Langley E-07, Langley K-30, and Kumak I-25 Well Abandonment Program Closure, Reclamation, and Monitoring Plan

Submission to the Inuvialuit Water Board

Final Report

March 21, 2025

Prepared for:
MGM Energy
Calgary, AB

Prepared by:
KAVIK-STANTEC Inc.
Inuvik, NWT and Calgary, AB

Program Number: 123515084

KAVIK-STANTEC


KAVIK-STANTEC

Table of Contents

List of Tables

Appendices

Abbreviations

% ..... percent
> ..... greater than
°C ..... degrees Celsius
µg/m^3 ..... micrograms per cubic metre
AENV ..... Alberta Environment
APEC ..... Areas of Potential Environmental Concern
CCME ..... Canadian Council of Ministers of the Environment
cm ..... centimetre
CO ..... carbon monoxide
CRMP ..... Closure, Reclamation, and Monitoring Plan
CSQG ..... Canadian Soil Quality Guidelines
CWQG ..... Canadian Water Quality Guidelines
CWS ..... Canada Wide Standards
DFO ..... Department of Fisheries and Oceans Canada
DOL ..... Department of Lands
E-07 ..... Langley E-07 Wellsite
EC ..... electrical conductivity
ECG ..... Ecosystem Classification Group
EISC ..... Environmental Impact Screening Committee
EM ..... electromagnetic
ENR ..... Department of Environment and Natural Resources
ESA ..... Environmental Site Assessment
GNWT ..... Government of Northwest Territories
HTC ..... Hunters and Trappers Committees
I-25 ..... Kumak I-25 Wellsite
INAC ..... Indigenous and Northern Affairs Canada
IRC ..... Inuvialuit Regional Corporation
ISR ..... Inuvialuit Settlement Region
IWB ..... Inuvialuit Water Board
K-30 ..... Langley K-30 Wellsite
km ..... kilometre
km/h ..... kilometres per hour
L ..... litres
LUP ..... Land Use Permit
m ..... metre
mg/m^3 ..... milligrams per cubic metre
MGM ..... MGM Energy

mm ..... millimetre
MVLWB ..... Mackenzie Valley Land and Water Board
NEB ..... National Energy Board
NO_2 ..... nitrogen dioxide
NO_x ..... nitrogen oxides
NT ..... Northwest Territories
NWT ..... Northwest Territories
O_3 ..... ozone
OROGO ..... Office of the Regulator of Oil and Gas Operations - NWT
PAL ..... Protection of Aquatic Life
PDR ..... Project Description Report
PHC ..... Petroleum Hydrocarbons
PM ..... particulate matter
$PM_{2.5}$ ..... fine particulate matter
ppbv ..... parts per billion by volume
SAR ..... sodium adsorption ratio
SCARG ..... Salt Contamination Assessment & Remediation Guidelines
SO_2 ..... sulfur dioxide
TSP ..... total suspended particulate
VOC ..... volatile organic compound
WL ..... Water Licence

1 Plain Language Summary

The following Closure, Reclamation, and Monitoring Plan (CRMP) describes the planned approach to site closure for MGM Energy's (MGM) Langley E-07, Langley K-30, and Kumak I-25 Wellsites and associated areas (project components). Monitoring of K-30 has indicated shoreline erosion along the Beaufort Sea. Consequently, MGM has decided the priority is to abandon this well although MGM still considers the potential reserves are valuable. Two additional wells, E-07 and I-25, were identified for potential abandonment due to their proximity to K-30.

The goal of the CRMP is to return the wellsites and project components to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment.

Annual monitoring programs consisting of vegetation, soil, water, and terrain assessments have been conducted at the wellsites and sump sites since they were constructed. The K-30 well and sump sites were constructed during winter 2002/2003. The I-25 well and sump sites were constructed during winter 2006/2007 winter and the E-07 wellsite was constructed during winter 2007/2008. Suspended wellheads remain on all three wellsites and the K-30 and I-25 sites both have remote drilling sumps where the drilling fluids remain in inground sumps. There is no sump associated with the E-07 wellsite as drilling wastes were trucked or barged out of the Mackenzie Delta (KAVIK-AXYS 2007b).

Details of the additional work planned to be completed at each project component are provided in Section 5 and Table 5-1.

2 Introduction

2.1 Purpose and Scope

MGM hereby submits this final CRMP for the abandonment and reclamation of one to three MGM wellsites and project components (the Sites) located in the Inuvialuit Settlement Region (ISR) of the Northwest Territories (NWT) (the Program). The purposes of the CRMP include the following:

- provide details on the project and the project environment;
- provide details on permanent closure and end land use goals, objectives, and criteria;
- detail how Phase 1 and 2 Environmental Site Assessments (ESAs) will guide the CRMP;
- describe methods for reclamation of the Sites including site preparation and revegetation methods; and
- describe post closure monitoring activities following completion of decommissioning and reclamation works including vegetation and terrain monitoring to confirm reclamation success and undertaking reclamation maintenance treatments to address any issues that may affect reclamation success.

The scope of this CRMP includes the following wellsites and associated areas: Langley K-30 and, potentially, Langley E-07 and Kumak I-25. Monitoring of K-30 has indicated shoreline erosion along the Beaufort Sea. Consequently, MGM has decided the priority is to abandon the K-30 well although MGM still considers the potential reserves are valuable. The E-07 and I-25 wells were identified for potential abandonment due to their proximity to K-30. The wellsite locations are provided on Figure A.1 to Figure A.4 in Appendix A. In addition to the aforementioned wellsites, the abandonment program will include the following project components:

- barge landing and staging areas for the storage of equipment and supplies. The chosen barge landing and staging sites will be at, or as close to the well(s) as possible. If advance barge and/or staging is not employed, all equipment and supplies may be transported from permanent land bases, such as Inuvik, using winter roads;
- winter roads alignments within the Mackenzie River and associated channels and overland routes;
- camp facilities; and
- airstrips and helicopter pads.

2.2 Goal of the Closure, Reclamation, and Monitoring Program

The goal of the closure, reclamation, and monitoring program is to return the applicable sites and project components to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment.

The anticipated future land use of each project component is arctic tundra supporting wildlife habitat consistent with the undisturbed off-site areas surrounding each wellsite area.

2.3 Closure, Reclamation, and Monitoring Team

The current closure, reclamation, and monitoring team consists of the following MGM Energy personnel:

Table 2-1 Closure, Reclamation, and Monitoring Planning Team

Role	Name	Contact
Director, Asset Management	John Hawkins	Telephone: 403-817-5074 E-mail: john.hawkins@Paramountres.com
Environmental Coordinator	Ian Keir	Telephone: 403-817-5077 E-mail: ian.keir@Paramountres.com
Regulatory and Community Affairs Advisor	Terence Hughes	Telephone: 403-206-3859 Email: terence.hughes@Paramountres.com

2.4 Engagement

The level of engagement with Inuvialuit and other stakeholders by MGM has been and will continue to be, reflective of its activity level in the area. Prior to, and during, construction and development activities, engagement activities were more frequent and intense and included community meetings, open houses, meetings with community leaders and councils, telephone calls and both written and electronic notifications.

In support of abandonment and reclamation activities, MGM undertook engagement and community consultations in 2018. Meetings were completed with the local Tuktoyaktuk, Inuvik, and Aklavik Hunters and Trappers Committees (HTC) and Community Corporations. MGM also met with the Inuvialuit Game Council, the Inuvialuit Regional Corporation, Department of Fisheries & Oceans (DFO), Aurora Research Institute, Government of Northwest Territories (GNWT) Department of Lands (DOL), and the Industry Tourism and Investment, Petroleum Division. The details of the engagement/consultation activities are documented in the 2019 Well Abandonment Program Project Description Report (PDR) (KAVIK-STANTEC 2019).

2.5 Regulatory Instruments for Closure, Reclamation, and Monitoring

Regulatory documents pertinent to this CRMP include:

- Government of the Northwest Territories Office of the Regulator of Oil and Gas Operations (OROGO) Well Suspension and Abandonment Guidelines (OROGO 2017) and the *Oil and Gas Operations* Act.
- Mackenzie Valley Land and Water Board / Aboriginal Affairs and Northern Development Canada Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories (MVLWB 2013).
- Canadian Council of Ministers of the Environment (CCME) standards and practices.

Historically, the Kumak I-25 Sump Area and Kumak I-25 Wellsite Area were operated under the Inuvialuit Water Board (IWB) (formerly the Northwest Territories Water Board) water licence (WL) N7L1-1815 and Indigenous Services Canada (formerly Indigenous and Northern Affairs Canada) land use permit (LUP) N2006A0029. LUP N2019A0001 was issued on March 2, 2020, for the Langley E-07, Langley K-30 and Kumak I-25 Well Abandonment Program. In addition, the Sump Area was operated under the WL amendment N7L1-1815 issued in 2007. As a requirement of the WL and LUP, MGM is required to submit annual reports to the IWB.

Historically, the Langley K-30 Wellsite Area and Sump Area were operated under the IWB WL N7L1-1787 and Indigenous Services Canada LUP N2002A0035. LUP N2019A0001, issued on March 2, 2020, for the Langley E-07, Langley K-30 and Kumak I-25 Well Abandonment Program. As a requirement of the WL and LUP, MGM is required to submit annual reports to the IWB.

The Langley E-07 Wellsite Area was operated under the Indigenous Services Canada LUP N2007A0020 and IWB WL N7L1-1822. Annual reporting to the IWB was not required for the E-07 wellsite since the 2015 monitoring program findings were reported (KAVIK-STANTEC 2016a). LUP N2019A0001 was issued on March 2, 2020, for the Langley E-07, Langley K-30 and Kumak I-25 Well Abandonment Program.

The permits and authorizations applicable to the wellsites and associated facilities addressed by this CRMP are listed in Table 2-2. LUP and WL conditions and the status of compliance for the wellsites and associated facilities are detailed in Table 2-3, Table 2-4, and Table 2-5. The listed LUP and WL conditions pertain to LUPs N2006A0029, N2002A0035, N2007A0020, and N2019A0001 and WLs N7L1-1815 and N7L1-1822. Compliance to LUP and WL conditions was determined based on previous GNWT DOL inspection findings (GNWT DOL 2024a, 2024b, and 2024c) and findings from previous environmental monitoring reports (KAVIK-STANTEC 2016a, 2016b, 2016c, 2017, 2024a, and 2024b).

Table 2-2 Summary Table of Permits and Authorizations for the E-07, K-30, and I-25 Wellsites

List of Authorizations	Applicable Sites	Authorizing Agency & Expiration
Land Use Permit (LUP) N2006A0029	I-25	INAC December 5, 2009
LUP N2002A0035	K-30	INAC August 31, 2006
LUP N2007A0020	E-07	INAC October 29, 2009
LUP N2019A0001	E-07, K-30, I-25	GNWT March 1, 2025
Water Licence (WL) N7L1-1822	E-07 K-30	Inuvialuit Water Board (IWB), December 31, 2010
WL N7L1-1815	I-25	IWB November 30, 2008
WL N7L1-1829	K-30	NWT Water Board January 6, 2012

Table 2-3 Summary of I-25 Exploration Land Use Permit and Water Licence Conditions and Status of Compliance

Land Use Permit Condition (N2006A0029)		Was Compliance Achieved?[1]
31(1)(a)(5)	The Permittee shall remove from Territorial Lands, all scrap metal, discarded machinery and parts, barrels and kegs, buildings and building material.	Yes.
31(1)(b)(16)	The Permittee shall restore all sumps prior to spring break-up, unless otherwise authorized in writing by a land use inspector.	Yes.
31(1)(b)(17)	The Permittee shall commence and foster revegetation on all parts of the land used, as may be directed by a Land Use Inspection, within one year of the completion of the land use operation.	Yes.
31(1)(e)(30)	The Permittee shall backfill and restore all sumps prior to the expiry date of the permit.	Yes.
31(1)(e)(31)	The Permittee shall backfill all sumps in such a manner that drill waste is maintained below the 1.2 metre freeboard.	Yes.
31(1)(e)(32)	The Permittee shall: (a) Place all excavated material over the sump area so that ponding does not occur. (b) Overlap the material a minimum of two metres beyond the edges of the existing sump.	Yes.
31(1)(f)(43)	The Permittee shall establish vegetation on all areas stripped of vegetation during this land use operation to a minimum of seventy (70%) percent ground cover, unless otherwise authorized, in writing, by the Engineer.	No. Greater than 70% cover at Wellsite and most of the Sump Area; however, at the Sump Area South Depression, it was only 40% cover. Additional reclamation will be completed, post abandonment activities.

Land Use Permit Condition (N2006A0029)		Was Compliance Achieved?[1]
31(1)(g)(49)	The Permittee shall deposit all drill waste into a sump.	Yes.
31(1)(g)(50)	The Permittee shall not allow any drilling waste to spread to the surrounding lands.	Yes. However, ongoing monitoring will be carried out to inspect for compliance.
31(1)(h)(62)	The Permittee shall not in any circumstances deposit or allow the deposit of any deleterious substances (including but not limited to fuels, lubricants, hydraulics, and coolants) of any type into any waters, or in any place under any conditions where the deleterious substances may enter any waters.	Yes. No known deleterious substances were reported to have been deposited or released.
Water Licence Condition (N7L1-1815)		**Was Compliance Achieved?[1]**
D.12	All drilling waste shall be contained in the Sump a minimum one (1) metre below the permafrost table.	Yes. Drilling waste disposed of at 4-6 m below grade. Active layer is approximately 1.5 m below grade.
D.15	There shall be no disposal of drilling fluids from the sumps into any waters or onto any land surface where drilling fluids may enter any waters.	Yes. There were electromagnetic (EM) survey anomalies at the sump that will be investigated during reclamation.
D.21	No oil-based waste products are to be disposed of on-site. Oil-based additives and drill cuttings associated with these additives are to be disposed of at an approved off-site location to the satisfaction of an inspector.	Yes. Oil-based products were not disposed of into the sump during drilling.
G.2	The Licensee shall ensure that petroleum products, hazardous materials and other wastes associated with the project do not enter any waters.	Yes; however, ongoing monitoring is completed to inspect for compliance.
H.2	The Licensee shall monitor the drilling waste sump after closure for a period of at least fifteen (15) years in accordance with the Northwest Territories Water Board publication “Protocol for the Monitoring of Drilling-Waste Disposal Sumps, October 2005”.	Yes.

Note:
[1] Information sourced from: GNWT DOL 2024a, KAVIK-STANTEC 2016b, 2024a

Table 2-4 Summary of K-30 Exploration Land Use Permit and Water Licence Conditions and Status of Compliance

	Land Use Permit Condition (N2002A0035)	Was Compliance Achieved?[1]
31(1)(a)(5)	The Permittee shall remove from Territorial Lands all scrap metal, discarded machinery and parts, barrels and kegs, buildings and building material.	Yes.
31(1)(b)(18)	The Permittee shall restore all sumps prior to spring break-up, unless otherwise authorized in writing by a land use inspector.	Yes.
31(1)(b)(19)	The Permittee shall commence and foster revegetation on all parts of the land used, as may be directed by a Land Use Inspection, within one year of the completion of the land use operation.	Yes.
31(1)(e)(30)	The Permittee shall maintain all drill waste at least 1.2 m below the lowest elevation of contiguous surrounding ground surface at all times.	Yes. Sump cap thickness is greater than 1.2 m. If historical records cannot confirm sump cap thickness, and depth of drill waste, then confirmatory drilling may be considered during reclamation.
31(1)(e)(31)	The Permittee shall backfill and restore all sumps prior to the expiry date of the permit.	No. The Land Use Permit expired in 2006.
31(1)(e)(33)	The Permittee shall: (a) Place all excavated material over the sump area to ensure ponding does not occur. (b) Overlap the material a minimum of two metres beyond the edges of the existing sump.	No, standing water was observed in depressions within the sump cap. Depressions will be backfilled and revegetated during reclamation.
31(1)(f)(44)	The Permittee shall establish vegetation on all areas stripped of vegetation during this land use operation to a minimum of seventy (70%) percent ground cover, unless otherwise authorized, in writing, by the Engineer.	No. Vegetation cover requirement has been met within Wellsite Area; however, less than 70% vegetation cover was documented within several areas in the Sump Area. Additional reclamation will be completed, post abandonment activities.
31(1)(g)(51)	The Permittee shall not allow any drilling waste to spread to the surrounding lands.	Yes. Drilling wastes were placed in the sump.
31(1)(g)(54)	The Permittee shall dispose of all waste petroleum products by removal.	Yes.
31(1)(g)(55)	The Permittee shall dispose of all toxic or persistent substances in a manner as approved, in writing, by the Engineer.	Yes.
31(1)(h)(64)	The Permittee shall not in any circumstances deposit or allow the deposit of any deleterious substances of any type into any waters, or in any place under any conditions where the deleterious substances may enter any waters.	Yes.
31(1)(k)(72)	The Permittee shall not allow petroleum products to spread to surrounding lands or into water bodies.	Yes.

Water Licence Condition (N7L1-1822)		Was Compliance Achieved?[1]
D.5	All drilling waste shall be contained in the drilling waste sump a minimum one (1) metre below the active layer.	Yes. Drilling waste disposed of at 4-6 m below grade. Active layer is approximately 1.5 m below grade.
D.8	There shall be no disposal of drilling fluids from the sumps into any waters or into any land surface.	Yes. Disposal of drilling muds was to the in-ground sump.
D.14	No oil-based waste products are to be disposed of on-site. Oil-based additives and drill cuttings associated with these additives are to be disposed of at an approved off-site location to the satisfaction of an inspector.	Yes. Water-based potassium chloride mud was used for well drilling.
G.2	The Licensee shall ensure that petroleum products, hazardous materials and other wastes associated with the project do not enter any waters.	Unknown. No reported spills or hazardous materials; however, a Phase 2 ESA is recommended to determine if any impacts are present at the Wellsite Area or Sump Area.

