | | | |

**FIELD HEADSPACE TEST**
**Photoionizable Vapours (ppm)** ●
50 100 150 200

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| **R.M. of St. Clements** | **A. SINCLAIR/R. BOWER** | Draft | 30/6/16 |

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Prepared By: on

KGS GROUP

# SUMMARY LOG

HOLE NO. **TP-4**



| | | | |
|---|---|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** | JOB NO. | **16-0607-003** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** | GROUND ELEV. | |
| | | TOP OF CASING ELEV. | |
| **SITE** | **R.M. of Clements** | WATER ELEV. | |
| **LOCATION** | **East side of proposed storage pond** | DATE DRILLED | **20/05/2016** |
| **DRILLING METHOD** | **Excavator** | UTMs (NAD83) | N<br>E |

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | FIELD HEADSPACE TEST Photoionizable Vapours (ppm) ● 50 100 150 200 |
|---|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | | | |
| | | | **SILTY CLAY** - Grey, damp, stiff, low plasticity. | | | |
| | 0.5 | | | | | |
| | | | - Tan to brown, very moist, low to intermediate plasticity below 0.76 m. | | | |
| | 1.0 | | | | S1 | |
| | 1.5 | | | | | |
| | 2.0 | | | | | |
| | 2.5 | | | | | |
| | 3.0 | | | | S2 | |
| | | | **END OF TEST PIT AT 3.20 m.** | | | |
| | 3.5 | | | | | |
| | 4.0 | | | | | |
| | 4.5 | | | | | |
| | 5.0 | | | | | |
| | 5.5 | | | | | |
| | 6.0 | | | | | |
| | 6.5 | | | | | |
| | 7.0 | | | | | |
| | 7.5 | | | | | |
| | 8.0 | | | | | |
| | 8.5 | | | | | |
| | 9.0 | | | | | |
| | 9.5 | | | | | |

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

KGS GROUP

# SUMMARY LOG

HOLE NO. **TP-5**



| | | | |
|---|---|---|---|
| **CLIENT** | RM OF ST. CLEMENTS | JOB NO. | **16-0607-003** |
| **PROJECT** | Engineered Leachate Evaporation / Storage Pond | GROUND ELEV. | |
| | | TOP OF CASING ELEV. | |
| **SITE** | R.M. of Clements | WATER ELEV. | |
| **LOCATION** | West side of proposed storage pond | DATE DRILLED | **20/05/2016** |
| **DRILLING METHOD** | Excavator | UTMs (NAD83) | N **5,575,411**<br>E **671,561** |

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER |
|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | |
| | 0.5 | | **SILTY CLAY** - Tan, very moist, stiff, low to intermediate plasticity. | S1 |
| | 1.0 | | - Intermediate to high plasticity, nuggetty below 0.91 m. | |
| | 1.5 | | | S2 |
| | 2.0 | | | |
| | 2.5 | | | |
| | 3.0 | | | S3 |
| | 3.5 | | **END OF TEST PIT AT 3.51 m.** | |
| | 4.0 | | | |
| | 4.5 | | | |
| | 5.0 | | | |
| | 5.5 | | | |
| | 6.0 | | | |
| | 6.5 | | | |
| | 7.0 | | | |
| | 7.5 | | | |
| | 8.0 | | | |
| | 8.5 | | | |
| | 9.0 | | | |
| | 9.5 | | | |

**FIELD HEADSPACE TEST**

**Photoionizable Vapours (ppm)** ●

50 100 150 200

SAMPLE TYPE ⧓ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

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# SUMMARY LOG

HOLE NO.
**TP-6**



| | |
|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** |
| **SITE** | **R.M. of Clements** |
| **LOCATION** | **West side of proposed storage pond** |
| **DRILLING METHOD** | **Excavator** |

JOB NO. **16-0607-003**
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED **20/05/2016**
UTMs (NAD83) N **5,575,378** E **671,565**