Note:
[1] Information sourced from: GNWT DOL 2024b, KAVIK-STANTEC 2016c, 2017, 2024b

Table 2-5 Summary of E-07 Exploration Land Use Permit and Water Licence Conditions and Status of Compliance

Land Use Permit Condition (N2007A0020)		Was Compliance Achieved?[1]
31(1)(a)(5)	The Permittee shall remove from Territorial Lands all scrap metal, discarded machinery and parts, barrels and kegs, buildings and building material.	Yes.
31(1)(b)(17)	The Permittee shall commence and foster revegetation on all parts of the land used, as may be directed by a Land Use Inspection, within one year of the completion of the land use operation.	Yes.
31(1)(b)(18)	The Permittee shall complete all clean up and restoration of the lands used prior to the expiry of this permit.	Yes.
31(1)(e)(27)	The Permittee shall ensure that the land use area is kept clean and tidy at all times.	Yes, good housekeeping practices will be used.
31(1)(f)(37)	The Permittee shall establish vegetation on all areas stripped of vegetation during this land use operation to a minimum of seventy (70%) percent ground cover, unless otherwise authorized, in writing, by the Engineer.	Yes.
31(1)(f)(38)	The Permittee shall apply grass seed and fertilizer to areas designated, in writing, by a Land Use Inspector.	Yes.
31(1)(g)(41)	The Permittee shall not allow any drilling waste to spread to the surrounding lands.	Yes.
31(1)(g)(43)	The Permittee shall remove all noncombustible garbage and debris from the land use area to a disposal site approved in writing by a Land Use Inspector.	Yes.
31(1)(g)(44)	The Permittee shall dispose of all combustible waste petroleum products by removal.	Yes.

Land Use Permit Condition (N2007A0020)		Was Compliance Achieved?[1]
31(1)(h)(50)	The Permittee shall not in any circumstances deposit or allow the deposit of any deleterious substances of any type into any waters, or in any place under any conditions where the deleterious substances may enter any waters.	Yes.
31(1)(k)(57)	The Permittee shall not allow petroleum products to spread to surrounding lands or into water bodies.	Yes.
Water Licence Condition (N7L1-1822)		**Was Compliance Achieved?[1]**
D.9	The Licensee shall dispose of all solid wastes in a manner acceptable to the Inspector.	Yes.
D.18	No oil-based waste products are to be disposed of on-site. Oil-based additives and drill cuttings associated with these additives are to be disposed of at an approved off-site location to the satisfaction of an Inspector.	Yes.
D.19	The Licensee shall retain riparian vegetation to maintain bank earthwork stability.	Yes.
G.3	The Licensee shall ensure that petroleum products, hazardous materials and other wastes associated with the project do not enter any waters.	Yes.
H.1	Upon completion of all activities, the Licensee shall ensure that all equipment and materials not required for monitoring are removed from the site. Other final restoration activities as outlined in the Project Description shall be implemented to the satisfaction of the Inspector.	Yes.

Note:
[1] Information sourced from: GNWT DOL 2024c, KAVIK-STANTEC 2016a

3 Project Environment

3.1 Atmospheric Environment

3.1.1 Air Quality

It is anticipated that the ambient levels for the air quality parameters listed in Table 3-1 for the E-07, K-30, and I-25 sites would not exceed the NWT Ambient Air Quality Standards (GNWT 2015) because of a lack of current development and industrial activity in the region. During well abandonment activities, flaring may be required to remove gas from the wells, which may result in increased levels of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter (PM); however, emissions concentrations are anticipated to be low due to the limited amount of time flaring would be carried out and are predicted to not exceed the standards.

Table 3-1 Northwest Territories Ambient Air Quality Standards

Parameter	Concentration (in µg/m^3)[1]	Concentration (in ppbv)[2]
Sulphur Dioxide (SO_2)		
1-hour average	450	172
24-hour average	150	57
Annual arithmetic mean	30	11
Nitrogen Dioxide (NO_2)		
1-hour average	400	213
24-hour average	200	106
Annual arithmetic mean	60	32
Total Suspended Particulate (TSP)		
24-hour average	120	-
Annual geometric mean	60	-
Ground Level Ozone (O_3)		
8-hour running average	126	63
Fine Particulate Matter ($PM_{2.5}$)		
24-hour average	28	-
Annual arithmetic mean	10	-
Carbon Monoxide (CO)		
1-hour average	15,000 (15 mg/m^3)	13,000
8-hour average	6,000 (6 mg/m^3)	5,000

Notes:
[1] Micrograms per cubic metre
[2] Parts per billion by volume
Source: GNWT Air Quality Report 2015 (GNWT 2015)

3.1.2 Climate

The climate in the region the E-07, K-30, and I-25 sites are located is characterized by long, very cold winters and short, cool summers (ECG 2012). Climate normals data from the nearest weather stations (Tuktoyaktuk- ID 71985, about 84 to 102 km to the east; Inuvik- ID 71364, about 112 to 131 km to the south) indicated a daily average temperature of -10.1°C in Tuktoyaktuk and daily average of -8.2°C in Inuvik between 1981 and 2010. The coldest month for Tuktoyaktuk and Inuvik is January (-26.6°C and -26.9°C, respectively) and July is the warmest (11.0°C and 14.1°C, respectively) (ECCC 2022a, 2022b).

The average annual precipitation in the region ranges from 160.7 mm in Tuktoyaktuk to 240. 6 mm in Inuvik with the greatest accumulations occurring from July to October (ECCC 2022a, 2022b).

Wind speeds in the region vary depending on season and geographic location. For Inuvik and Tuktoyaktuk, the lowest maximum hourly wind speeds typically occur from April through July and the highest wind speeds occur from December to March. For Inuvik, the April to July wind speed is 46 km/h and the prevailing direction is from northeast; the December to March maximum hourly wind speed reaches greater than 60 km/h. For Tuktoyaktuk, the April to July wind speed is 61 km/h and the December to March wind speed is 85 km/h; for both time periods the prevailing wind direction is from the west.

3.2 Physical (Terrestrial) and Permafrost Environment

3.2.1 Regional Overview

The Langley E-07, Langley K-30, and Kumak I-25 wellsites and associated facilities are located in the Tundra Plains Mackenzie Delta Lower Arctic North and Richard Island Coastal Plain Ecoregions (ECG 2012). The Mackenzie Delta Ecoregion (location of K-30 and E-07) is a low, wet floodplain with alluvial silts and clays and is dominated by numerous channels, lakes, ponds and branches of the Mackenzie River. This area is considered to be the active delta and is continually shaped by a range of processes, including (but not limited to) isostatic rebound, marine effects from the Beaufort Sea, flooding from the Mackenzie River, and the influence of underlying permafrost (ECG 2012). This area is within the discontinuous permafrost zone (Heginbottom et al.1995). Depending on location, between 35% and 65% of the land surface may be underlain by permafrost (Heginbottom 2000). Due to active fluvial processes, such as flooding and storm surges, soils tend to be rich in calcium, saline and of a very fine-silty and fine-loamy texture. Cryosols are the dominant soils in this ecoregion and include Regosolic Static Cryosols, Gleysolic Static Cryosols and Gleyed Cumulic Regosols (ECG 2012). Soils in the outer delta vary in relation to permafrost depth, drainage, and frequency of inundation. Where the active layer (i.e., the uppermost portion of the soil profile that is subjected to annual freezing and thawing) is deeper than 1.0 m and soils are not frequently flooded (i.e., less than annually), Orthic Regosol soils have developed (Heginbottom 2000).

The Richard Island Coastal Plain Ecoregion (location of I-25) is characterized as a low relief terrain with undulating hummocky till and outwash deposits with several lakes and ponds. The environment is not as influenced by fluvial or marine processes as other nearby ecoregions (e.g., Mackenzie Delta Lower Arctic North) (ECG 2012). The landscape is characterised by ice-wedge polygons and pingos. The area is within the continuous permafrost zone (Heginbottom et al.1995). Soil in the region generally consists of Turbic Cryosols associated with weakly to moderately calcareous fine clayey and fine loamy glacial till (ECG 2012).

The bedrock geology of the E-07, K-30, and I-25 sites located in the Tundra Plains Mackenzie Delta Lower Arctic North and Richard Island Coastal Plain Ecoregions consists of sedimentary rock from the Cenozoic Era (Wheeler 1996). The surficial geology of the E-07, K-30, and I-25 sites consists of alluvial sediment deposits composed of silt, sand, clay, gravel, and organic sediment, deposited as channel, overbank, flood basin, deltaic, and debris flow deposits and may overlie and include glaciofluvial sediments (GSC 2014, Rampton 1987). For floodplains and deltas, ground material will consist of silt, clay, fine sand, minor gravel, coarse sand and organic sediment; sediment depth on deltas may be greater than 20 m thick (Rampton 1987).

3.2.2 Langley E-07

The E-07 wellsite is located along the northwestern portion of Langley Island, approximately 6 km south of the Beaufort Sea. The terrain conditions at the wellsite consist of a flat to very gently undulating topography, where ground surface elevations are typically less than 1.5 m above mean sea level. Soils in the area consist of fluvial (alluvial) deposits. Permafrost is present at the site, although, its thickness in the outer delta region may vary from hundreds of metres to only a few metres on the point bars of migrating channels (Nguyen et al. 2009). While no recent data is available regarding the thickness of the active layer at the site, recent site monitoring conducted at the K-30 sump and wellsite (respectively 5 and 7 km further north) indicates that permafrost is generally found at depths ranging between 0.5 and 1.75 m below ground surface (KAVIK-Stantec 2024b). Past field observations by KAVIK-AXYS (2008b) and KAVIK-Stantec (2016a) and the review of available satellite imagery have confirmed that low-centered ice-wedge polygons are present in the area. While no apparent ice-wedges are visible within approximately 100 m of the wellhead, their presence may be concealed by the vegetation.

3.2.3 Kumak I-25

The I-25 wellsite lies south of Trench Lake on flat ground (0% to 2% grade) covered with hummocky peat overlying silty soil (KAVIK-STANTEC 2016b). The wellsite is located in an area where freeze-thaw cycles are common, and a network of ice-wedge polygons is present including immediately adjacent to the wellhead.

3.2.4 Langley K-30

The K-30 wellsite is located at the northern end of a low-lying island located at the seaward edge of the Mackenzie Delta. The surface of the island is flat and sits approximately 1.5 m above mean sea level. Soil on the wellsite is characterized as peaty organic material mixed with a minor fraction of fine sand and silt

(KAVIK-STANTEC 2017). Recent (2024) aerial reconnaissance of the wellsite conducted via helicopter showed that most of Langley Island's shoreline was impacted by erosion. The 2024 shoreline position was surveyed and documented using a drone, and the minimum distance separating the wellhead from the shoreline was measured at approximately 27.5 m (KAVIK-STANTEC 2025). The presence of permafrost was confirmed as part of the same visit, with frozen ground encountered at depths ranging between 110 and 120 cm below ground surface.

3.3 Chemical Environment

Previous monitoring programs completed as part of the land use permit requirements have included collection and analysis of soil and standing water samples collected from locations at the K-30 and I-25 wellsites and sump sites. The collected samples were submitted for chemical analysis of contaminants of potential concern (COPCs) including benzene, toluene, and ethylbenzene, xylenes (BTEX), petroleum hydrocarbons (PHCs), detailed salinity, and select metal parameters. Figures showing the sampling locations are provided in Appendix A (Figure A.5 to Figure A.8). Tables showing the results of the analysis are provided in Appendix B (Table B.1 to Table B.9). Overall findings have included the following:

- Concentrations of select soluble inorganic parameters such as potassium and chloride were elevated in samples from the sump sites when compared to the background reference chemistry.
- Concentrations of barium from two soil samples collected from the West Depression area at the K-30 sump site were higher than the applied CCME guideline.

While some of the elevated inorganic concentrations from soil and standing water samples collected from the sump sites can be attributed to the influence of seawater, select inorganic parameter concentrations such as potassium and chloride were elevated when compared with background reference chemistry and suggest the presence of sump material. As such, potassium, chloride, and barium (K-30 sump site only) are considered contaminants of concern (COCs) for the soil and surface water chemistry at the sump sites.

Previous water sampling at the I-25 wellsite has reported chemistry within range of reference background chemistry; previous soil samples from 2017 at the I-25 wellsite reported chemistry within range of reference background chemistry with the exception of lower soil pH levels which may be attributed to organic matter (peat) content. Water samples have not been collected at the K-30 wellsite due to a lack of visible evidence to trigger sampling (i.e., lack of vegetation, staining, hydrocarbon-like sheen etc.). Soil samples collected at K-30 in 2017 reported elevated electrical conductivity (EC) and sodium adsorption ratio (SAR) values when compared with the guidelines. However, the results were comparable to background soil chemistry. As such, there currently are no identified COCs in soil and surface water for the wellsites.

3.4 Biological Environment

Vegetation communities present at E-07, K-30, and I-25 areas are dominated by wet sedge and cotton-grass species, including water sedge (*Carex aquatilis*), narrow-leaved cotton-grass (*Eriophorum*

angustifolium), and Fisher's tundra grass (*Dupontia fisheri*) (KAVIK-STANTEC 2016a, 2016b, 2016c, 2017). Stable areas of the active delta support more structurally developed vegetation communities characterized by short willows with a sedge understory. These communities typically get established on raised habitats and channel embankments (created by deposition of fine sand and silt) and intersperse the wet sedge community type. The northern portion of the E-07, K-30, and I-25 areas (K-30 vicinity) is influenced by both marine and freshwater processes, which combine to produce a diverse wetland environment. Within Langley Island dwarf/low native shrubs, sedges and grasses dominate the landscape in areas that are not influenced by fluvial or marine processes (in the vicinity of I-25). Characteristic species include felt-leaf willow (*Salix alaxensis*), Richardson's willow (*Salix richardsonii*), horsetail (*Equisetum* sp.) and narrow-leaved cotton-grass. Low centered polygons which develop are dominated by sedges, cotton-grasses and sphagnum mosses.

3.4.1 Langley E-07

Vegetation cover at the E-07 wellsite in 2015 was approximately 85%, consisting of current year foliage (70% cover) and plant litter (15% cover) with the remainder of ground cover consisting of wood debris (5%) and bare ground (10%). The wellsite has had minimal topsoil and vegetation disturbance, since site activities were completed, which has resulted in the growth of native sedge, grass, forb and shrub vegetation reaching 0.1 m to 0.4 m heights (KAVIK-STANTEC 2016a). Vegetation observed on the wellsite consisted of foxtail (*Alopecurus* sp.), sedges (*Carex* spp.), hairgrass (*Deschampsia* sp.), Fisher's tundra grass, tall and tussock cotton-grasses (*Eriophorum angustifolium and E. vaginatum*), Sudetan lousewort (*Pedicularis sudetica*), Jacob's ladder (*Polemonium* sp.) and willows (*Salix* spp.) (Table 3-2). Overall, vegetation at the wellsite appeared in healthy condition. No invasive plant species were observed at the wellsite (KAVIK-STANTEC 2016a).

Table 3-2 Vegetation Species present in E-07 Wellsite Area

Vegetation Species	% Cover
foxtail (*Alopecurus* sp.)	10
sedges (*Carex* spp.)	15
hairgrass (*Deschampsia* sp.)	5
Fisher's tundra grass (*Dupontia fisherii*)	10
tall cotton-grass (*Eriophorum angustifolium*)	10
tussock cotton-grass (*Eriophorum vaginatum*)	10
Sudetan lousewort (*Pedicularis sudetica*)	<1
Jacob's ladder (*Polemonium* sp.)	<1
willows (*Salix* spp.)	10
vegetation/plant litter	15
wood debris	5
bare ground	10
Total	**100**

Source: KAVIK-STANTEC 2016a

3.4.2 Langley K-30

Vegetation cover at the K-30 wellsite in 2015 was approximately 90%, consisting of current year foliage (75%) and plant litter (15%) with the remainder of ground cover consisting of bare ground (10%). The wellsite has had minimal topsoil and vegetation disturbance, which has resulted in the native grass, forb and shrub vegetation re-establishing and growing to 0.1 m to 0.5 m heights (KAVIK-STANTEC 2016c). Vegetation at the wellsite was predominantly bluejoint/bent reed grass (*Calamagrostis canadensis*), sedges, and cotton-grass (Table 3-3). Overall, vegetation at the wellsite appeared in healthy condition. No invasive plant species were observed at the wellsite (KAVIK-STANTEC 2017).

Table 3-3 Vegetation Species present in the K-30 Wellsite Area

Vegetation Species	% Cover
bluejoint/bent reed grass (*Calamagrostis canadensis*)	15
sedges (*Carex* spp.)	35
cotton-grass (*Eriophorum* sp.)	15
Sudetan lousewort (*Pedicularis sudetica*)	5
willow (*Salix* sp.)	5
vegetation/plant litter	15
wood debris	0
bare ground	10
Total	**75**

Source: KAVIK-STANTEC 2016c

3.4.3 Kumak I-25

Vegetation cover at the I-25 wellsite in 2015 was approximately 95%, consisting of current year foliage (85%) and plant litter (10%) with the remainder of ground cover consisting of bare ground (5%). The area immediately surrounding the wellhead culvert was seeded with native grasses during reclamation treatments completed in 2010 to revegetate bare areas around the wellhead (Priddis 2014). The wellsite had minimal topsoil and vegetation disturbance, which has resulted in native grass, forb and shrub vegetation re-establishing to a height of 0.1 m to 0.4 m. Vegetation observed on the wellsite included green alder (*Alnus viridis*), polargrass (*Arctagrostis latifolia*), glandular birch (*Betula glandulosa*), tufted hairgrass (*Deschampsia caespitosa*), crowberry (*Empetrum nigrum*), tussock cotton-grass, northern Labrador tea (*Ledum decumbens*), cloudberry (*Rubus chamaemorus*), net-veined willow (*Salix reticulata*), willow, and mosses (Table 3-4). Overall, vegetation at the wellsite appeared in healthy condition. No invasive plant species were observed at the wellsite (KAVIK-STANTEC 2016b).

Table 3-4 Vegetation Species present in the I-25 Wellsite Area

Vegetation Type	% Cover
green alder (*Alnus viridis*)	5
polargrass (*Arctagrostis latifolia*)	4
dwarf birch (*Betula glandulosa*)	10
tufted hairgrass (*Deschampsia caespitosa*)	1
crowberry (*Empetrum nigrum*)	5
tussock cotton-grass (*Eriophorum vaginatum*)	25
northern Labrador tea (*Ledum decumbens*)	5
cloudberry (*Rubus chamaemorus*)	5
net-veined willow (*Salix reticulata*)	5
willow (*Salix* sp.)	5
mosses	15
vegetation/plant litter	10
wood debris	0
bare ground	5
Total	**100**

Source: KAVIK-STANTEC 2016b

4 Project Description

4.1 Location and Access

K-30, E-07 and I-25 are located within the outer Mackenzie Delta of the ISR, NWT (Figure A.1, Appendix A). The K-30 well is located on the northern tip of Langley Island, E-07 is located approximately 6 km south of K-30, and I-25 is located approximately 20 km southeast of E-07. Well abandonment program (the Program) activities will take place on Crown land with the exception of a potential barge landing, winter roads and camp site, which are within Inuvialuit 7(1)(a) Private Lands (i.e., ISR Inuvialuit Private Lands where the Inuvialuit own surface and subsurface title or rights; IRC 2024). I-25 is located within the Kendall Island Migratory Bird Sanctuary. Distances from each well to Inuvik, Aklavik and Tuktoyaktuk are provided in Table 4-1.

Table 4-1 Approximate Distances of the Program Wells from Inuvik, Aklavik and Tuktoyaktuk

Well	Distance from Inuvik (km)	Distance from Aklavik (km)	Distance from Tuktoyaktuk (km)
Langley K-30	131	126	102
Langley E-07	125	120	100
Kumak I-25	112	115	84

Barges may be used to mobilize equipment and materials to the Program footprint for staging as close to the well(s) as possible. If barges are used, they will be originating from locations such as Hay River, Ft. Simpson, or Inuvik. Previous PDs submitted to the Environmental Impact Screening Committee (EISC) by MGM and Chevron Canada Limited (the previous operator of K-30 and I-25) identified suitable, potential advance barge landing sites (KAVIK-AXYS 2006, 2007a, 2007b, 2008a and 2008b). These locations are being considered for this Program and are identified in Figures 5-2 to 5-4 of the 2019 Well Abandonment Program PDR (KAVIK-STANTEC 2019). These locations are preferred since bathymetric surveys and archaeological and biophysical assessments were previously completed.

4.2 Site History, Project Development and Current Status

Between 2003 and 2010, various oil and gas companies conducted hydrocarbon exploration drilling programs in the outer Mackenzie Delta within the ISR of the NWT. Prior to MGM carrying out exploration activities, the area had been previously disturbed naturally (fire) or anthropogenically (seismic lines). MGM operates 10 wells in the region. As a result of delays and eventual cancellation of the construction of the Mackenzie Gas Project, MGM's wells within the region have not produced and are either in a suspended state or abandoned. MGM has monitored these wells since 2009 and has decided to begin abandonment of selected wells, including Langley E-07, Langley K-30, and Kumak I-25.

Monitoring of K-30 has indicated shoreline erosion (KAVIK-STANTEC 2017). Consequently, MGM has decided to abandon this well although MGM still considers the potential reserves are valuable. Two additional wells, E-07 and I-25, were identified for potential abandonment due to their proximity to K-30, and the opportunity to abandon multiple wells in a local area during one program.

4.3 Permit History

The permit history for the E-07, K-30, and I-25 sites is discussed in Section 2.5 and Table 2-2.

4.4 Site Geology

The Sites within this CRMP were used for oil and gas exploration not mining. Surficial and bedrock geology information is provided above in Section 3.2.1.

4.5 Project Summary

The Program will consist of abandoning one to three wells (E-07, K-30, and I-25). The K-30 well is MGM's priority for abandonment due to ongoing shoreline erosion.

5 Permanent Closure, Reclamation, and Monitoring

5.1 Definition of Permanent Closure, Reclamation, and Monitoring

Permanent closure is the final closure of a site with no foreseeable intent by the proponent to return to either active exploration or development. Permanent closure indicates that the proponent does not intend to have activity on the site aside from post-closure monitoring and potential contingency actions. Permanent closure does not preclude the proponent or another party from pursuing opportunities at the existing site or in the area at a time beyond the foreseeable future.

MGM will be seeking permanent closure of the E-07, K-30, and I-25 wellsites and associated project areas. It is anticipated that, with the proposed remediation during well abandonment and follow up permanent reclamation treatments, MGM will have reclaimed the well locations to the standards as per the closure conditions in LUP N2019A0001. Permanent reclamation will involve undertaking treatments which re-establish natural drainage (where needed), create stable ground conditions to prevent erosion, and re-establish vegetation cover which is self-sustaining and compatible with the surrounding undisturbed ecosystem.

Post reclamation activities will consist of vegetation and terrain monitoring to confirm reclamation success. Vegetation monitoring will include documentation of vegetation establishment and surveillance for invasive plant species. Terrain monitoring will include identification of erosion and ground subsidence issues. If the presence of standing water is observed, it will be monitored and sampled as necessary. Post reclamation monitoring is proposed during summer months, to meet water licence and land use permit conditions to confirm that native vegetation and natural contouring is established and compatible with surrounding lands. The first year of monitoring will also include confirmatory soil sampling to verify that there are no COCs, as identified in Section 3.3 (i.e., select salinity and metal parameters) present at the reclaimed sites.

If issues are identified that need to be addressed during the monitoring or from sampling, minor reclamation treatments will be conducted via helicopter access. These could include invasive species management, scarification, recontouring, erosion control measures, seeding and other vegetation management techniques.

5.2 Permanent Closure and Reclamation Requirements

Closure, and reclamation requirements for the wellsites and associated areas are detailed in Table 5-1 below. Closure and reclamation requirements for the wellsites undergoing abandonment activities will also follow conditions specified in the current LUP N2019A0001.

Table 5-1 Project Component Descriptions and Conditions

Project Component Description				Site Conditions	Final Closure and Reclamation Requirements
Locations	**Components**	**Dimensions**	**Current Status**		
Langley E-07	Wellsite Area	150 m x 150 m	Built/ Suspended	Site contains a wellhead, above ground protective culvert around the wellhead, and a steel well marker post and sign at the wellhead location. Wellsite Area has well established native vegetation cover, no terrain stability or erosion issues.	Cutting of well casing to approved depth, removal of wellhead and associated infrastructure, capping of the casing string, backfilling of excavated soil; creating stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate areas re-disturbed by Langley E-07 well abandonment activities. Confirmatory soil sampling will be carried out in the first year following reclamation activities to verify that there are no COCs present at the reclaimed E-07 wellsite.
Langley K-30	Wellsite Area	120 m x 120 m	Built/ Suspended	Site contains a suspended wellhead, protective culvert and cage, and a steel well marker post with a sign at the wellhead location. Wellsite Area has well established native vegetation cover, but has been exposed to continuous shoreline erosion on the west, north, and east portions of the site.	Cutting of well casing to approved depth, removal of wellhead and associated infrastructure, capping of the casing string, backfilling of excavated soil; creating stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate areas re-disturbed by Langley K-30 well abandonment activities. Shoreline stabilization treatments are not proposed for the K-30 wellsite. Confirmatory soil sampling will be carried out in the first year following reclamation activities to verify that there are no COCs present at the reclaimed K-30 wellsite.
	Sump Area	40 m x 60 m	Built	Site contains a remote drilling sump which is located approximately 2 km south of the K-30 Wellsite Area.	Sump Area will continue to be monitored. Risk assessment to be conducted to assess conditions and potential remediation/reclamation options. If sump removal and final decommissioning, remediation, and reclamation is proposed, it will be under a separate application.

Project Component Description				Site Conditions	Final Closure and Reclamation Requirements
Locations	**Components**	**Dimensions**	**Current Status**		
Kumak I-25	Wellsite Area	120 m x 120 m	Built/ Suspended	Site contains a wellhead, above ground protective culvert around the wellhead, and a steel well marker post and sign at the wellhead location. Wellsite Area has well established native vegetation cover, no terrain stability or erosion issues.	Cutting of well casing to approved depth, removal of wellhead and associated infrastructure, capping of the casing string, backfilling of excavated soil; creating stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate areas re-disturbed by Kumak I-25 well abandonment activities. Confirmatory soil sampling will be carried out in the first year following reclamation activities to verify that there are no COCs present at the reclaimed I-25 wellsite.
	Sump Area	65 m x 35 m	Built	Site contains a remote drilling sump which is located approximately 15 km southeast of the I-25 Wellsite Area.	Sump Area will continue to be monitored. Risk assessment to be conducted to assess conditions and potential remediation/reclamation options. If sump removal and final decommissioning, remediation, and reclamation is proposed, it will be under a separate application.
Barge landing sites, staging areas, and camp facilities	-	TBD	Proposed	Sites not developed yet; sites undisturbed	MGM will utilize existing cleared and linear disturbances from previous activities in the area, where possible, for proposed barge landing sites, staging areas, and camp facilities to minimize ground and vegetation disturbance. To minimize ground and vegetation disturbance during abandonment operations, ice pads will be constructed on these areas. Where ground or vegetation disturbance has occurred, reclamation treatments will be carried out in order to create stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate disturbed areas.

Project Component Description				Site Conditions	Final Closure and Reclamation Requirements
Locations	**Components**	**Dimensions**	**Current Status**		
Winter roads	-	TBD	Proposed	Roads not developed yet; sites undisturbed	MGM will utilize existing cleared and linear disturbances from previous activities in the area, where possible, for proposed winter roads to minimize ground and vegetation disturbance. Winter roads and ice pads of at least 15 cm in thickness will be used to protect surface vegetation and prevent ground surface erosion and compaction. Where ground or vegetation disturbance has occurred, reclamation treatments will be carried out in order to create stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate disturbed areas.
Airstrips, helicopter pads	-	TBD	Proposed	Sites not developed yet; sites undisturbed	Proposed airstrips will be constructed on frozen river channels thereby minimizing ground and vegetation disturbance. Proposed helicopter landing pads will be located in the vicinity of wellsites, barge landing sites, staging areas or camp facilities, all of which will be on ice pads, thereby minimizing ground and vegetation disturbance. Where ground or vegetation disturbance has occurred, reclamation treatments will be carried out in order to create stable ground conditions to prevent erosion and re-establish native vegetation to >70% ground cover to mitigate disturbed areas.

Note:
TBD= to be determined.

5.3 Areas Affected by Spills and Unauthorized Discharges

A summary of spills or unauthorized discharges reported for the Sites are listed below in Table 5-2.

Table 5-2 Spills or Unauthorized Discharges at the Project Sites

Sites	Spills or Unauthorized Discharges
Langley E-07	• Spill No.: 2008097, March 25, 2008: The spill consisted of drilling mud for a total volume of 500 litres (L). The information was obtained from GNWT-ECC 2024.
Kumak I-25	• Spill No.: N/A, occurred in 2006-2007. The spills consisted of hydraulic fluids, engine oil, antifreeze, oil, diesel fuel, drilling muds, glycol, wastewater, transmission fluid, etc. A total of 57 spills ranging from less than 1 L to 100 L volumes. The information is based on drilling records. Spilled materials were scraped from ice surfaces and were immediately and completely cleaned-up with no residual impacts identified (Chevron 2008).
Langley K-30[1]	• Spill No. 2003196, unspecified date. 182 L of drilling fuel spilled, no details were provided regarding the location or the remedial action taken in response to the spill. • Spill No. 200317, March 5, 2003: 1 L of unspecified chemical was spilled at the campsite. No details were provided regarding the remedial action. • Spill No. 2003168, March 6, 2003: 1 L of unspecified chemical was spilled at the Wellsite. No details were provided regarding the remedial action. • Spill No. 2003167, March 9, 2003: 1 L of unspecified chemical spilled. No details were provided regarding the location or remedial action. • Spill No. 2003161, March 14, 2003: 114 L of petroleum fuel oil (Jet A, diesel, turbo A, heat). No details were provided regarding the location or remedial action taken. • Spill No. 2003163, March 15, 2003: Lubricating oil and spill of 3 L. No details were provided regarding the location or remedial action. • Spill No. 2003182, March 19, 2003: Drilling fluid spill of 20 L. No details were provided regarding the location or remedial action taken. • Spill No. 2003227, March 31, 2003: 9,000 L of drilling fluid was released related to a pipe leak. No details were provided regarding the location or remedial action taken. • Spill No. 2003228, April 1, 2003: 2,000 L of drilling fluid spilled related to a pipe leak within a rig structure. No details were provided regarding the remedial action. • Spill No. 2003230, April 2, 2003: 200 L of wastewater/impacted water was released. No details were provided regarding the location or remedial action taken. • Spill No. 2003229, April 3, 2003: 3,000 L of drilling fluid released related to a tank leak. No details were provided regarding the remedial action taken. • Spill No. 2003231, April 5, 2003: 500 L of drilling fluid released. No details were provided regarding the location or remedial action.
Notes: Langley K-30 spill information obtained from GNWT-ECC Spill Database (GNWT-ECC 2026).	

5.4 Other Areas Affected by Project Activities

All areas associated with the project are listed and described under project components in Table 5-1.

5.5 Closure Objectives and Criteria

The closure objectives for the project are to assess the soils on-site to confirm: there are no parameters of concern present at concentrations that pose a risk to the applicable receptors at each location; that the site is stabilized, with no erosion present; that on-site drainage is consistent with the surrounding landscape and is not causing excess water retention; that the site is revegetated with native plant species consistent with the surrounding arctic tundra; that invasive plant species concentrations are less than or equal to off-site conditions.

5.5.1 Remediation

The following sections present the regulatory framework considered applicable to the Sites for interpretation of the soil and surface water chemistry and are hereinafter referred to as the applied guidelines. These guidelines were used to interpret soil and surface water chemistry monitoring conducted since 2015 as a screening tool to determine if concentrations of parameters of concern associated with former site operations or the remaining sump material pose a risk to site ecological and human health receptors. Chemistry results compared to the applied guidelines for soil and surface water samples collected at the Sites to date are summarized in Table B.1 to Table B.5 within Appendix B.

Background soil and surface water reference chemistry was collected from locations away/upgradient from former site operations to determine expected background concentration ranges of select parameters known to be elevated due to site specific characteristics (i.e., sea water intrusion, peat type soils). The results from on-site samples were evaluated by comparison to the median, 75th percentile, 95th percentile, and 95% upper confidence limit of the mean and maximum concentrations of the background reference chemistry for each soil type (i.e., organic soils vs mineral soils).

5.5.1.1 Land Use

Based on the current and future anticipated land use of the Site, the analytical results are compared with the CCME residential/parkland land use guidelines since the Sites are not occupied and are subject to natural ecological succession. Current and future human use of the Site is expected to consist of recreational activity and possibly country food harvesting (i.e., hunting, fishing, gathering vegetation for consumption or other uses).

5.5.1.2 Soil

The following applied guidelines are used for interpretation of the soil chemistry:

- Canadian Council of the Ministers of the Environment (CCME) Canadian Soil Quality Guidelines (CSQG) (CCME 2024).

- Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil (CCME 2008), for interpretation of PHC F1 to F4 Gravimetric in soil samples.
- Government of Alberta, Alberta Environment (AENV) Salt Contamination Assessment & Remediation Guidelines (AENV 2001).
- AENV Soil Remediation Guidelines for Barite: Environmental Health and Human Health (AENV 2009).

The AENV Salt Contamination Assessment & Remediation Guidelines (SCARG; AENV 2001) present soil remediation guidelines for electrical conductivity (EC) and sodium adsorption ratio (SAR) based on reference soil data. Although these guidelines are not applicable in the NWT, they have been referenced to provide an indication of soil quality in relation to EC and SAR.

At sites with unrestricted land use, rating categories have been developed for EC and SAR, providing indicators of soil quality ranging from “good” to “unsuitable”. The rating categories are presented for both surface and subsoil conditions, with topsoil guidelines being applied to the L, F, H, O, and A soil horizons or equivalent surficial material where the horizons are not present. As specified in the guidelines, the purpose of the SCARG guideline is to “return the site to the same rating category as the noncontaminated soils of the same type”.

Both surface and subsoil guidelines (where available) were used for comparison with the analytical results.

In 2009, the AENV developed the *Soil Remediation Guidelines for Barite* due to concern relating to the presence of barite in drilling wastes at oil and gas sites (AENV 2009). Although the CCME guidelines present total barium guidelines for soil, these guidelines are not considered applicable to barite because the guidelines were developed based on soluble barium compounds.

5.5.1.3 Surface Water

The following applied guidelines are used for interpretation of the surface water chemistry:

- Canadian Water Quality Guidelines (CWQGs) (CCME 2024) for interpretation of surface water quality for the Protection of Aquatic Life (PAL).

Although standing water samples collected from features such as ice wedges and surface depressions are not necessarily an aquatic habitat, the CCME CWQG were used to evaluate water quality. These were applied as a guideline only and limited conclusions can be made as to the quality of the standing water, which is a temporary feature with a limited volume of water.

5.5.2 Reclamation

The criteria that will be used to assess if reclamation of a site is complete are as follows:

- Vegetation cover is greater than 70% of ground cover.
- Vegetation species diversity and composition is compatible with the surrounding land-use.

- Native plant species are present with a range of shrub and forb vegetation that are likely to continue (i.e., become self-sustaining) and diversify with future successional development.
- Presence of invasive plant species should be no greater than the surrounding undisturbed areas.
- Slopes have been stabilized with no visible erosion, slumping, sloughing or other evidence of ground instability.
- Drainage on and around the site is consistent with off-site areas and does not result in increased erosion potential or excess ponding.

5.5.3 Monitoring

E-07 has not required ongoing monitoring since 2015 since site conditions have been reported to meet permit requirements. Monitoring at the K-30 and I-25 sites since 2015 has focused on erosion conditions at the K-30 wellsite, vegetation conditions at the I-25 wellsite, and sump subsidence conditions at the K-30 and I-25 sump areas.

The E-07, K-30, and I-25 wellsites will be monitored to meet water licence and land use permit conditions post reclamation to confirm that native vegetation and natural contouring is established and compatible with surrounding lands.

5.6 Consideration of Closure Options and Selection of Closure Activities

The following information provides an overview of the closure and reclamation process and a summary of activities at the Sites to date.