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER |
|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | | |
| | 0.5 | | **CLAY** - Brown, damp, stiff, low to intermediate plasticity. | | |
| | 1.0 | | - Tan to brown, high plasticity, nuggetty below 1.22 m. | | |
| | 1.5 | | | | |
| | 2.0 | | | | S1 |
| | 2.5 | | | | |
| | 3.0 | | | | S2 |
| | | | **END OF TEST PIT AT 3.20 m.** | | |
| | 3.5 | | | | |
| | 4.0 | | | | |
| | 4.5 | | | | |
| | 5.0 | | | | |
| | 5.5 | | | | |
| | 6.0 | | | | |
| | 6.5 | | | | |
| | 7.0 | | | | |
| | 7.5 | | | | |
| | 8.0 | | | | |
| | 8.5 | | | | |
| | 9.0 | | | | |
| | 9.5 | | | | |

**FIELD HEADSPACE TEST**
**Photoionizable Vapours (ppm)** ●
50 100 150 200

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

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# SUMMARY LOG

HOLE NO. **TP-7**



| | | | |
|---|---|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** | JOB NO. | **16-0607-003** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** | GROUND ELEV. | |
| | | TOP OF CASING ELEV. | |
| **SITE** | **R.M. of Clements** | WATER ELEV. | |
| **LOCATION** | **West side of proposed storage pond** | DATE DRILLED | **20/05/2016** |
| **DRILLING METHOD** | **Excavator** | UTMs (NAD83) | N **5,575,340**<br>E **671,571** |

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER | FIELD HEADSPACE TEST Photoionizable Vapours (ppm) 50 100 150 200 |
|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | | |
| | | | **SILTY CLAY** - Grey to tan, damp, stiff, intermediate plasticity. | | |
| | 0.5 | | - Brown, very moist, intermediate to high plasticity, nuggetty below 0.61 m. | | |
| | 1.0 | | | | |
| | 1.5 | | | | |
| | 2.0 | | - Grey to Tan, high plasticity below 1.83 m. | S1 | |
| | 2.5 | | | S2 | |
| | 3.0 | | | S3 | |
| | | | **END OF TEST PIT AT 3.20 m.** | | |
| | 3.5 | | | | |
| | 4.0 | | | | |
| | 4.5 | | | | |
| | 5.0 | | | | |
| | 5.5 | | | | |
| | 6.0 | | | | |
| | 6.5 | | | | |
| | 7.0 | | | | |
| | 7.5 | | | | |
| | 8.0 | | | | |
| | 8.5 | | | | |
| | 9.0 | | | | |
| | 9.5 | | | | |

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

KGS GROUP

# SUMMARY LOG

HOLE NO.
**TP-8**



| | | | |
|---|---|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** | JOB NO. | **16-0607-003** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** | GROUND ELEV. | |
| | | TOP OF CASING ELEV. | |
| **SITE** | **R.M. of Clements** | WATER ELEV. | |
| **LOCATION** | **West side of proposed storage pond** | DATE DRILLED | **20/05/2016** |
| **DRILLING METHOD** | **Excavator** | UTMs (NAD83) | N **5,575,278**<br>E **671,572** |

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | FIELD HEADSPACE TEST Photoionizable Vapours (ppm) 50 100 150 200 |
|---|---|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | | | |
| | | | **CLAY** - Tan, damp, stiff, high plasticity. | | | |
| | 1.5 | | | | S1 | |
| | 3.0 | | | | S2 | |
| | | | **END OF TEST PIT AT 3.20 m.** | | | |

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

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Prepared By: on

KGS GROUP

# SUMMARY LOG

HOLE NO.
**TP-9**



| | |
|---|---|
| **CLIENT** | **RM OF ST. CLEMENTS** |
| **PROJECT** | **Engineered Leachate Evaporation / Storage Pond** |
| **SITE** | **R.M. of Clements** |
| **LOCATION** | **Centre of proposed storage pond** |
| **DRILLING METHOD** | **Excavator** |