5.6.1 Abandonment and Surface Equipment Removal

All surface facilities and equipment have been previously decommissioned with the exception of the wellheads, aboveground protective culverts around the wellhead, and steel well marker posts and signs. The well heads at the E-07, K-30, and I-25 wellsites are proposed to be abandoned and cut and capped during the abandonment program scheduled for 2026 to 2031.

5.6.2 Assessment

Further assessment work is anticipated during the abandonment, closure, and reclamation programs to confirm the site conditions meet the applied guidelines and remedial objectives.

5.6.2.1 Phase 1 Environmental Site Assessment

The Phase 1 Environmental Site Assessment (ESA) will consist of a review and evaluation of existing information collected from publicly available information and MGM file review. Site conditions observed during inspections and monitoring programs conducted at the Sites will be incorporated into the findings of the Phase 1 ESAs.

5.6.2.2 Phase 2 Environmental Site Assessment

Based on the results of the Phase 1 ESA, which is anticipated to be completed prior to commencement of the abandonment program, further intrusive sampling may be required to resolve data gaps or assess areas of potential environmental concern (APECs) identified during the Phase 1 ESA. The purpose of a Phase 2 ESA is to resolve the identified data gaps and assess any identified APECs for the presence or absence of COPCs and determine the extent of any areas of environmental concern. Should Phase 2 ESAs be required, they will be completed during the abandonment program when Site access is available (i.e. winter roads) and sampling around the well heads can be completed to confirm no residual COPCs (i.e., salinity, metals, BTEX, and PHC) as identified in Section 3.3 remain in-situ.

5.6.2.3 Vegetation Monitoring

Vegetation monitoring conducted at the E-07, K-30, and I-25 wellsites since 2015 indicated that native shrubs, grasses, sedges, and forbs were observed to be well established. Vegetation cover estimates have ranged from approximately 80% to 95% and vegetation has appeared healthy during previous site visits. These vegetation conditions met previous LUP N2007A0020, N2002A0035, and N2006A0029 requirements of greater than 70% vegetation cover and vegetation in a healthy condition. The results of the previous years' monitoring will be used as a baseline for future monitoring that will be conducted following completion of well decommissioning and closure activities, and remediation and revegetation treatments. Post reclamation monitoring will include vegetation and terrain monitoring to assess and confirm site stability, and establishment of a self-sustaining native vegetation cover that is compatible with the surrounding undisturbed ecosystems and meets current LUP N2019A0001 conditions (refer to Section 5.10).

5.6.3 Remediation

Soil sampling and assessment will be conducted around the well head during the abandonment program to assess if soil remediation (i.e., excavation) is required. Where soil around the well head is reported to exceed the applied guidelines, the soil will be excavated and replaced with compatible backfill sourced from Inuvik, NT. Backfill sources will be tested for chemistry and texture parameters to confirm they are compatible and free from COPCs prior to being used.

Where results at the sump sites indicate exceedances of the applied guidelines which are not attributed to background conditions (i.e., elevated potassium and chloride concentrations), further remediation options will be considered.

Remedial options are expected to consist of the following:

1. Remediate all soil to the applied screening guidelines discussed in Section 5.5.1. This remedial option would require excavation of soil with reported concentrations above the applied guidelines for disposal off-site at an approved landfill location. The excavated area would then be reclaimed with clean backfill and contoured and seeded.

2. Evaluation of site-specific data to revise the applied screening guidelines based on physical site conditions and applicable receptor pathways. This remedial option will use background regional data in addition to the site-specific background sample chemistry to evaluate the site-specific risks to ecological and human health receptors. The findings from the risk assessment will be used to develop a risk management plan as a remedial option which may still require soil remediation (i.e., excavation). However, the target remedial guidelines will be site specific rather than the generic screening guidelines used currently.

Both remedial options will likely require some reclamation (i.e., seeding, erosion repairs) to retain and promote natural revegetation and ecosystem functionality.

5.6.4 Reclamation

Reclamation works at the E-07, K-30, and I-25 wellsites will consist of two activities:

Reclamation Activity 1 (wellhead decommissioning and site preparation treatments):

- Clear established vegetation around the immediate vicinity of the wellheads to create a workspace for abandonment activities; strip and stockpile the surface layer of vegetation, organic material and topsoil from the wellhead areas for later use in site reclamation.
- Excavation of the soil around the wellheads to expose the casing string. If the soil around the wellheads is contaminated, it will be removed from the Sites and hauled to an approved disposal facility. The contaminated soil will be replaced with clean backfill material that is of suitable quality.
- Cutting of the casing and casing string to an appropriate depth approved by the Canada Energy Regulator (CER), and removal of the wellhead.
- Capping of the casing string and backfilling of the excavated soil.
- Replacement of stockpiled vegetation/organic material layer and topsoil onto the former wellhead areas. If the volume of stockpiled vegetation/organic material layer and topsoil is not sufficient to adequately cover the decommissioned wellhead areas, additional topsoil material will be hauled in and applied. The additional topsoil material will be applied first, then covered with the stockpiled vegetation/organic material layer and topsoil to promote faster vegetation establishment. The backfilling and recontouring activities will be completed so that volume of stockpiled organic material layer and topsoil applied above the former wellhead does not result in the formation of settlement and depression.
- Where needed, recontouring will be carried out to re-establish the original natural topography and drainage patterns in the wellsite areas.

Reclamation Activity 2 (revegetation treatments):

- If needed, broadcast application of soil amendment materials such as fertilizer to improve soil fertility and application of organic mulch pellets to increase organic matter content and soil moisture capacity for the site.
- Broadcast application of a candidate native grass seed mix (Table C.1, Appendix C).

- The proposed native grass seed mix was applied in previous MGM wellsite and sump reclamation treatments in the ISR area and has successfully established. This mix includes species that are native to the region and adapted to a range of ground conditions such as flooding/high soil moisture, high salt conditions, low/high soil pH, and drought.
- MGM will consider the feasibility of incorporating other native forb and shrub species which are endemic in the Mackenzie Delta region into the reclamation seed mix through consultations with seed suppliers and local agencies (e.g., Aurora Research Institute). Potential native forb and shrub species include: green alder (*Alnus viridis*), red bearberry (*Arctous rubra*), glandular birch (*Betula glandulosa*), sedges (*Carex* spp.), fireweed (*Chamerion angustifolium*), black crowberry (*Empetrum nigrum*), cottongrass (*Eriophorum* sp.), Arctic sweet coltsfoot (*Petasites frigidus*), narrow-leaved Labrador tea (*Rhododendron tomentosum*), cloudberry (*Rubus chamaemorus*), willows (*Salix* spp.), and bog cranberry (*Vaccinium vitis-idaea*).
- In order to increase the components of native shrub and forb vegetation in the reclaimed areas, native shrub/forb seed will be added to the native grass seed mix if the species are commercially available.
- If feasible, transplant cuttings or young, small seedlings of local shrub species including willow and net-veined willow (*Salix reticulata*), green alder, glandular birch, crowberry, northern Labrador tea, or cloudberry.

- If needed, install jute netting or erosion control blankets over the reclaimed area to protect the soil surface from potential erosion.

5.7 Engineering Work Associated with Selected Closure Activity

Removal of the wellheads will be included in the well abandonment program under the jurisdiction of the Canadian Energy Regulator.

5.8 Water Management and Restoration of Natural Drainage

Natural drainage will be restored where needed through reclamation earthworks (Reclamation Activity 1).

5.9 Predicted Environmental Effects During and After Closure and Reclamation Activities

The potential environmental impacts/effects of the well abandonment program on valued components and general mitigation measures are discussed in detail in the 2019 Well Abandonment PDR (KAVIK-STANTEC 2019). Table 5-3 below provides a summary of the potential effects and recommended mitigation measures.

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation
Terrain, Soils and Permafrost	
Disturbance and erosion • Barge activity, winter roads and well pad construction have potential to disturb underlying soils through vehicle and equipment use	• Barge landing sites that were successfully screened by the EISC for past PDRs will be selected from previous applications. Sites will have stable shorelines and deeper channels for transport. • Equipment will be unloaded using portable barge ramps or packed snow and ice ramps, which will protect channel banks. • Ice pads will be constructed using low ground pressure vehicles. • Only low ground pressure equipment will be used if there is less than 15 cm of snow. • Other vehicles and equipment will only be used on constructed ice pads a minimum of 15 cm thick. • Rutting will be avoided. Vehicle movements will be suspended if rutting occurs. • Mushroom shoes or boots will be used on bladed equipment.
Reduced permafrost integrity • Change in terrain and permafrost conditions resulting from the construction and operation of winter roads • Flaring may cause local melting of the active layer and permafrost • Accidental release of COCs • Excavation at wellhead area may cause permafrost degradation and subsidence	• On-land Program activities will be confined to winter (frozen ground) conditions. • Winter roads and ice pads of at least 15 cm in thickness will be used to protect surface vegetation and prevent compaction. • The areal extent of on-land ice pads and winter roads areas will be minimized. • Vehicles and equipment will only be used if there is a minimum 15 cm of snow/ice on ice pads and overland access roads. • Ice flare pads will be constructed to maintain insulating barrier; the size and depth of this ice pad will be designed to avoid thawing surface vegetation or soil. Flaring will adhere to National Energy Board Guidelines (NEB 2014). • Flaring is not expected unless there is residual gas in the well bores or the plugs are leaking. • If ground disturbance is unavoidable (e.g., soil excavation around the wellhead, or soil excavation in the course of spill clean-up), the resulting depression(s) will be backfilled and recontoured to above natural surface elevation using uncontaminated cut vegetation and disturbed soil. If some differential settlement occurs following the spring thaw, recontouring will be carried out to re-establish the original natural topography and drainage patterns in the wellsite areas.

Potential Effects on Valued Components	Mitigation
Vegetation Communities (including rare plants and uncommon communities)	
Localized loss or damage of vegetation • Damage to vegetation from accidental releases of COCs • Compaction and breakage of stems by vehicles during construction • Compaction and effects of delayed melting associated with ice pads and roads • Damage caused by local ice melting and temporary thawing of frozen vegetation as a result of flaring (note that very short term thawing of vegetation is not expected to cause long term vegetation damage or die-back)	• Vegetation clearing will be avoided as much as possible through the use of previous disturbance for winter roads and staging. Vegetation clearing will not occur on the ice pads. • On-land Program activities will be confined to winter (frozen ground) conditions. • Winter roads and ice pads of at least 15 cm in thickness will be used to protect surface vegetation and prevent compaction. • The areal extent of on-land ice pads and winter roads areas will be minimized. • Vehicles and equipment will only be used if there is a minimum 15 cm of snow/ice on ice pads and overland access roads. • Vegetation will be 'walked down' instead of cut, wherever possible. • Proposed overland access will be pre-scouted to select appropriate routing with least likelihood of vegetation disturbance. • Where vegetation removal or damage is necessary (e.g., in the case of spill clean-up), the area will be reinsulated with cut organic matter to prevent possible thawing of permafrost and facilitate re-vegetation in the upcoming growing season. • Equipment will be operated on winter roads and ice pads to protect surface vegetation. • Reclamation activities will be completed at each wellsite after abandonment activities take place using appropriate seed mix as necessary.
Water Quality	
Potential effects to surface water quality • Accidental release of COCs	• All wastes will be contained and disposed in approved facilities designed for proper containment, treatment and disposal of wastes in accordance with permit requirements. • All Program activities will take place on constructed ice pads or winter roads, which will facilitate thorough cleanup of any accidental spills. • Fuel containment and handling procedures will minimize the risk of fuel spills. • In the event of accidental spills, MGM's Spill Response Plan (refer to Appendix A of the 2019 Well Abandonment Program PDR, KAVIK-STANTEC 2019) will warrant containment, thorough clean-up and proper disposal of absorbent materials and contaminated snow and ice. Evaporators will be used to reduce the volume of contaminated snow and ice. • Prior to demobilization, all working areas will be inspected for contaminant residues and cleaned up as required. • Fuel barges will be inspected bi-weekly. • No sumps will be used during the Program.
Hydrology	
Potential effects to surface hydrology • Effects to localized surface drainage may occur because of location of ice pads	• Ice pads will be sited on level ground. • An ice berm will be built up-slope from the ice pads to deflect overland meltwater around the ice pads. • DFO protocol for winter water withdrawal from ice-covered waterbodies in the NWT and Nunavut (DFO 2010) will be followed.

Potential Effects on Valued Components	Mitigation
Fish and Fish Habitat	
Potential fish entrainment and mortality • Water withdrawal using pumps and hoses (necessary to make ice pads and roads) may result in fish kills • Accidental release of COCs	• DFO protocol for winter water withdrawal from ice-covered waterbodies in the NWT and Nunavut (DFO 2010) will be followed, which will include use of fine mesh screen on water intakes. • Mitigation will be developed using DFO measures to avoid causing harm to fish and fish habitat (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html) (DFO 2018). • Water withdrawal will be from the Mackenzie River, and the Program will also explore location options from previous applications for approval. • Regular inspection of water trucks to confirm compliance. • Fuel containment and handling procedures will minimize the risk of fuel spills. • In the event of accidental release, MGM's Spill Response Plan (refer to Appendix A of the 2019 Well Abandonment Program PDR, KAVIK-STANTEC 2019) will confirm containment, thorough clean-up and proper disposal of absorbent materials and contaminated snow and ice. Evaporators will be used to reduce the volume of contaminated snow and ice. • Fuel barges will be inspected bi-weekly.
Potential alteration of fish habitat • Approaches to shore along the winter roads may lead to erosion and increased sedimentation.	• Approaches to the shoreline will be snow filled. • Avoid exposed soil. • Previously used routes, where discernible, will be used and no new winter road alignments will be made. • All Program activities will take place on constructed ice pads or winter roads, which will facilitate thorough cleanup of any accidental spills and protect soils from erosion and contamination, which could subsequently affect surface water quality.
Migratory Birds and Habitat	
Temporary sensory disturbance of migratory birds • Demobilization of barges (approximately mid-June) may flush birds from preferred nesting locations • Helicopter use associated with the monitoring of barging and barge staging may increase sensory disturbance	• EISC Operating Guidelines and Procedures (EISC 2004) will be followed, where applicable. Observed concentrations of migratory birds will be avoided (1,000 m vertically, 1,500 m horizontally). • Disruptions to migratory birds will be kept to a minimum by removing barges in the shortest possible timeframe. • Wildlife monitors will be consulted during activities.
Temporary loss of bird habitat on the Program footprint • Equipment used directly on snow covered tundra may affect vegetation used by birds • Equipment used on ice pads may potentially affect vegetation used by birds	• Program activities will only occur within the Program footprint and on ice pads or winter roads. • Low ground pressure equipment will be used if there is less than 15 cm of snow. • Other Program equipment and vehicles will only be operated on constructed ice pads with a thickness greater than 15 cm.

Potential Effects on Valued Components	Mitigation
Grizzly and Polar Bears	
Disturbance of denning bears • Direct disturbance during construction and abandonment activities • Sensory disturbance during construction and abandonment activities **Disturbance of foraging bears** • Direct and sensory disturbance from barge mobilization/demobilizing • Helicopter use causing sensory disturbance **Bear-human interactions** • Attractants from camps and Program work areas • Safety	• Avoidance will be the primary mitigation. Coordination between ENR and MGM will occur to provide location of current and historic grizzly and polar bear den locations and/or conduct a survey prior to Program start-up to allow avoidance by >800 m. • MGM will incorporate the results of ENR identified den location information into Program planning. • Prior to construction, surveys will be conducted to locate active and suspected active bear dens within setback distances of areas scheduled for activity. • If an active den or if a bear is observed during the winter season (October 1 to May 30) within 800 m of Program activity, activities will be suspended within the exclusion zone and ENR will be contacted to determine appropriate mitigation. • ENR Bear Encounter Response Guidelines for Oil and Gas Programs (ENR 2005) will be followed. • Proper storage, transportation and disposal of wastes will be carried out to avoid attracting bears to work sites. • Wildlife monitors will be on-site at all times.
Marine Mammals and Habitat	
Disturbance to beluga whales and seals • Direct and sensory disturbance by barge mobilizing/demobilizing	• Avoidance will be the primary mitigation during barge staging activities as staging will take place in late September or October and may overlap with the presence of beluga whales or seals. A wildlife monitor will be present during times where there is an overlap with beluga whale and seal movements. • Avoidance will be the primary mitigation for barge demobilization activities. A wildlife monitor will be present during times where there is an overlap with beluga whale and seal movements.
Traditional Camps	
Disturbance to traditional camps • Sensory disturbance by Program activities	• HTCs will be notified of Program activities prior to commencement to minimize interactions with traditional camps and harvesters. • EISC Operating Guidelines and Procedures (EISC 2004) will be implemented where possible.

Note:

Adapted from Table 13-3, MGM Energy Langley K-30, Langley E-07 and Kumak I-25 Well Abandonment Program Project Description Report (KAVIK-STANTEC 2019).

5.10 Post-Closure Monitoring, Maintenance and Reporting

Post-closure activities at the E-07, K-30, and I-25 wellsites will consist primarily of vegetation and terrain monitoring to confirm reclamation success, implementing follow-up reclamation maintenance treatments, if required, and reporting. Use of thermistor cables to monitor ground temperature is not recommended as a post-closure monitoring method. Post-closure monitoring, maintenance, and reporting is proposed following completion of decommissioning and reclamation works to meet water licence and land use permit conditions to confirm that native vegetation and natural contouring is established and compatible with surrounding lands.

Vegetation monitoring will include documentation of parameters such as types of vegetation present (i.e., shrubs, forbs, mosses, lichens), vegetation species observed, plant stem density, vegetation percent cover, plant heights, plant health and condition, invasive plant species observed and degree of infestation, site slope gradient, soil material type, and evidence of erosion. The documented parameters will be used to determine if the revegetation treatments were successful in establishing a native vegetation cover that is on a trajectory to becoming a self-sustaining cover that is compatible with the native vegetation cover in surrounding undisturbed areas and meets LUP N2019A0001 conditions.

Terrain monitoring will include documenting ground stability conditions in the wellsite areas, assessment of permafrost conditions, and identification of erosion and ground subsidence issues. If the presence of standing water is observed, it will be monitored and sampled as necessary. Monitoring is proposed to be carried out during summer months, to meet water licence and land use permit conditions. The first year of monitoring will also include confirmatory soil sampling to verify previous reclamation results.

If issues are identified during the monitoring or from sampling that need to be addressed, minor reclamation maintenance treatments will be carried out. These could include invasive plant control, scarification or recontouring, re-application of soil mulch, fertilizer, or native grass seed mix, re-planting of cuttings or seedlings, and repairing or installing erosion control measures. Reclamation maintenance treatments, if required, will be carried out in the summer months in conjunction with the field monitoring programs; maintenance treatment work and associated materials required will only be completed with helicopter support.

Monitoring reports will be prepared following completion of the field monitoring programs. The reports will be updated following subsequent monitoring events until the Sites have met the applicable closure criteria. The monitoring reports will provide details on monitoring methodology, vegetation and terrain conditions, reclamation maintenance treatments carried out, discussion and recommendations on vegetation and terrain conditions, and recommendations for reclamation maintenance.

5.11 Uncertainties and Contingencies

Some of the project components such as barge landing sites, staging areas, camp facilities, airstrips/helicopter pads will require inspection following final completion of abandonment activities proposed from 2026 to 2031 to confirm if additional reclamation work is required.

5.12 Climate Change Considerations

The equipment used for reclamation earthworks will produce emissions including nitrous oxides, sulphur dioxide, carbon monoxide and particulate matter. Equipment and the duration of reclamation activity will be minimized to the extent possible. Equipment idling will be avoided where possible.

5.13 Closure and Reclamation Research Plans

Closure and reclamation research plans are not applicable as this is the final reclamation and closure of the Sites.

6 Progressive Reclamation

Progressive reclamation is not applicable as MGM is pursuing final permanent closure of the wellsites and associated project components.

7 Temporary Closure

MGM has no intention of resuming activities on sites slated for closure. Therefore, temporary closure is not applicable to this CRMP.

8 Implementation Schedule

Currently, MGM is planning to carry out abandonment of the wellsites and associated project components between 2026 and 2031. The amount of time required to complete abandonment at each wellsite will be dependent on the site-specific conditions. The CRMP will be implemented over the multiple years as the Sites become available for reclamation and will be subject to changes as new information becomes available. Key events and approximate timing for each year are:

- Barge Mobilization: September to October
- Winter roads/ice pad construction: November to mid-April
- Abandonment activities: December to mid-April
- Demobilization (winter roads): when winter road conditions are no longer safe for travel (likely mid-April)
- Demobilization (barge): after spring break-up (late June to early July dependent on breakup timing)
- Site preparation and revegetation treatments: May to June (once snow cover is gone) and late August to early October (before snow cover becomes established)
- Monitoring: July to August

9 Financial Security

Currently MGM has security posted under water licence N7L1-1815. MGM will be addressing the financial security of the Sites separate from the CRMP.

10 References

AENV (Alberta Environment) 2001. Salt Contamination Assessment and Remediation Guidelines. Environmental Sciences Division, Pub No. T/606. Available at: http://open.alberta.ca/dataset/d53c62c1-7dec-4396-aa8a-2a01703d2060/resource/b7bee18b-c7cf-4f85-957d-bcd2dc68a13a/download/2001-SaltContaminationRemediationGuidelines.pdf.

AENV. 2009. Soil Remediation Guidelines for Barite: Environmental Health and Human Health. Environmental Sciences Division, Pub No. T/606. Available at: https://open.alberta.ca/publications/9780778576914.

CCME (Canadian Council of Ministers of the Environment). 2008. Canada-Wide Standards for Petroleum Hydrocarbons in Soil. Canadian Council of Ministers of the Environment, Winnipeg. Available at: https://ccme.ca/en/res/cws_phc_user_guide_1.1_e.pdf

CCME. 2024. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Canadian Council of Ministers of the Environment, Winnipeg. Available at: http://st-ts.ccme.ca/en/index.html.

Chevron. 2008. *2007 Annual Report Type "B" Water Licence N7L1-1815 Chevron 2006-2007 Taktuk, Langley, and Farewell Drilling Program*. Submitted to NWT Water Board February 29, 2008.

DFO (Department of Fisheries and Oceans). 2010. DFO *Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut.*

DFO. 2018. *Measures to Avoid Causing Harm to Fish and Fish Habitat.* Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html.

ECCC (Environment and Climate Change Canada). 2022a. Canadian Climate Normals 1981-2010 Station Data–Tuktoyaktuk. Available at: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=Tuktoyaktuk&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=1700&dispBack=1 Accessed October 2024

ECCC. 2022b. Canadian Climate Normals 1981-2010 Station Data–Inuvik. Available at: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=Inuvik&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=1669&dispBack=1. Accessed September 2024.

ECG (Ecosystem Classification Group). 2012. Ecological Regions of the Northwest Territories – Southern Arctic. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NWT, Canada. + map. Available at: http://www.enr.gov.nt.ca/sites/default/files/reports/2012_southern_arctic_final_reporterrata_corrected_april2013webversion.pdf

EISC (Environmental Impact Screening Committee). 2004. Operating Guidelines and Procedures. Inuvik, NWT. November 2004.

ENR (NWT Department of Environment and Natural Resources). 2005. Bear Encounter Response Guidelines- Oil and Gas Programs. Prepared by: Dept. of ENR, Inuvik, NT.

GNWT (Government of the Northwest Territories). 2015. Northwest Territories Air Quality Report. Government of the Northwest Territories. Department of Environment and Natural Resources. Yellowknife, NT. Available at: https://www.enr.gov.nt.ca/sites/enr/files/air_quality_report_2015.pdf

GNWT DOL (Department of Lands). 2024a. *LUP: N2006A0029 Oil and Gas Drilling – Yaya Sump and Kumak I-25 Wellsite Environmental Inspection Report*. August 12, 2024.

GNWT DOL. 2024b. *LUP: N2002A0035 Oil and Gas Drilling – K30 sump and Wellhead Environmental Inspection Report*. August 12, 2024.

GNWT DOL. 2024c. *LUP: N2019A0001 Oil and Gas Drilling – Langley E-07 Wellhead Environmental Inspection Report*. August 19, 2024.

GNWT-ECC (Government of the Northwest Territories- Environment and Climate Change). 2024. *Government of Northwest Territories Environment and Climate Change Spills search*. Available at: https://www.gov.nt.ca/ecc/en/spills

GSC (Geological Survey of Canada). 2014. Surficial Geology of Canada. Geological Survey of Canada, Canadian Geosciences Map 195 (preliminary, Surficial Data Model v. 2.0, conversion of Map 1880A. Scale: 1: 5,000,000. DOI: 10.4095/295462.

Heginbottom, J.A. 2000. Permafrost Distribution and Ground Ice in Surficial Materials. In L.D. Dyke and G.R. Brooks (ed). The Physical Environment of the Mackenzie River Valley, Northwest Territory: A Base line for the Assessment of Environmental change. Geological Survey of Canada.

Heginbottom, J.A., M.A. Dubreuil, and P.T. Harker. 1995. Canada: Permafrost. National Atlas of Canada Fifth Edition. Natural Resources Canada, MCR 4177

IRC (Inuvialuit Regional Corporation). 2024. Inuvialuit Lands and Map of the Inuvialuit Settlement Region. Available at: https://irc.inuvialuit.com/lands/

KAVIK-AXYS. 2006. Chevron Canada Limited - Taktuk, Langley and Farewell Drilling Program: Winter 2006-2008. Prepared for Chevron Canada Limited on behalf of the Mackenzie Delta Joint Venture. Calgary AB. Prepared by: KAVIK-AXYS Inc. in associated with FMA Heritage Resource Consultants, Calgary AB. June 2006.

KAVIK-AXYS. 2007a. Submission to the Inuvialuit Environmental Impact Screening Committee – MGM Energy Corp. 2007, 2008, and 2009 Summer Field Assessment and Advance Barge Project. Prepared for: MGM Energy Corp, Calgary AB. Prepared by: KAVIK-AXYS Inc. in associated with FMA Heritage Resource Consultants, Calgary AB. April 2007.

KAVIK-AXYS. 2007b. MGM Energy Corp. –Ellice, Langley and Olivier Drilling, Completion and Testing Project. Winters 2007-2008, 2008-2009 and 2009-2010. Prepared for: MGM Energy Corp, Calgary AB. Prepared by: KAVIK-AXYS Inc. in associated with FMA Heritage Resource Consultants, Calgary AB. April 2007.

KAVIK-AXYS. 2008a. MGM Energy Corp. – West Langley Drilling, Completion, Testing and Abandonment Project: 2008-2011. Prepared for: MGM Energy Corp, Calgary AB. Prepared by: KAVIK-AXYS Inc. in associated with FMA Heritage Resource Consultants, Calgary AB. June 2008.

KAVIK-AXYS. 2008b. MGM Energy Corporation. – Summer 2007 Mackenzie Delta Field Assessment: Biophysical Study Summary Report. Prepared for: MGM Energy Corp, Calgary AB. Prepared by: KAVIK-AXYS Inc., Calgary AB. May 2008.

KAVIK-STANTEC. 2016a. MGM Energy Corporation – 2015 Environmental Site Monitoring Report. Site: Langley E-07. Prepared for: MGM Energy Corporation, Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. March 2016.

KAVIK-STANTEC. 2016b. MGM Energy Corporation – 2015 Environmental Site Monitoring Report. Site: Kumak I-25 Wellsite. Prepared for: MGM Energy Corporation, Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. March 2016.

KAVIK-STANTEC. 2016c. MGM Energy Corporation – 2015 Environmental Site Monitoring Report. Site: Langley K-30 Wellsite. Prepared for: MGM Energy Corporation, Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. March 2016.

KAVIK-STANTEC. 2017. MGM Energy – 2017 Environmental Site Monitoring Report: Langley K-30 Wellsite and Sump. Prepared for: MGM Energy Corporation, Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. December 2017.

KAVIK-STANTEC. 2019. MGM Energy – Langley K-30, Langley E-07 and Kumak I-25 Well Abandonment Program. Prepared for: MGM Energy, Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. July 2019.

KAVIK-STANTEC. 2024a. MGM Energy – 2023 Environmental Site Monitoring Report: Unipkat M-45/Kumak I-25 Wellsite Area and Sump Area. Prepared for: MGM Energy Ltd., Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. February 15, 2024.

KAVIK-STANTEC. 2024b. MGM Energy – 2023 Environmental Site Monitoring Report: Langley K-30 Wellsite Area and Sump Area. Prepared for: MGM Energy Ltd., Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. February 15, 2024.

KAVIK-STANTEC. 2025. MGM Energy – 2024 Environmental Site Monitoring Report: Langley K-30 Wellsite Area and Sump Area. Prepared for: MGM Energy Ltd., Calgary, Alberta. Prepared by: KAVIK-STANTEC Inc., Inuvik, NWT. May 15, 2025.

MVLWB (Mackenzie Valley Land and Water Board). 2013. Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories. Published by: Mackenzie Valley Land and Water Board and Aboriginal Affairs and Northern Development Canada. November 2013.

NEB (National Energy Board of Canada) 2014. NEB Event Reporting Guidelines. December 2014.

Nguyen, T.-N., C. R. Burn, D. J. King, and S. L. Smith (2009), Estimating the extent of near-surface permafrost using remote sensing, Mackenzie Delta, Northwest Territories, Permafrost Periglacial Processes, 20, 141–153, doi:10.1002/ppp.637

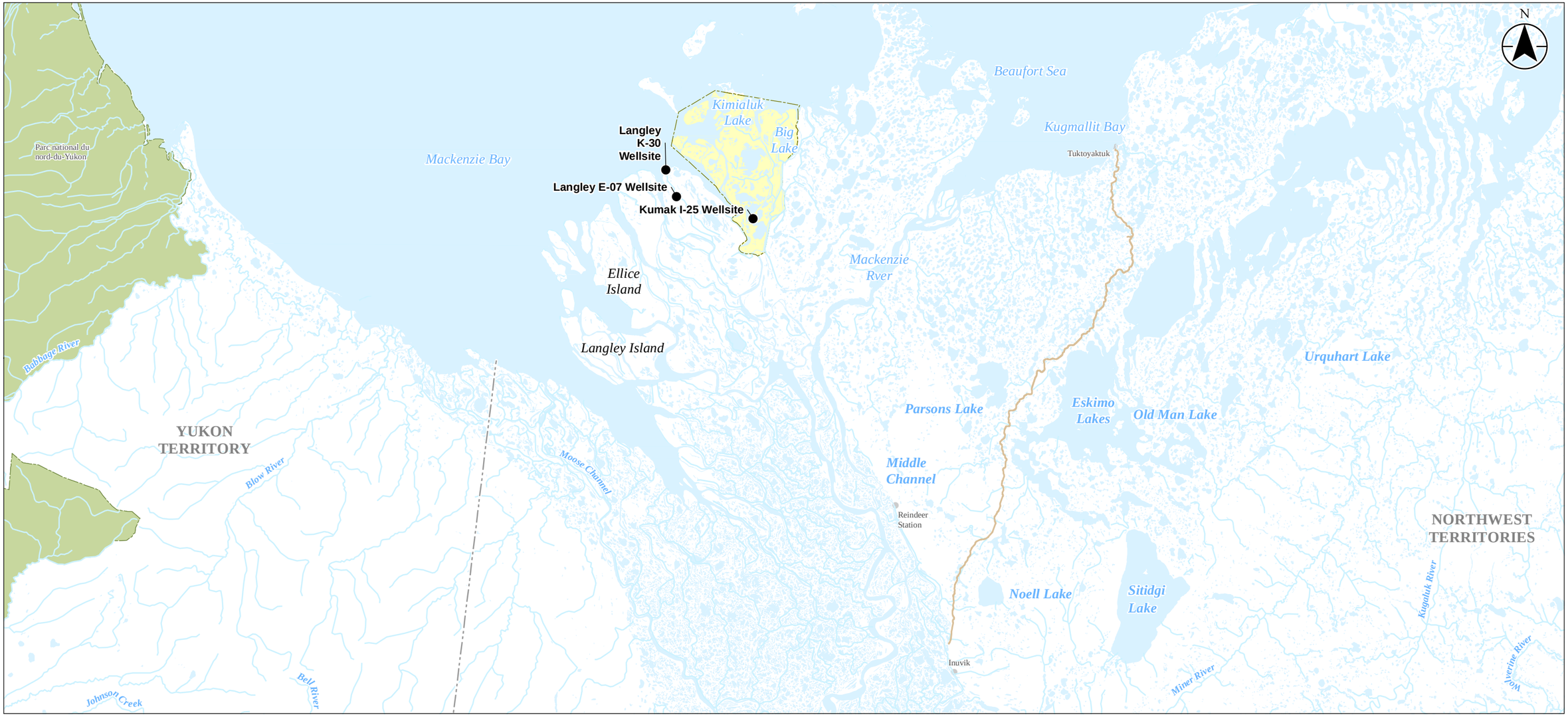
OROGO (NWT Office of the Regulator of Oil and Gas operations). 2017. *Well Suspension and Abandonment Guidelines and interpretation notes.* Available at: https://www.orogo.gov.nt.ca/sites/orogo/files/resources/orogo_well_suspension_and_abandonment_guidelines_and_interpretation_notes.pdf

Priddis (Priddis Environmental Solutions Ltd.). 2014. Environmental Inspection Report: Kumak I-25 Wellsite: 2014 Delta Program. Prepared for: MGM Energy Corp. December 2014.

Rampton, V.N. 1987. Surficial Geology, Tuktoyaktuk Coastlands, Northwest Territories. Geological Survey of Canada. Map1647A. Scale 1:500,000.

Wheeler, J.O., Hoffman, P.F. Card, K.D., Davidson, A., Sanford, B.V., Okulitch, A.V., Roest, W.R. 1996. Geological Map of Canada. Geological Survey of Canada. Map 1860A, scale 1:5,000,000.