JOB NO. **16-0607-003**
GROUND ELEV.
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED **20/05/2016**
UTMs (NAD83) N **5,575,362** E **671,600**

| ELEV. (m) | DEPTH (m) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE NUMBER |
|---|---|---|---|---|
| | 0.0 | | **TOPSOIL** - Black, dry, soft, non-plastic, rootlets. | |
| | | | **CLAY** - Tan, damp, stiff, low to intermediate plasticity. | |
| | 0.5 | | | |
| | 1.0 | | - Very moist, high plasticity below 0.91 m. | |
| | 1.5 | | | S1 |
| | 2.0 | | | |
| | 2.5 | | | S2 |
| | 3.0 | | | S3 |
| | 3.35 | | **END OF TEST PIT AT 3.35 m.** | |
| | 3.5 | | | |
| | 4.0 | | | |
| | 4.5 | | | |
| | 5.0 | | | |
| | 5.5 | | | |
| | 6.0 | | | |
| | 6.5 | | | |
| | 7.0 | | | |
| | 7.5 | | | |
| | 8.0 | | | |
| | 8.5 | | | |
| | 9.0 | | | |
| | 9.5 | | | |

**FIELD HEADSPACE TEST**
**Photoionizable Vapours (ppm)** ●
50 100 150 200

SAMPLE TYPE ⊠ Grab from Bucket

| CONTRACTOR | INSPECTOR | APPROVED | DATE |
|---|---|---|---|
| R.M. of St. Clements | A. SINCLAIR/R. BOWER | Draft | 30/6/16 |

ENVIRO (VAPOUR) U:\FMS\16-0607-003\R.M. OF ST. CLEMENTS_16-0607-003.GPJ

Prepared By: on

# APPENDIX C

# SOIL TESTING RESULTS (STANTEC REPORT)

**Stantec Consulting Ltd.**
199 Henlow Bay, Winnipeg MB R3Y 1G4

June 14, 2016
File: 123312583

**Attention: Mr. Andrew Sinclair**
KGS Group Inc.
3rd Floor – 865 Waverley Street
Winnipeg, Manitoba R3T 5P4

Good day Andrew,

**Reference: St. Clements Landfill (16-0607-003)**

Soil samples were submitted to our laboratory on May 24, 2016. The following tests were conducted on selected soil samples:

- Liquid limit (multi-point), plastic limit, and plasticity index (ASTM D4318)
- Maximum dry density (Proctor) of soil (ASTM D698)
- Hydraulic conductivity (ASTM D5084)

We appreciate the opportunity to assist you in this project. Please call if you have any questions regarding this report.

Regards,

**STANTEC CONSULTING LTD.**

Larry Presado, C.Tech.
Geotechnical Technologist
Phone: (204) 488-6999
larry.presado@stantec.com

Jason Thompson, C.E.T.
Senior Associate – Team Lead
Manager, Materials Testing Services
Phone: (204) 928-4004
jason.thompson@stantec.com

Attachments: Table 1 – Atterberg Limits Test Data
3 x Atterberg Limits Reports
1 x Proctor Test Report
1 x Hydraulic Conductivity Report

**Reference: St. Clement Landfill (16-0607-003)**

**TABLE 1**
**ATTERBERG LIMITS TEST DATA**

| Testpit | Field Sample No. | Depth (ft.) | Atterberg Limits | | |
|---|---|---|---|---|---|
| | | | Liquid Limit | Plastic Limit | Plasticity Index |
| TP2 | S3 | 10.5 | 90 | 26 | 64 |
| TP4 | composite | 1.2 -10 | 96 | 28 | 68 |
| TP6 | S2 | 10 | 90 | 26 | 64 |

**Note:**
1. The soil samples were air-dried during sample preparation for Atterberg limits

**LABORATORY**
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

**Atterberg Limits**
ASTM D4318
Method A- Multi-Point

| | |
|---|---|
| Client: | KGS Group Inc. |
| Project Name: | St. Clement Landfill |
| Project No: | 123312583 |
| Date Received: | May 24, 2016 |
| Date Tested: | May 27, 2016 |
| Tested By: | Nestor Abarca |

Sample : TP2 - S3 @ 10.5'