Appendix A Figures



Wellsite
ITH
Kendall Island Migratory Bird Sanctuary
National Park

0 10 20 kilometers
(At original document size of 11x17)
1:900,000

KAVIK-STANTEC

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20240912

Client/Project 123515084

MGM Energy Langley E-07, Langley K-30, and Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.1

Title
Wellsite Abandonment Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories

W:\Clients\Kalo_Kavik\MGM\figures\2024\RCM_Plan\ISR_well_overview.mxd Revised: 2024-11-06 By: nforrester

Wellhead

Wellsite Area

0 20 40 metres

(At original document size of 11x17)
1:1,200

KAVIK-STANTEC

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project 123515084

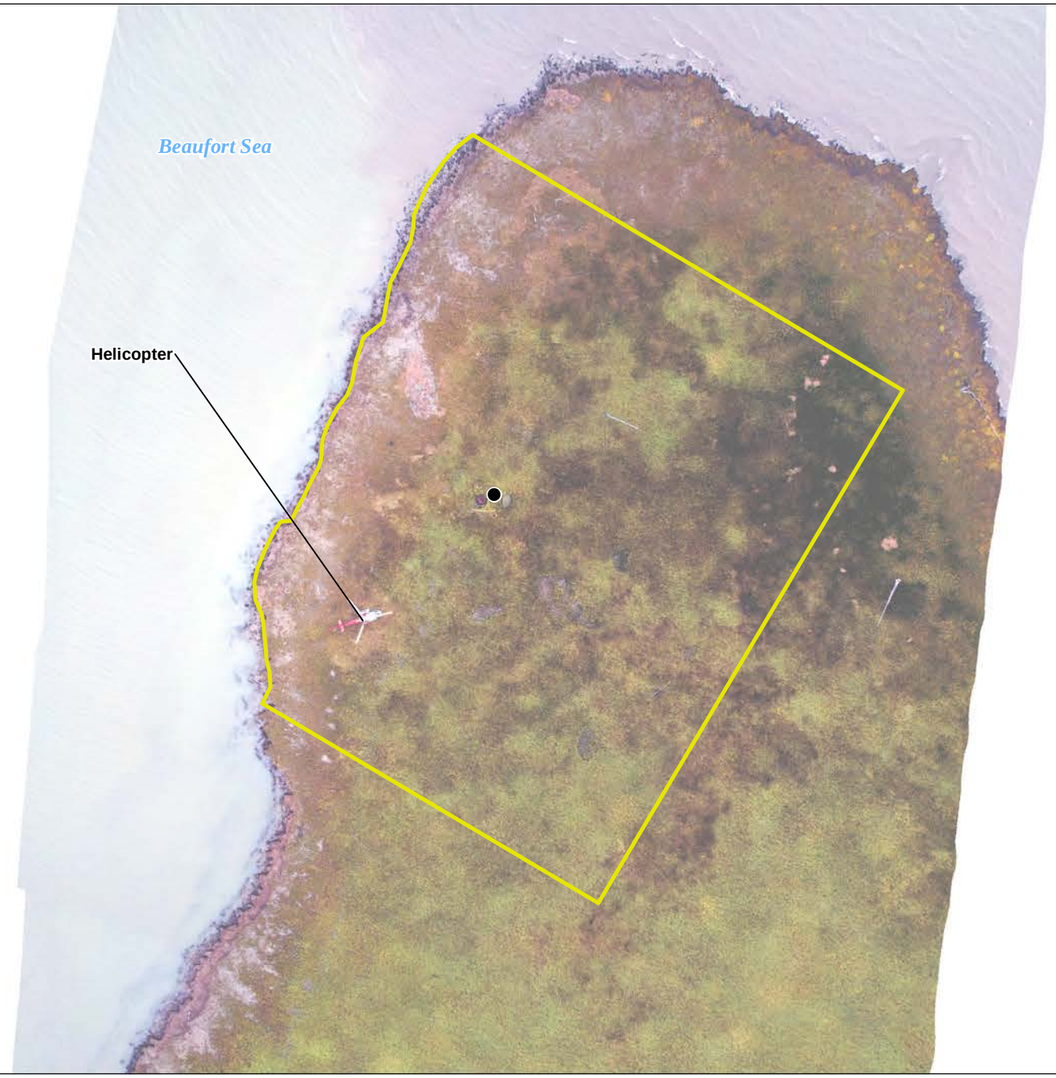
MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.2

Title
Langley E-07 Wellsite Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

W:\Clients\Kalo_Kavik\MGM\figures\2024\RCM_Plan\123515084_E07_A2.mxd Revised: 2024-10-16 By: nforrester



N

Wellhead

Wellsite Area

0 25 50 metres

(At original document size of 11x17)
1:1,200

KAVIK-STANTEC

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project
123515084

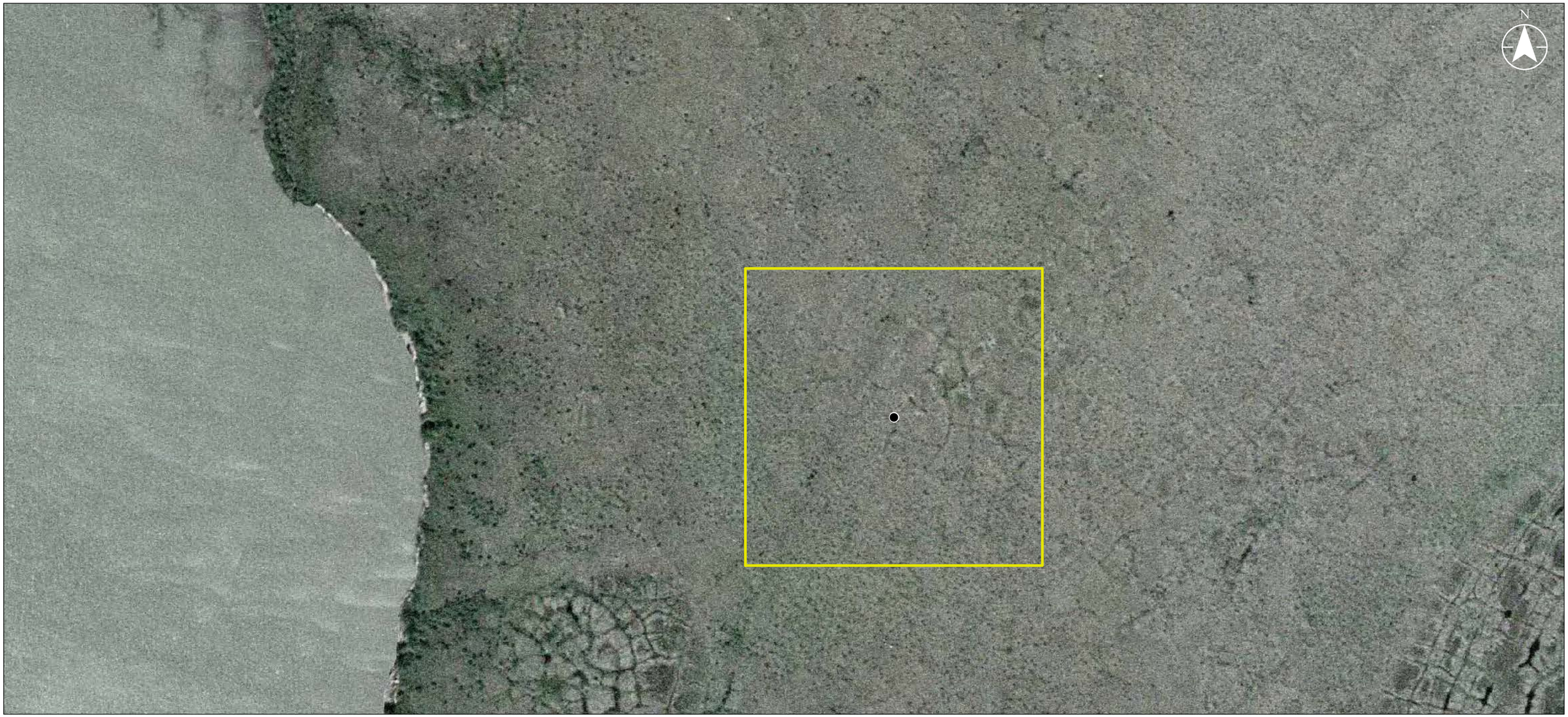
MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.3

Title
Langley K-30 Wellsite Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

W:\Clients\Kalo_Kavik\MGM\figures\2024\RCM_Plan\123515084_K30_A3.mxd Revised: 2024-10-16 By: nforrester



Wellhead

Wellsite Area

0 20 40 metres

(At original document size of 11x17)
1:2,000

KAVIK-STANTEC

Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project 123515084

MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

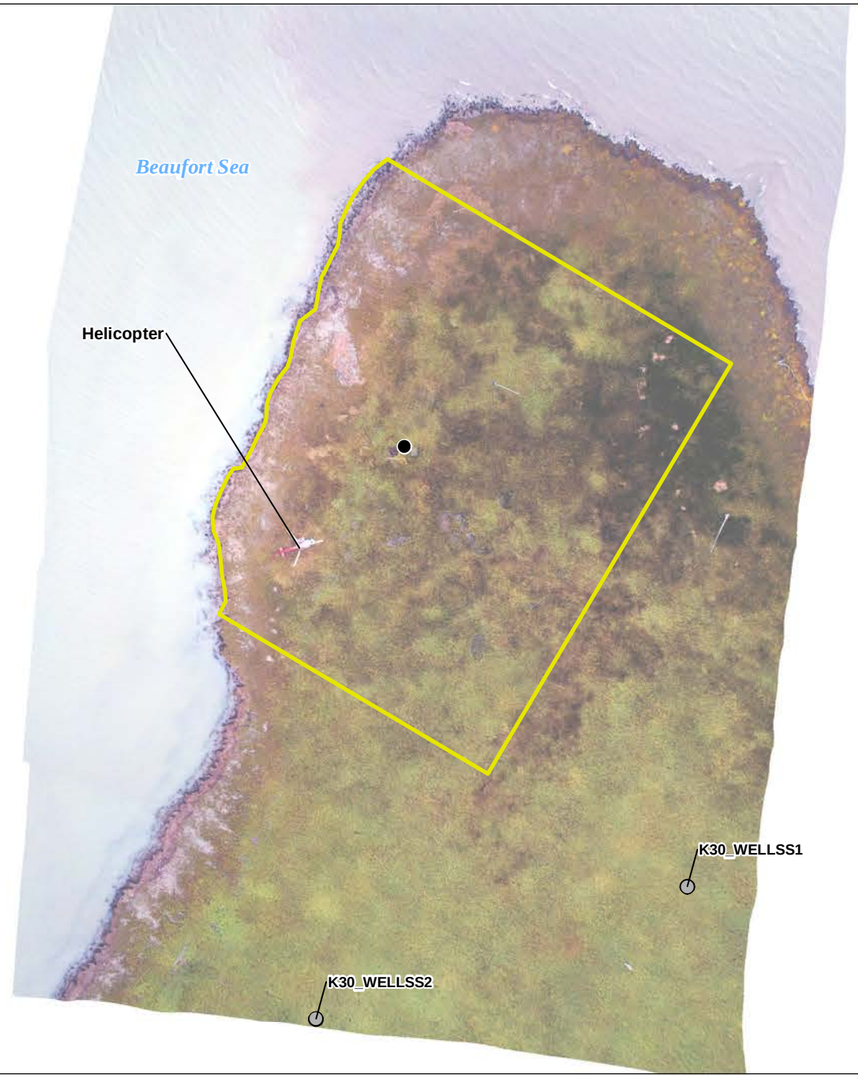
Figure No.

A.4

Title

Kumak I-25 Wellsite Area

W:\Clients\Kalo_Kavik\MGM\figures\2024\RCM_Plan\123515084_I25_A4.mxd Revised: 2024.10.16 By: nforrester



Historical Soil Sample
Wellhead
Wellsite Area

0 25 50 metres
(At original document size of 11x17)
1:1,500

KAVIK-STANTEC

Notes
1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

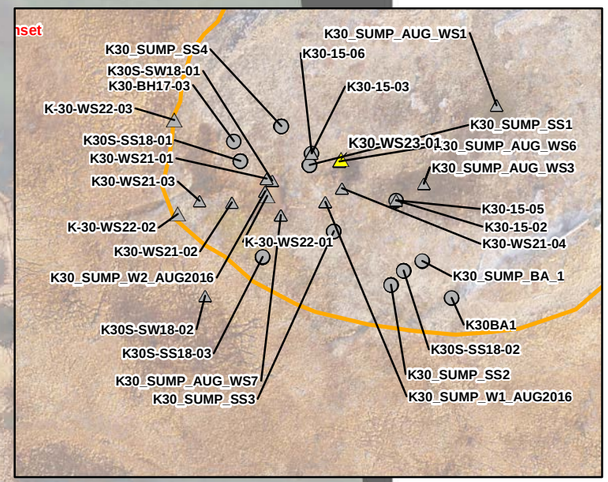
Client/Project
123515084
MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.5

Title
Langley K-30 Wellsite Area Soil Sampling Locations

W:\Clients\Kalo_Kavik\MCM\figures\2024\RCM_Plan\123515084_K30_A5.mxd Revised: 2024-10-16 By: nforrester

K-30-WS22-06
K-30-WS22-05
K30_SUMP_SS5
K-30-WS22-04
K30S-RW18-01
K30S-SS18-05
K30S-SS18-04
K30S-SW18-03
K30_SUMP_W3_AUG2016
K30-15-04
Helicopter
K30S-RS18-02
K30_SUMP_AUG_SS1
See Inset
K30_BACKGROUND_1
K30S-RS18-01
K30S-RW18-02
K30-15-01
K30-15-07



2023 Water Sample
Historical Soil Sample
Historical Water Sample
Sump Area

0 20 40 metres
(At original document size of 11x17)
1:1,625

Notes
1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

KAVIK-STANTEC

Project Location
Inuvialuit Settlement Region
NT

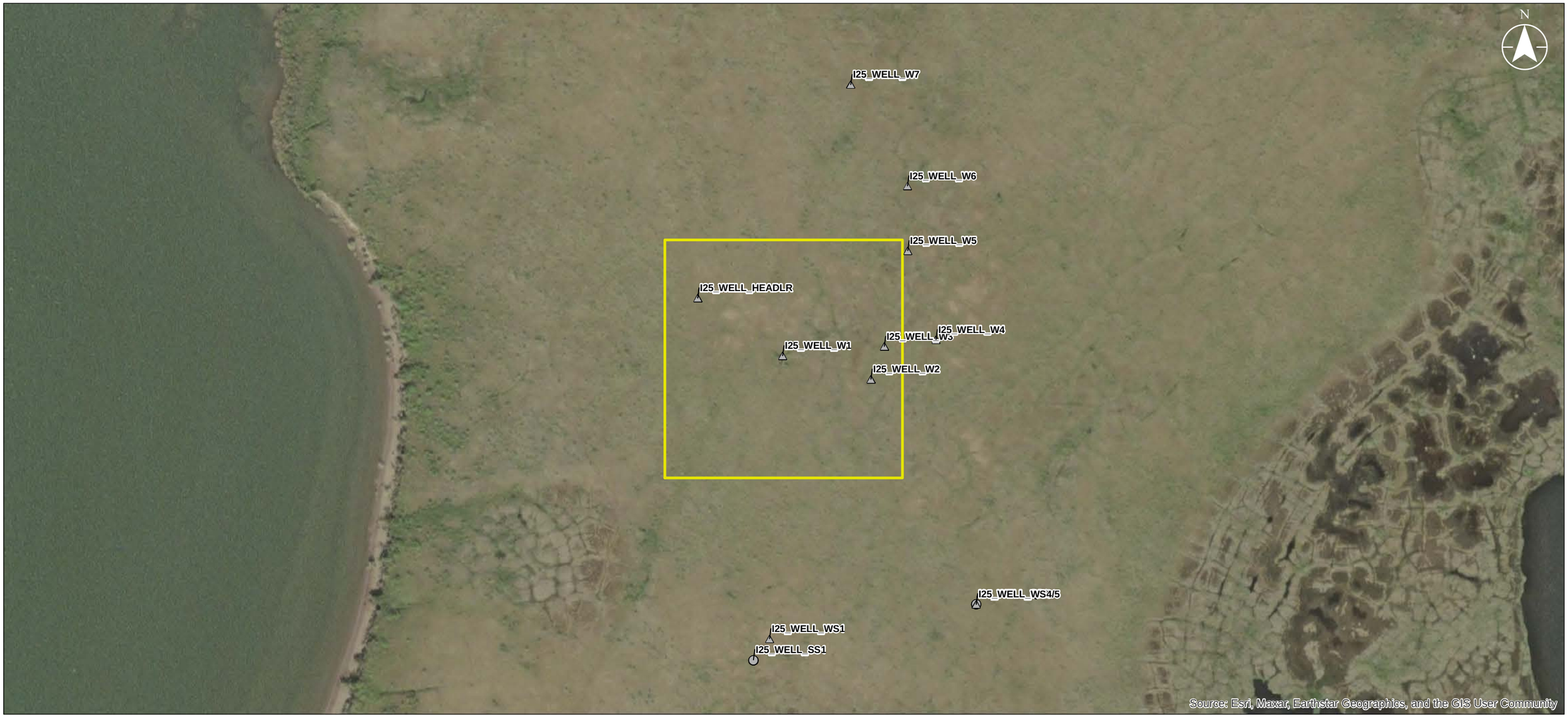
Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project
123515084
MGM Energy Langley E-07, Langley K-30, and Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.6

Title
Langley K-30 Sump Area - Soil and Water Sample Locations

W:\Client\Kalo_Kavik\MGM\figures\20241RCM_Plan\123515084_K30_A6.mxd Revised: 2024-10-17 By: nforrester



Historical Soil Sample (2012-2021)

Historical Water Sample

Wellsite Area

0 50 100 metres

(At original document size of 11x17)
1:2,500

KAVIK-STANTEC

Notes

1. Coordinate System: NAD 1983 UTM Zone 8N

2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories

3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

Project Location
Inuvialuit Settlement Region
NT

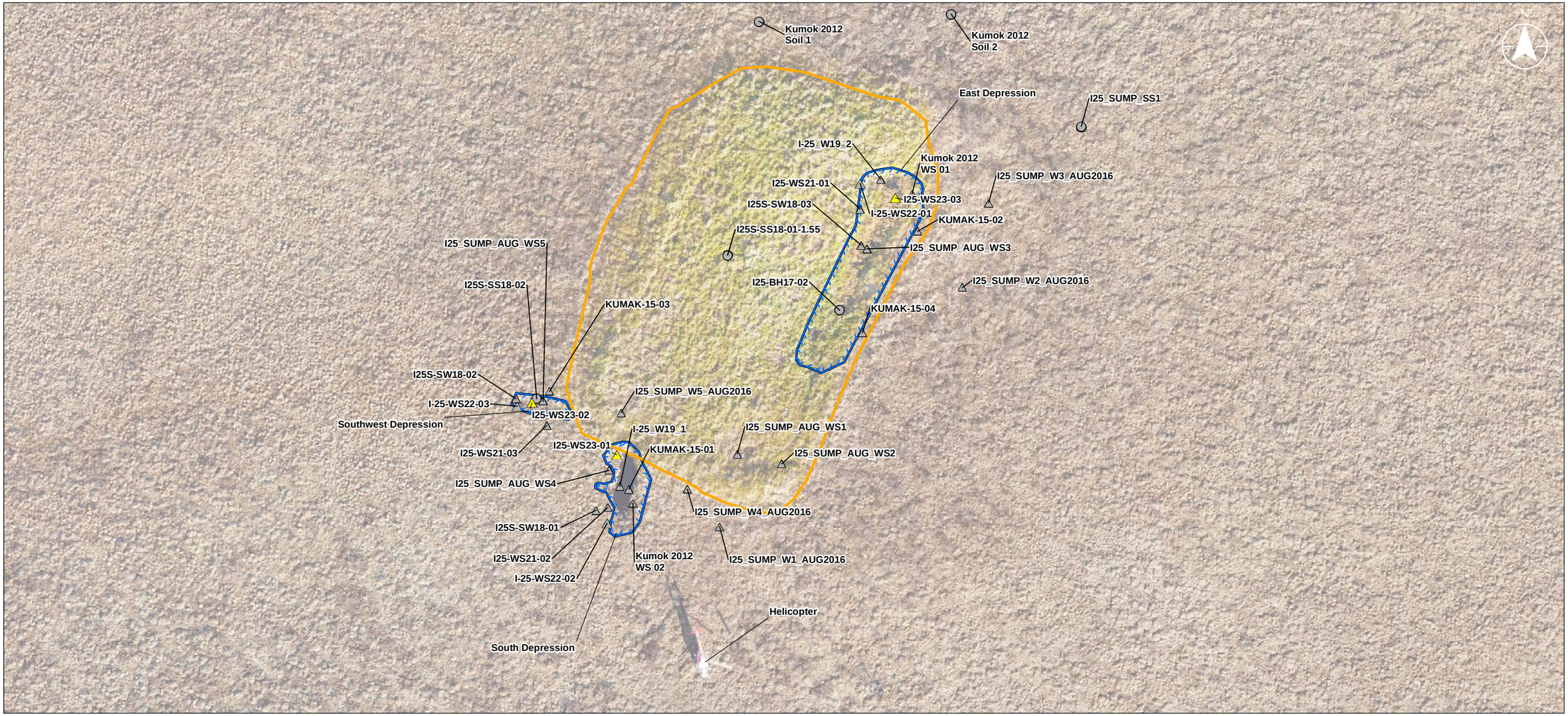
Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project
123515084
MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.7

Title
Kumak I-25 Wellsite Area -Water and Soil Sampling Locations

W:\Clients\Kalo_Kavik\MGM\figures\2024\RCM_Plan\123515084_I25_A7.mxd Revised: 2024-11-06 By: nforrester



2023 Water Sample
Historical Soil Sample
Historical Water Sample
Depression
Sump Area

0 10 20 metres
(At original document size of 11x17)
1:700

Notes
1. Coordinate System: NAD 1983 UTM Zone 8N
2. Data Sources: Base Data - Natural Earth. Thematic Data - KAVIK-STANTEC Inc., Government of Northwest Territories
3. GPS coordinates for sampling locations were recorded in the field by an iPad collector tool. Accuracy of GPS coordinates may vary plus or minus 5 metres

KAVIK·STANTEC

Project Location
Inuvialuit Settlement Region
NT

Prepared by NFORRESTER on 20241016
QR by LBORGES on 20241016

Client/Project 123515084
MGM Energy Langley E-07, Langley K-30, and
Kumak I-25 Well Abandonment
Program Closure, Reclamation, and Monitoring Plan

Figure No.
A.8

Title
Kumak I-25 Sump Area -Water and Soil Sample Locations

W:\Clients\Kalo_Kavik\MGM\figures\20241RCM_Plan\123515084_I25_A8.mxd Revised: 2024-10-16 By: nforrester

Appendix B Soil and Water Analytical Tables

Table B.1
Summary of Sump Soil Sample Analytical Results: Reference Samples and Statistical Calculations
Langley K-30 Sump
MGM Energy Corporation

Location		CCME		AENV SCARG Rating Categories	K-30 Sump													Statistical Calculations											
Sample Date					9-Jul-15	20-Aug-15	20-Aug-15	20-Aug-16	20-Aug-16	21-Aug-16	30-Aug-18	30-Aug-18	30-Aug-18	30-Aug-18	30-Aug-18	30-Aug-18	30-Aug-18													
Sample ID					K30_BACKGROUND 1 0-0.18	K30-15-07 @ 1M	K30-15-07 @ 1MLR	K30_SUMP_SS5_0-0.25	K30_SUMP_SS5_0.25-0.5	K30 BACKGROUND	K30S-RS18-01 0.25m	K30S-RS18-01 0.50m	K30S-RS18-01 1.00m	K30S-RS18-02 0.25m	K30S-RS18-02 0.25m Lab-Dup	K30S-RS18-02 0.50m	K30S-RS18-02 1.00m											
Sample Depth		Residential/Parkland Use			0 - 0.18 m	1 m	1 m	0 - 0.25 m	0.25 - 0.5 m		0.25 m	0.5 m	1 m	0.25 m	0.25 m	0.5 m	1 m											
Sampling Company					STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC											
Laboratory					MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX											
Laboratory Work Order				Table 2.2 Topsoil	B559302	B573450	B573450	B673175	B673175	B673175	B875267	B875267	B875267	B875267	B875267	B875267	B875267											
Laboratory Sample ID		Fine	Coarse		MQ6633	MZ0253	MZ0253	PJ3031	PJ3032	PJ3280	UF6618	UF6619	UF6620	UF6621	UF6621	UF6622	UF6623											
Sample Type	Units	A	B	C			Lab Replicate								Lab Replicate			Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Count	Detect	ND	Exceed	95 UCLM
General Chemistry																													
Soluble (CaCl2) pH	S.U.	6-8	6-8	n/v	7.05	7.32	-	-	-	7.15	7.49	7.62	7.80	7.60	-	7.60	7.79	7.05	7.8	7.41	7.6	7.32	7.09	log	log	9	9	0	0	NC
Soluble Conductivity	dS/m	2	2	Poor	3.4[AB]	3.2[AB]	-	-	-	0.34	6.3[AB]	9.2[AB]	8.1[AB]	2.3[AB]	2.2[AB]	3.7[AB]	4.0[AB]	0.34	9.2	4.27	3.55	5.72	8.7	2.77	0.88	10	10	0	9	5.9948
Sodium Adsorption Ratio (SAR)	none	5	5	Poor	7.9[AB]	4.8	-	-	-	2.0	5.4[AB]	14[AB]	11[AB]	5.7[AB]	-	7.3[AB]	5.0	2	14	7	5.7	7.9	12.8	3.6	1.2	9	9	0	6	9.352
Calcium	mg/kg	n/v	n/v	n/v	120	170	-	-	-	4.3	620	340	250	98	-	160	220	4.3	620	220.3	170	250	508	177.8	59.3	9	9	0	0	336.528
Calcium	mg/L	n/v	n/v	n/v	180	310	-	-	-	20	690	450	490	150	140	270	360	20	690	306	290	427.5	600	198.8	62.9	10	10	0	0	429.284
Cation/EC Ratio	none	n/v	n/v	n/v	9.8	11	-	-	-	9.8	11	9.9	9.9	10	-	10	9.9	9.8	11	10.1	9.9	10	11	0.5	0.2	9	9	0	0	10.492
Chloride	mg/kg	n/v	n/v	n/v	650	410	-	-	-	10	1,800	2,200	1,400	300	-	560	560	10	2200	876.7	560	1400	2040	744.2	248.1	9	9	0	0	1362.976
Chloride	mg/L	n/v	n/v	n/v	970 CD	760	-	-	-	50	2,000 CD	2,900 CD	2,700 CD	480 CD	470	930 CD	920 CD	50	2900	1218	925	1742.5	2810	974.6	308.2	10	10	0	0	1822.072
Ion Balance	none	n/v	n/v	n/v	1.1	1.1	-	-	-	1.3	0.95	1.1	1.0	1.2	-	1.1	1.0	0.95	1.3	1.09	1.1	1.1	1.26	0.11	0.04	9	9	0	0	1.1684
Magnesium	mg/kg	n/v	n/v	n/v	30	24	-	-	-	1.2	120	99	67	20	-	27	34	1.2	120	46.9	30	67	111.6	39.8	13.3	9	9	0	0	72.968
Magnesium	mg/L	n/v	n/v	n/v	45	46	-	-	-	5.7	130	130	130	31	29	45	56	5.7	130	64.8	45.5	111.5	130	47	14.9	10	10	0	0	94.004
Moisture Content	%	n/v	n/v	n/v	35	-	-	-	-	4.9	-	-	-	-	-	-	-	4.9	35	20	20	27.5	33.5	21.3	15	2	2	0	0	49.4
Percent Saturation	%	n/v	n/v	n/v	67	53	-	-	-	21	91	75	51	63	62	60	61	21	91	60.4	61.5	66	83.8	17.9	5.7	10	10	0	0	71.572
Potassium	mg/kg	n/v	n/v	n/v	13	6.5	-	-	-	1.0	28	9.4	6.7	4.7	-	6.6	3.6	1	28	8.8	6.6	9.4	22	8	2.7	9	9	0	0	14.092
Potassium	mg/L	n/v	n/v	n/v	19	12	-	-	-	4.9	31	13	13	7.5	7.2	11	5.9	4.9	31	12.5	11.5	13	25.6	7.8	2.5	10	10	0	0	17.4
Sodium	mg/kg	n/v	n/v	n/v	310	180	-	-	-	8.1	540	990	520	190	-	290	240	8.1	990	363.1	290	520	810	287.6	95.9	9	9	0	0	551.064
Sodium	mg/L	n/v	n/v	n/v	460	340	-	-	-	39	600	1,300	1,000	290	280	490	390	39	1300	518.9	425	572.5	1165	371.3	117.4	10	10	0	0	749.004
Soluble pH	S.U.	n/v	n/v	n/v	7.81	-	-	-	-	-	-	-	-	-	-	-	-													0
Sulphate	mg/kg	n/v	n/v	n/v	80	280	-	-	-	11	860	170	85	190	-	290	380	11	860	260.7	190	290	668	253.4	84.5	9	9	0	0	426.32
Sulphate	mg/L	n/v	n/v	n/v	120	520	-	-	-	54	950	230	170	300	270	480	620	54	950	371.4	285	510	801.5	272.9	86.3	10	10	0	0	540.548
Theoretical Gypsum Requirement	tons/ha	n/v	n/v	n/v	4.1	0.77	-	-	-	<0.20	5.9	47	18	1.1	-	4.0	1.3	0.2	47	9.15	4	5.9	35.4	15.21	5.07	9	8	1	0	19.0872
Physical Properties																													
Percent Sand	%	n/v	n/v	n/v	5.5	-	-	-	-	84	-	-	-	-	-	-	-	5.5	84	44.8	44.8	64.4	80.1	55.5	39.2	2	2	0	0	121.632
Percent Silt	%	n/v	n/v	n/v	78	-	-	-	-	11	-	-	-	-	-	-	-	11	78	44.5	44.5	61.2	74.6	47.4	33.5	2	2	0	0	110.16
Percent Clay	%	n/v	n/v	n/v	16	-	-	-	-	5.4	-	-	-	-	-	-	-	5.4	16	10.7	10.7	13.4	15.5	7.5	5.3	2	2	0	0	21.088
Texture	none	n/v	n/v	n/v	SILTLOAM	-	-	-	-	LOAMYSAND	-	-	-	-	-	-	-													
Sieve - Pan	%	n/v	n/v	n/v	-	-	-	-	-	4.2	-	-	-	-	-	-	-													
Sieve - #200 (>0.075mm)	%	n/v	n/v	n/v	-	-	-	-	-	96	-	-	-	-	-	-	-													
Grain Size	%	n/v	n/v	n/v	-	-	-	-	-	COARSE	-	-	-	-	-	-	-													
Metals																													
Aluminum	mg/kg	n/v	n/v	n/v	-	8,400	8,200	-	-	-	-	-	-	-	-	-	-	8200	8400	8300	8300	8350	8390	141.4	100	2	2	0	0	8496
Antimony	mg/kg	20	20	n/v	<0.50	<0.50	<0.50	-	-	-	-	-	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	3	0	3	0	0.5
Arsenic	mg/kg	12	12	n/v	7.3	6.3	5.9	-	-	-	-	-	-	-	-	-	-	5.9	7.3	6.5	6.3	6.8	7.2	0.7	0.4	3	3	0	0	7.284
Barium	mg/kg	500	500	n/v	360	410	390	-	-	-	-	-	-	-	-	-	-	360	410	386.7	390	400	408	25.2	14.5	3	3	0	0	415.12
Barium, Extractable	mg/kg	n/v	n/v	n/v	30	-	-	23	35	-	-	-	-	-	-	-	-	23	35	29.3	30	32.5	34.5	6	3.5	3	3	0	0	36.16
Beryllium	mg/kg	4	4	n/v	0.45	0.44	0.46	-	-	-	-	-	-	-	-	-	-	0.44	0.46	0.45	0.45	0.46	0.46	0.01	0.01	3	3	0	0	0.4696
Boron	mg/kg	n/v	n/v	n/v	-	8.6	5.9	-	-	-	-	-	-	-	-	-	-	5.9	8.6	7.2	7.2	7.9	8.5	1.9	1.3	2	2	0	0	9.748
Boron (Available)	mg/kg	n/v	n/v	n/v	1.6	-	-	-	-	-	-	-	-	-	-	-	-													
Cadmium	mg/kg	10	10	n/v	0.46	0.40	0.34	-	-	-	-	-	-	-	-	-	-	0.34	0.46	0.4	0.4	0.43	0.45	0.06	0.03	3	3	0	0	0.4588
Calcium	mg/kg	n/v	n/v	n/v	-	48,000	48,000	-	-	-	-	-	-	-	-	-	-	48000	48000	48000	48000	48000	48000	0	0	2	2	0	0	48000
Chromium	mg/kg	64	64	n/v	14	15	14	-	-	-	-	-	-	-	-	-	-	14	15	14.3	14	14.5	14.9	0.6	0.3	3	3	0	0	14.888
Chromium (Hexavalent)	mg/kg	0.4	0.4	n/v	<0.080	-	-	-	-	-	-	-	-	-	-	-	-													
Cobalt	mg/kg	50	50	n/v	8.4	7.3	7.0	-	-	-	-	-	-	-	-	-	-	7	8.4	7.6	7.3	7.8	8.3	0.7	0.4	3	3	0	0	8.384
Copper	mg/kg	63	63	n/v	17	15	14	-	-	-	-	-	-	-	-	-	-	14	17	15.3	15	16	16.8	1.5	0.9	3	3	0	0	17.064
Iron	mg/kg	n/v	n/v	n/v	-	19,000	19,000	-	-	-	-	-	-	-	-	-	-	19000	19000	19000	19000	19000	19000	0	0	2	2	0	0	19000
Lead	mg/kg	140	140	n/v	8.4	6.9	6.7	-	-	-	-	-	-	-	-	-	-	6.7	8.4	7.3	6.9	7.6	8.2	0.9	0.5	3	3	0	0	8.28
Lithium	mg/kg	n/v	n/v	n/v	-	14	13	-	-	-	-	-	-	-	-	-	-	13	14	13.5	13.5	13.8	14	0.7	0.5	2	2	0	0	14.48
Magnesium	mg/kg	n/v	n/v	n/v	-	20,000	20,000	-	-	-	-	-	-	-	-	-	-	20000	20000	20000	20000	20000	20000	0	0	2	2	0	0	20000
Manganese	mg/kg	n/v	n/v	n/v	-	320	320	-	-	-	-	-	-	-	-	-	-	320	320	320	320	320	320	0	0	2	2	0	0	320
Mercury	mg/kg	6.6	6.6	n/v	0.053	-	-	-	-	-	-	-	-	-	-	-	-													
Molybdenum	mg/kg	10	10	n/v	1.3	1.1	1.1	-	-	-	-	-	-	-	-	-	-	1.1	1.3	1.2	1.1	1.2	1.3	0.1	0.1	3	3	0	0	1.396
Nickel	mg/kg	45	45	n/v	25	22	21	-	-	-	-	-	-	-	-	-	-	21	25	22.7	22	23.5	24.7	2.1	1.2	3	3	0	0	25.052
Phosphorus	mg/kg	n/v	n/v	n/v	-	690	730	-	-	-	-	-	-	-	-	-	-	690	730	710	710	720	728	28.3	20	2	2	0	0	749.2
Potassium	mg/kg	n/v	n/v	n/v	-	1,200	1,100	-	-	-	-	-	-	-	-	-	-	1100	1200	1150	1150	1175	1195	70.7	50	2	2	0	0	1248
Selenium	mg/kg	1	1	n/v	<0.50	<0.50	<0.50	-	-	-	-	-	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	3	0	3	0	0.5
Silver	mg/kg	20	20	n/v	<0.20	<0.20	<0.20	-	-	-	-	-	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0	0	3	0	3	0	0.2
Sodium	mg/kg	n/v	n/v	n/v	-	340	360	-	-	-	-	-	-	-	-	-	-	340	360	350	350	355	359	14.1	10	2	2	0	0	369.6
Strontium	mg/kg	n/v	n/v	n/v	-	71	71	-	-	-	-	-	-	-	-	-	-	71	71	71	71	71	71	0	0	2	2	0	0	71
Sulphur	mg/kg	n/v	n/v	n/v	-	540	520	-	-	-	-	-	-	-	-	-	-	520	540	530	530	535	539	14.1	10	2	2	0	0	549.6
Thallium	mg/kg	1	1	n/v	0.11	0.12	0.11	-	-	-	-	-	-	-	-	-	-	0.11	0.12	0.11	0.11	0.12	0.12	0.01	0	3	3	0	0	0.11
Tin	mg/kg	50	50	n/v	<1.0	<1.0	<1.0	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	0	0	3	0	3	0	1
Uranium	mg/kg	23	23	n/v	0.76	0.78	0.74	-	-	-	-	-	-	-	-	-	-	0.74	0.78	0.76	0.76	0.77	0.78	0.02	0.01	3	3	0	0	0.7796
Vanadium	mg/kg	130	130	n/v	23	30	27	-	-	-	-	-	-	-	-	-	-	23	30	26.7	27	28.5	29.7	3.5	2	3	3	0	0	30.62
Zinc	mg/kg	250	250	n/v	86	73	71	-	-	-	-	-	-	-	-	-	-	71	86	76.7	73	79.5	84.7	8.1	4.7	3	3	0	0	85.912

Notes:

CCME Canadian Council of Ministers of the Environment

A Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and fine grained soil

B Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and coarse grained soil

AENV Alberta Environment Salt Contamination Assessment and Remediation Guidelines, May 2001

C Table 2.2. Soil Quality Guidelines for Unrestricted Land Use

	Rating Category	Good	Fair	Poor	Unsuitable
Topsoil	EC	<2	2 to 4	4 to 8	>8
	SAR	<4	4 to 8	8 to 12	>12

6.5[A] Concentration exceeds the indicated standard.

15.2 Measured concentration did not exceed the indicated standard.

<0.50 Laboratory reporting limit was greater than the applicable standard.

<0.03 Analyte was not detected at a concentration greater than the laboratory reporting limit.

n/v No standard/guideline value.

- Parameter not analyzed / not available.

CD Detection limits raised due to dilution to bring analyte within the calibrated range.