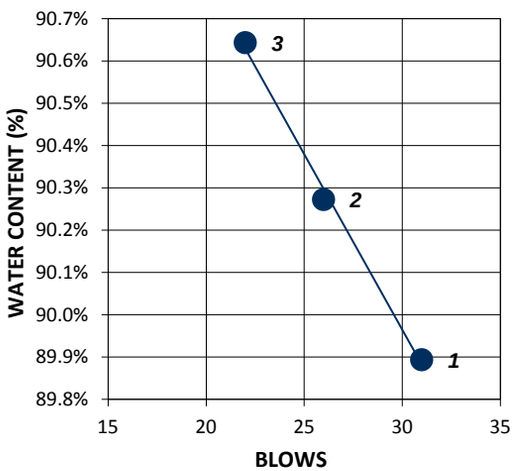
LIQUID LIMIT

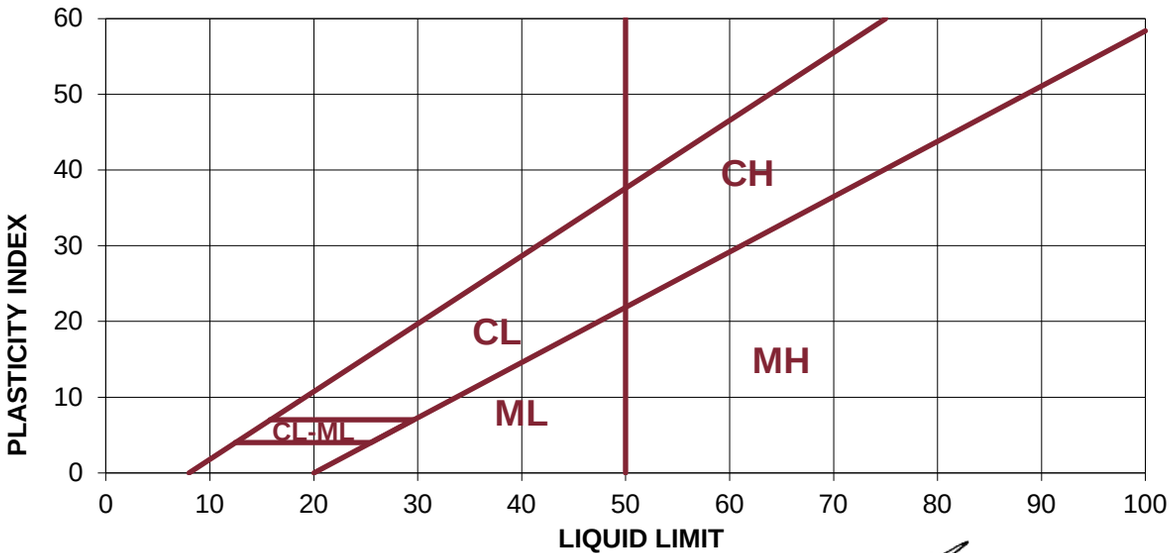
| Trial | 1 | 2 | 3 |
|---|---|---|---|
| No. of Blows | 31 | 26 | 22 |
| Tare No. | 200 | 216 | 223 |
| Wt. Sa. (wet+tare)(g) | 38 | 40 | 40 |
| Wt. Sa. (dry+tare)(g) | 29 | 30 | 31 |
| Wt. Tare (g) | 20 | 20 | 20 |
| Wt. Dry Soil (g) | 9.4 | 10.3 | 10.6 |
| Wt. Water (g) | 8.5 | 9.3 | 9.6 |
| Water Content (%) | 89.9% | 90.3% | 90.6% |

PLASTIC LIMIT

| Trial | 1 | 2 |
|---|---|---|
| Tare No. | 277 | 286 |
| Wt. Sa. (wet+tare)(g) | 29.32 | 31.29 |
| Wt. Sa. (dry+tare)(g) | 27.59 | 29.15 |
| Wt. Tare (g) | 20.86 | 20.83 |
| Wt. Dry Soil (g) | 6.7 | 8.3 |
| Wt. Water (g) | 1.7 | 2.1 |
| Water Content (%) | 25.7% | 25.7% |

| RESULTS | |
|---|---|
| LL | 90 |
| PL | 26 |
| PI | 64 |




Reviewed By: Jason Thompson, C.E.T.

**LABORATORY**
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

**Atterberg Limits**
ASTM D4318
Method A- Multi-Point

| | |
|---|---|
| Client: | KGS Group Inc. |
| Project Name: | St. Clement Landfill |
| Project No: | 123312583 |
| Date Received: | May 24, 2016 |
| Date Tested: | May 27, 2016 |
| Tested By: | Nestor Abarca |

Sample : TP4 @ 1.2' to 10' (composite sample)

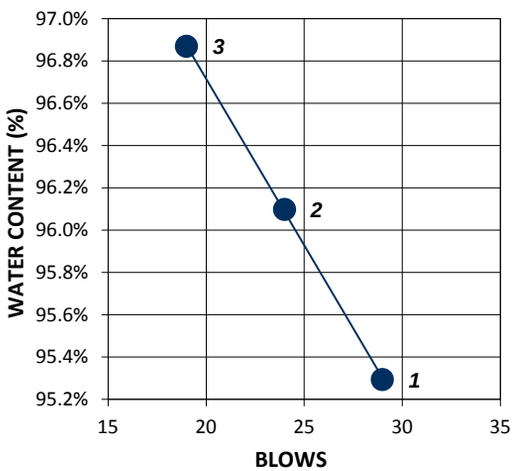
LIQUID LIMIT

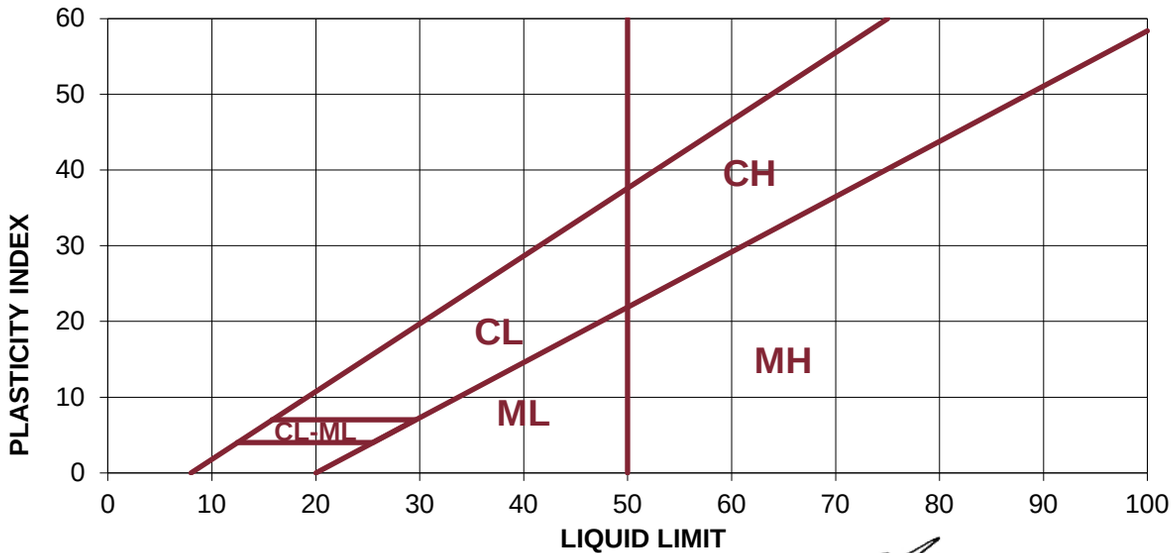
| Trial | 1 | 2 | 3 |
|---|---|---|---|
| No. of Blows | 29 | 24 | 19 |
| Tare No. | 242 | 258 | 273 |
| Wt. Sa. (wet+tare)(g) | 41 | 39 | 38 |
| Wt. Sa. (dry+tare)(g) | 31 | 30 | 30 |
| Wt. Tare (g) | 21 | 20 | 21 |
| Wt. Dry Soil (g) | 10.2 | 9.5 | 8.9 |
| Wt. Water (g) | 9.7 | 9.1 | 8.7 |
| Water Content (%) | 95.3% | 96.1% | 96.9% |

PLASTIC LIMIT

| Trial | 1 | 2 |
|---|---|---|
| Tare No. | 304 | 174 |
| Wt. Sa. (wet+tare)(g) | 28.35 | 30.11 |
| Wt. Sa. (dry+tare)(g) | 26.58 | 28.03 |
| Wt. Tare (g) | 20.30 | 20.67 |
| Wt. Dry Soil (g) | 6.3 | 7.4 |
| Wt. Water (g) | 1.8 | 2.1 |
| Water Content (%) | 28.2% | 28.3% |

| RESULTS | |
|---|---|
| LL | 96 |
| PL | 28 |
| PI | 68 |




Reviewed By: Jason Thompson, C.E.T.

**LABORATORY**
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

**Atterberg Limits**
ASTM D4318
Method A- Multi-Point

| | |
|---|---|
| Client: | KGS Group Inc. |
| Project Name: | St. Clement Landfill |
| Project No: | 123312583 |
| Date Received: | May 24, 2016 |
| Date Tested: | May 27, 2016 |
| Tested By: | Nestor Abarca |

Sample : TP6 - S2 @ 10'

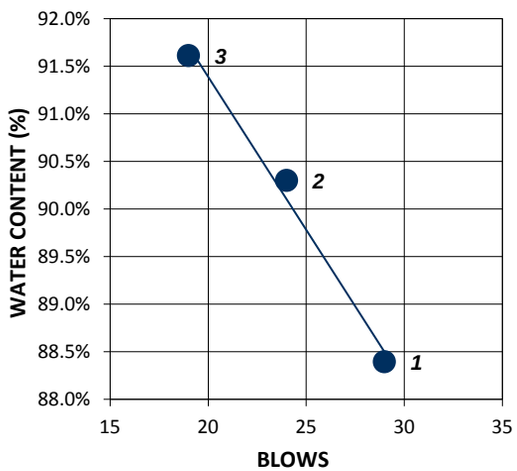
LIQUID LIMIT

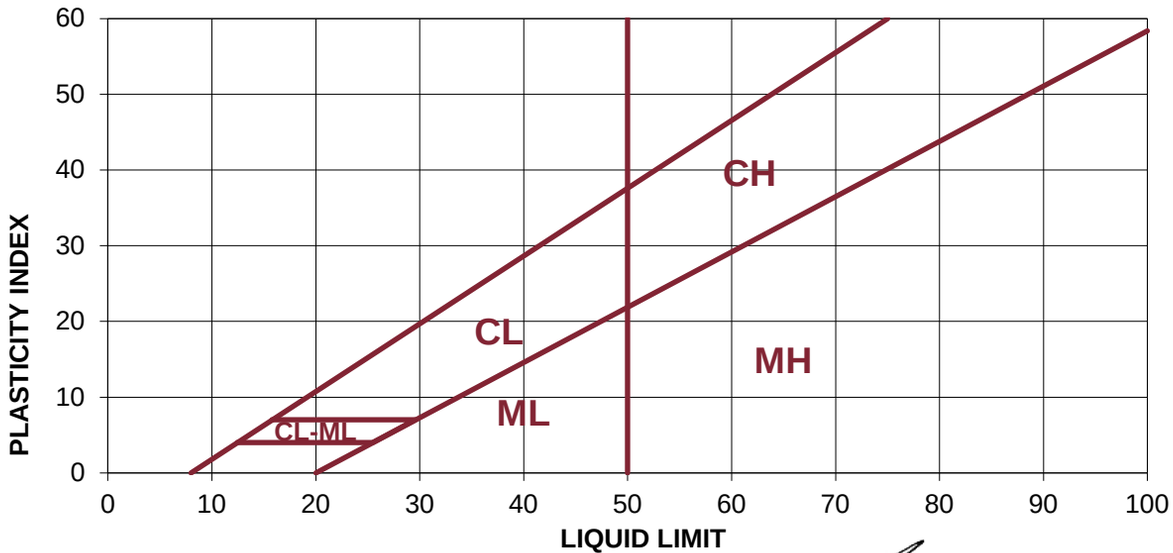
| Trial | 1 | 2 | 3 |
|---|---|---|---|
| No. of Blows | 29 | 24 | 19 |
| Tare No. | 153 | 255 | 256 |
| Wt. Sa. (wet+tare)(g) | 39 | 41 | 41 |
| Wt. Sa. (dry+tare)(g) | 30 | 31 | 31 |
| Wt. Tare (g) | 20 | 21 | 21 |
| Wt. Dry Soil (g) | 10.3 | 10.7 | 10.7 |
| Wt. Water (g) | 9.1 | 9.7 | 9.8 |
| Water Content (%) | 88.4% | 90.3% | 91.6% |

PLASTIC LIMIT

| Trial | 1 | 2 |
|---|---|---|
| Tare No. | 271 | 279 |
| Wt. Sa. (wet+tare)(g) | 29.95 | 29.55 |
| Wt. Sa. (dry+tare)(g) | 28.13 | 27.62 |
| Wt. Tare (g) | 21.12 | 20.27 |
| Wt. Dry Soil (g) | 7.0 | 7.4 |
| Wt. Water (g) | 1.8 | 1.9 |
| Water Content (%) | 26.0% | 26.3% |

| RESULTS | |
|---|---|
| LL | 90 |
| PL | 26 |
| PI | 64 |




Reviewed By: Jason Thompson, C.E.T.

Stantec
199 Henlow Bay
Winnipeg, Manitoba
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Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com

# PROCTOR TEST REPORT

TO KGS Group Inc.
3rd Floor - 865 Waverley St
Winnipeg, MB
R3T 5P4

ATTN: Andrew Sinclair

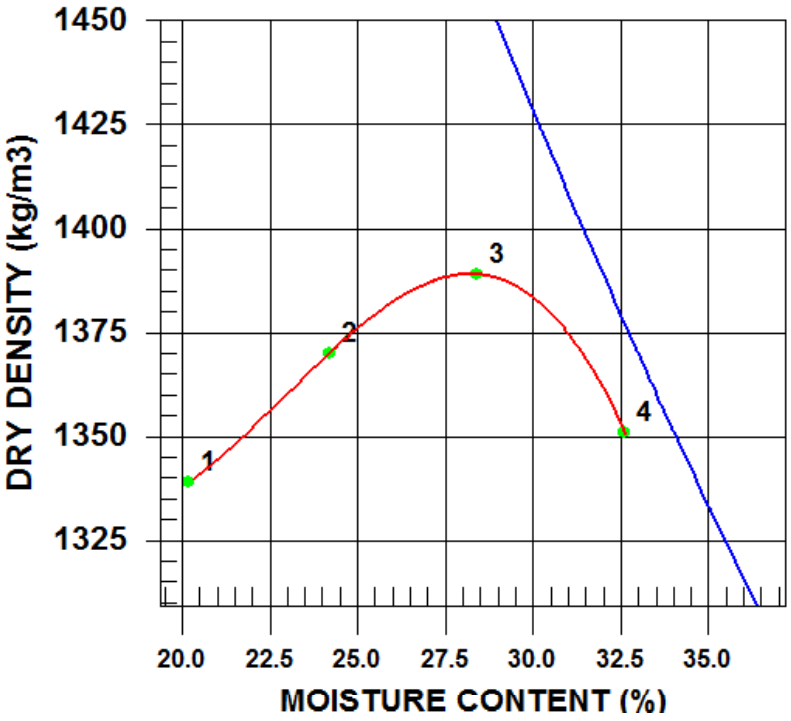
CLIENT KGS Group Inc.
C.C.

PROJECT St. Clement Landfill
16-0607-003

PROJECT NO. 123312583
PROCTOR NO. 1 DATE SAMPLED 2016.May.20 DATE RECEIVED 2016.May.24 DATE TESTED 2016.May.27

INSITU MOISTURE 47.4 %
TESTED BY Pervez Safdar
MATERIAL IDENTIFICATION
MATERIAL USE Sugrade
MAX. NOMINAL SIZE
MATERIAL TYPE Clay
SUPPLIER
SOURCE Existing Material

COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE A: 101.6mm Mold, Passing 4.75mm
RAMMER TYPE Manual
PREPARATION Moist
OVERSIZE CORRECTION METHOD None
RETAINED 4.75mm SCREEN




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1610 | 1339 | 20.2 |
| 2 | 1702 | 1370 | 24.2 |
| 3 | 1783 | 1389 | 28.4 |
| 4 | 1791 | 1351 | 32.6 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED | 1390 | 28.0 |
| OVERSIZE CORRECTED | | |

COMMENTS
Material tested was identified by the client as being a composite sample of materials taken from depths of 1.2' to 10' at testpit no. 4.

Page 1 of 1 2016.May.30

REVIEWED BY Jason Thompson, C.E.T.

**LABORATORY**
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

# HYDRAULIC CONDUCTIVITY
# ASTM D5084

KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

PROJECT: St. Clements Landfill
(16-0607-003)

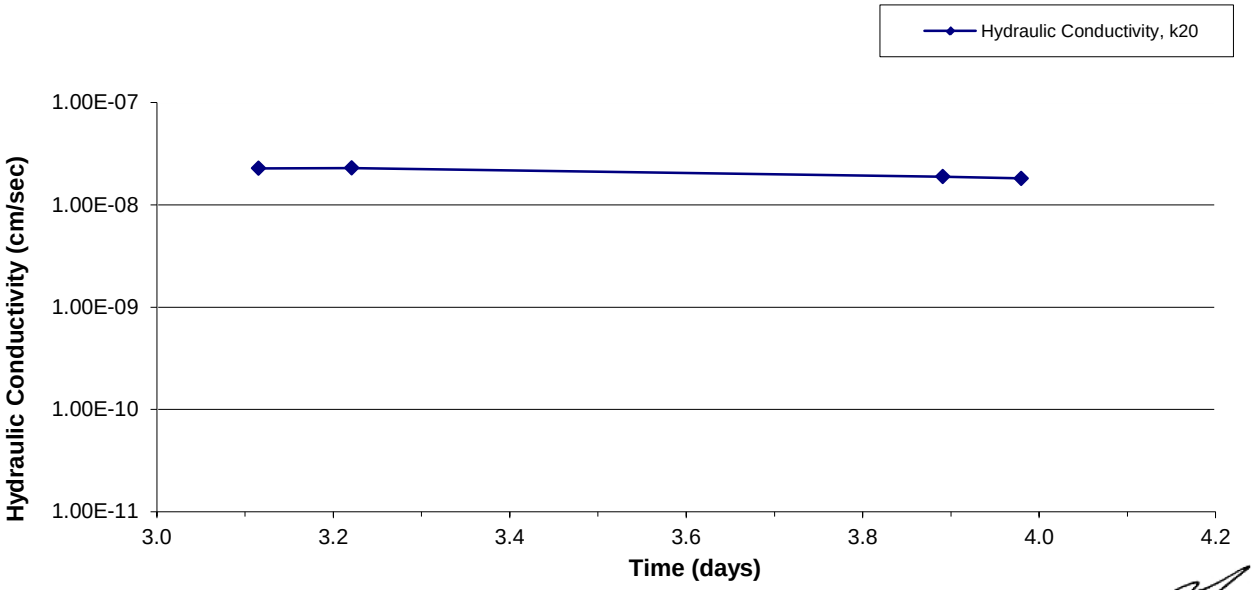
REPORT NO.:

Attention: Andrew Sinclair

PROJECT NO.: 123312583

| | |
|---|---|
| **SAMPLE FIELD I.D.:** | **TP4 @ 1.2' - 10'** |
| SOIL DESCRIPTION: | composite remoulded HC sample |
| DATE TESTED: | June 1 to June 7, 2016 |
| CONFINING PRESSURE (kPa): | 137.9 |
| EFFECTIVE SATURATION STRESS (kPa): | 34.5 |
| ASSUMED SPECIFIC GRAVITY: | 2.71 |
| HYDRAULIC GRADIENT: | 18.8 |
| TYPE OF PERMEANT LIQUID: | De-aired Water |
| HYDRAULIC CONDUCTIVITY, "k" (cm/s): | 2.3E-08 |
| **HYDRAULIC CONDUCTIVITY, "$k_{20}$" (cm/s):** | **2.1E-08** |

| | Height (mm) | Diameter (mm) | Wet Mass (g) | Dry Density ($g/cm^3$) | Water Content (%) | Saturation (%) |
|---|---|---|---|---|---|---|
| **Initial Reading** | 77.5 | 70.9 | 577.5 | 1.431 | 31.5 | 95.6 |
| **Final Reading** | 79.1 | 72.0 | 596.2 | 1.342 | 38.1 | 101.3 |




REPORT DATE: June 14, 2016

REVIEWED BY: Jason Thompson, C.E.T.