Table B.2
Langley K-30 Sump Area
Water Sample Analytical Results: Reference Samples and Statistical Calculations
MGM Energy

			K-30									Statistical Calculations													
			Sump Reference Sample																						
Sample Location			K-30_REF_15-01	K-30_REF_15-04	K-30_REF_W3	K-30_REF_RW18-01	K-30_REF_RW18-01	K-30_REF_RW18-02	K-30-WS22-04	K-30-WS22-05	K-30-WS22-06															
Sample Date			20-Aug-15	20-Aug-15	20-Aug-16	29-Aug-18	29-Aug-18	29-Aug-18	22-Aug-22	22-Aug-22	22-Aug-22														
Sample ID			K30-15-01	K30-15-04	K30_SUMP_W3_AUG 2016	K30S-RW18-01	K30S-QCW18-01	K30S-RW18-02	K30-WS22-04	K30-WS22-05	K30-WS22-06														
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC														
Laboratory			MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	BV	BV	BV														
Laboratory Work Order			B573450	B573450	B673175	B875267	B875267	B875267	C264826	C264826	C264826														
Laboratory Sample ID			MZ0247	MZ0250	PJ3019	UF6599	UF6601	UF6600	BAP344	BAP345	BAP346														
Sample Type	**Units**	**CCME**					Field Duplicate					**Minimum**	**Maximum**	**Mean**	**Median**	**5th**	**25th**	**75th**	**90th**	**95th**	**Std. Dev.**	**Std. Err.**	**Geo. Mean**	**Count**	**Detect**	**ND**	**Exceed**
General Chemistry																											
Alkalinity (P as CaCO3)	mg/L	n/v	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	1	0.83	1	0.5	0.5	1	1	1	0.25	0.08	0.79	9	0	9	0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	350	120	460	350	350	240	240	240	260	120	460	302.2	350	168	240	350	372	416	98	32.7	285	9	9	0	0
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	1	0.83	1	0.5	0.5	1	1	1	0.25	0.08	0.79	9	0	9	0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	1	0.83	1	0.5	0.5	1	1	1	0.25	0.08	0.79	9	0	9	0
Alkalinity, Total (as CaCO3)	mg/L	n/v	280	100	370	290	290	290	200	200	210	100	370	247.8	280	140	200	290	306	338	78.4	26.1	234.2	9	9	0	0
Anion Sum	meq/L	n/v	14	3.3	44	18	19	13	-	-	-	3.3	44	18.6	16	5.7	13.2	18.8	31.5	37.8	13.7	5.6	14.4	6	6	0	0
Cation Sum	meq/L	n/v	14	3.5	45	19	19	15	-	-	-	3.5	45	19.2	17	6.1	14.2	19	32	38.5	13.8	5.6	15.1	6	6	0	0
Chloride	mg/L	120[A]	**230 CD[A]**	9.2	**1,300 CD[A]**	**380 CD[A]**	**410 CD[A]**	**240 CD[A]**	**290[A]**	**160[A]**	**270[A]**	9.2	1300	365.5	270	69.5	230	380	588	944	369.7	123.2	221.6	9	9	0	8
Electrical Conductivity, Lab	µS/cm	n/v	1,400	330	4,700	1,900	1,900	1,400	1,500	1,000	1,400	330	4700	1725.6	1400	598	1400	1900	2460	3580	1212	404	1417.1	9	9	0	0
Hardness (as CaCO3)	mg/L	n/v	420	150	760	410	420	380	370	290	330	150	760	392.2	380	206	330	420	488	624	162.3	54.1	363.6	9	9	0	0
Ion Balance	none	n/v	1.0	1.0	1.0	2.4	0.98	7.3	-	-	-	0.98	7.3	2.28	1	0.98	1	2.05	4.85	6.08	2.52	1.03	1.61	6	6	0	0
Ion Balance % Difference	%	n/v	-	-	-	-	-	-	3.3	1.6	3.0	1.6	3.3	2.6	3	1.7	2.3	3.2	3.2	3.3	0.9	0.5	2.5	3	3	0	0
Nitrate	mg/L	13[A]	<0.044	0.16	<0.044	<0.089	<0.089	<0.089	<0.044	<0.044	<0.044	0.044	0.16	0.072	0.044	0.044	0.044	0.089	0.103	0.132	0.04	0.013	0.064	9	1	8	0
Nitrate (as N)	mg/L	3.0[A]	<0.010	0.037	<0.010	<0.020	<0.020	<0.020	<0.010	<0.010	<0.010	0.01	0.037	0.016	0.01	0.01	0.01	0.02	0.023	0.03	0.009	0.003	0.015	9	1	8	0
Nitrate + Nitrite (as N)	mg/L	n/v	<0.020	0.037	<0.020	<0.020 XQ	<0.020 XQ	<0.020 XQ	<0.010	<0.010 MSE	<0.010	0.01	0.037	0.01855556	0.02	0.01	0.01	0.02	0.0234	0.0302	0.00844262	0.00281421	0.01699701	9	1	8	0
Nitrite	mg/L	0.2[n1][A]	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0	0	0.033	9	0	9	0
Nitrite (as N)	mg/L	0.06[A]	<0.010	<0.010	<0.010	<0.010 XQ	<0.010 XQ	<0.010 XQ	<0.010	<0.010	<0.010	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01	9	0	9	0
pH, lab	S.U.	6.5-9.0[A]	7.96	8.17	7.79	7.96	7.96	7.76	7.64	7.52	7.92	7.52	8.17	7.81	7.92	8.07	7.96	7.76	7.61	7.56	log	log	7.85	9	9	0	0
Sulfate	mg/L	n/v	90	50	31	57	60	33	140	91	100	31	140	72.4	60	31.8	50	91	108	124	35.6	11.9	64.8	9	9	0	0
Total Dissolved Solids	mg/L	n/v	770	180	2,500	990	1,000	750	830	570	770	180	2500	928.9	770	336	750	990	1300	1900	638.3	212.8	768.7	9	9	0	0
Metals - Dissolved																											
Calcium	mg/L	n/v	110	42	150	99	99	95	96	79	86	42	150	95.1	96	56.8	86	99	118	134	28.3	9.4	90.8	9	9	0	0
Iron	mg/L	n/v	<0.060	<0.060	0.091	0.079	0.084	2.6	<0.060	<0.060	<0.060	0.06	2.6	0.35	0.06	0.06	0.06	0.084	0.593	1.596	0.844	0.281	0.102	9	4	5	1
Magnesium	mg/L	n/v	34	12	93	40	41	34	32	23	27	12	93	37.3	34	16.4	27	40	51.4	72.2	22.7	7.6	32.6	9	9	0	0
Manganese	mg/L	0.46[EQ4][A]	<0.0040	<0.0040	**1.4[A]**	0.079	0.073	**0.47[A]**	0.033	0.044	<0.0040	0.004	1.4	0.2346	0.044	0.004	0.004	0.079	0.656	1.028	0.461	0.1537	0.0413	9	6	3	2
Potassium	mg/L	n/v	4.1	0.78	20	5.3	5.3	3.9	3.5	2.4	2.8	0.78	20	5.34	3.9	1.43	2.8	5.3	8.24	14.12	5.68	1.89	3.8	9	9	0	0
Sodium	mg/L	n/v	130	8.5	670 CD	230	240	170	150	97	150	8.5	670	205.1	150	43.9	130	230	326	498	187.5	62.5	135.3	9	9	0	0

Notes:

CCME	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
6.5[A]	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
EQ4	The long-term CWQG is found using the look-up table (see Table 5) or the CWQG and benchmark calculator is Appendix B of CCME (2019). The guideline was derived using a mean hardness of 392 mg/L.
n1	Guideline is expressed as Nitrite (as N) in ug/L. This value is equivalent to 197 ug/L for Nitrite.
CD	Detection limits raised due to dilution to bring analyte within the calibrated range.
MSE	Matrix spike exceeds acceptance limits due to probable matrix interference.
XQ	Sample was analyzed after holding time expired.

Table B.3
Langley K-30 Sump Area
Summary of Water Analytical Results
MGM Energy

			K-30																								
			South Bare Area	North of Sump	East Sump					South of Sump	West Depression Area																
Sample Location			K30-WS24-01	K30-WS24-03	K30_East_Sump_WS1	K30_East_Sump_WS3	K30_East_Sump_WS4	K30_Sump_SW18-03	K30-WS24-04	K30_Sump_SW18-02	K30_Sump_WS21-04	K30-WS22-01	K30-WS22-02	K30-WS22-03	K30-WS23-01	K30_Sump_15-02	K30_Sump_15-03	K30_Sump_W1	K30_Sump_W2	K30_Sump_WS6	K30_Sump_WS7	K30_Sump_WS7	K30_Sump_SW18-01	K30_Sump_WS21-01	K30_Sump_WS21-02	K30_Sump_WS21-03
Sample Date			19-Sep-24	19-Sep-24	17-Aug-17	17-Aug-17	17-Aug-17	29-Aug-18	19-Sep-24	29-Aug-18	25-Aug-21	22-Aug-22	22-Aug-22	22-Aug-22	27-Aug-23	20-Aug-15	20-Aug-15	20-Aug-16	20-Aug-16	17-Aug-17	17-Aug-17	17-Aug-17	29-Aug-18	25-Aug-21	25-Aug-21	25-Aug-21
Sample ID			K30-WS24-01	K30-WS24-03	K30_SUMP_AUG_WS1	K30_SUMP_AUG_WS3	K30_SUMP_AUG_WS4	K30S-SW18-03	K30-WS24-04	K30S-SW18-02	K30-WS21-04	K30-WS22-01	K30-WS22-02	K30-WS22-03	K30-WS23-01	K30-15-02	K30-15-03	K30_SUMP_W1_AUG2016	K30_SUMP_W2_AUG2016	K30_SUMP_AUG_WS6	K30_SUMP_AUG_WS7	K30_SUMP_AUG_QA1	K30S-SW18-01	K30-WS21-01	K30-WS21-02	K30-WS21-03
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC
Laboratory			BV	BV	MAXX	MAXX	MAXX	MAXX	BV	MAXX	BV	BV	BV	BV	BV	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	BV	BV	BV
Laboratory Work Order			C475537	C475537	B771681	B771681	B771681	B875267	C475537	B875267	C163712	C264826	C264826	C264826	C367995	B573450	B573450	B673175	B673175	B771681	B771681	B771681	B771681	B875267	C163712	C163712	C163712
Laboratory Sample ID	**Units**	**CCME**	CWF059	CWF061	RU4356	RU4357	RU4358	UF6598	CWF062	UF6597	AEU757	BAP341	BAP342	BAP343	BXY222	MZ0248	MZ0249	PJ3017	PJ3018	RU4360	RU4362	RU4361	UF6596	AEU754	AEU755	AEU756
General Chemistry																											
Alkalinity (P as CaCO3)	mg/L	n/v	<1.0	<1.0	<0.50	<0.50	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	110	410	170	200	-	360	350	350	210	200	250	240	270	390	220	370	330	250	210	200	330	310	310	310
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<1.0	<1.0	<0.50	<0.50	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<1.0	<1.0	<0.50	<0.50	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Total (as CaCO3)	mg/L	n/v	92	330	140	160	-	290	290	290	180	160	210	190	220	320	180	300	270	210	170	170	270	250	250	250
Anion Sum	meq/L	n/v	-	-	61	96	-	16	-	18	-	-	-	-	-	71	49	62	49	59	58	45	36	-	-	-
Cation Sum	meq/L	n/v	-	-	64	100	-	17	-	20	-	-	-	-	-	74	49	63	49	63	60	47	43	-	-	-
Chloride	mg/L	120	**680[A]**	**1,900[A]**	**1,300 CD[A]**	**2,500 CD[A]**	-	**350 CD[A]**	**1,900[A]**	**400 CD[A]**	**2,300[A]**	**220[A]**	89	120	**1,600[A]**	**1,900 CD[A]**	**1,200 CD[A]**	**1,700 CD[A]**	**1,300 CD[A]**	**1,300 CD[A]**	**1,500 CD[A]**	**960 CD[A]**	**940 CD[A]**	**1,900[A]**	**1,900[A]**	**1,400[A]**
Electrical Conductivity, Lab	µS/cm	n/v	2,900	6,200	5,700	9,300	-	1,800	6,300	1,900	8,300	1,200	780	860	6,200	7,100	4,800	6,300	5,000	5,600	5,800	4,400	4,100	7,100	7,000	5,600
Hardness (as CaCO3)	mg/L	n/v	810	1,200	1,900	2,000	-	430	1,000	570	3,700	480	290	350	2,300	2,500	1,600	1,600	1,200	1,800	2,000	1,400	1,400	2,600	2,500	1,800
Ion Balance	none	n/v	-	-	2.6	2.2	-	0.86	-	3.0	-	-	-	-	-	1.0	1.0	1.0	1.0	2.6	2.1	2.9	8.4	-	-	-
Ion Balance % Difference	%	n/v	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate	mg/L	13	0.35	1.8	-	-	-	-	0.46	-	5.4	5.4	3.8	2.4	0.31	-	-	-	-	-	-	-	-	1.5	1.7	0.77
Nitrate (as N)	mg/L	3.0	<0.22	<0.044	<0.22	13	-	<0.089	<0.044	<0.089	<0.44	<0.044	<0.044	<0.044	1.4	<0.044	<0.044	0.096	<0.044	<0.22	<0.22	<0.044	<0.089	<0.44	<0.44	<0.22
Nitrate + Nitrite (as N)	mg/L	n/v	<0.050	<0.010	<0.050 MI	2.9	-	<0.020	<0.010	<0.020	<0.10	<0.010	<0.010	<0.010	0.32	<0.020	<0.010	0.022	<0.010	<0.050 MI	<0.050 MI	<0.010	<0.020	<0.10	<0.10	<0.050
Nitrite	mg/L	0.197$_{t1}$	<0.050 MI	<0.010	<0.071	2.9	-	<0.020 XQ	<0.010	<0.020 XQ	<0.10 MI	<0.010	<0.010	<0.010	0.32 MI	<0.020	<0.010	0.022	<0.010	<0.071	<0.071	<0.014	<0.020 XQ	<0.10 MI	<0.10 MI	<0.050 MI
Nitrite (as N)	mg/L	0.06	<0.010	<0.010	<0.050 MI	<0.010	-	<0.010 XQ	<0.010	<0.010 XQ	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.050 MI	<0.050 MI	<0.010	<0.010 XQ	<0.010	<0.010	<0.010
pH, lab	S.U.	6.5-9.0	6.62	7.30	7.55	7.45	-	7.77	7.52	7.74	7.49	7.52	7.44	7.51	7.31	7.34	7.87	7.95	8.01	7.72	7.43	7.60	7.82	7.75	7.66	7.80
Sulfate	mg/L	n/v	330	91	1,100 CD	1,100 CD	-	30	62	67	840	93	77	80	650	520 CD	540 CD	380 CD	310 CD	840 CD	530 CD	680 CD	210 CD	630	650	460
Total Dissolved Solids	mg/L	n/v	1,600	3,500	3,700	5,800	-	900	3,400	1,000	5,300	670	440	500	3,700	4,200	2,900	3,600	2,800	3,600	3,400	2,700	2,200	4,400	4,300	3,200
Metals - Dissolved																											
Calcium	mg/L	n/v	230	260	540 CD	480	-	110	200	150	1,100	140	83	100	690	740 CD	440	400	300	490	550 CD	380	410	790	750	490
Iron	mg/L	n/v	<0.060	0.080	0.094	0.084	-	1.7	0.084	1.3	0.19	<0.060	<0.060	<0.060	<0.060	<0.060	0.18	<0.060	<0.060	0.092	0.076	0.14	0.33	0.062	<0.060	<0.060
Magnesium	mg/L	n/v	57	140	140	190	-	39	130	49	230	32	19	24	140	170	110	140	120	140	150	100	160	160	160	140
Manganese	mg/L	0.46$_{pH4}$	<0.0040	**1.8[A]**	0.10	0.018	-	0.39	**1.4[A]**	0.20	0.23	0.27	0.059	0.092	0.17	**2.2[A]**	0.0043	0.087	0.010	0.28	0.11	0.24	**1.8[A]**	**2.0[A]**	**1.2[A]**	0.19
Potassium	mg/L	n/v	24	28	24	28	-	7.6	30	5.2	300	31	6.7	16	220	280	200	180	170	50	150	32	170	360	360	210
Sodium	mg/L	n/v	260	810	580 CD	1,400 CD	-	180	910	180	350	57	40	46	260	370	300	610 CD	470	580 CD	390	430	230	320	320	340
Metals - Total																											
Aluminum	mg/L	0.100$_{pH5}$	0.073	0.056	-	-	-	-	0.0088	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	mg/L	n/v	<0.00060	<0.00060	-	-	-	-	<0.00060	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	mg/L	n/v	0.00036	0.00099	-	-	-	-	0.0013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium	mg/L	n/v	0.086	0.57	-	-	-	-	0.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	mg/L	n/v	<0.0010	<0.0010	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/L	1.5	0.16	0.25	-	-	-	-	0.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	mg/L	0.00037$_{t TO}$	0.000060	0.00018	-	-	-	-	0.000025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	mg/L	n/v	230	270	-	-	-	-	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	mg/L	n/v	<0.0010	<0.0010	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	mg/L	n/v	<0.00030	0.0046	-	-	-	-	0.0016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	mg/L	0.004$_{BC1,+}$	0.0027	0.0029	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	mg/L	0.3	0.15 MSE	**8.1[A]**	-	-	-	-	**7.3[A]**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	mg/L	0.007$_{BC1,\#}$	0.00062	<0.00020	-	-	-	-	<0.00020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lithium	mg/L	n/v	0.021	0.037	-	-	-	-	0.037	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	mg/L	n/v	57	150	-	-	-	-	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	mg/L	n/v	0.011	1.7	-	-	-	-	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	mg/L	0.073	0.00049	0.00095	-	-	-	-	0.00084	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	mg/L	0.150$_{pH7+}$^{A}	0.0017	0.0070	-	-	-	-	0.0030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus	mg/L	n/v	<0.10 MSE	<0.10	-	-	-	-	<0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	mg/L	n/v	24 MSE	29	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/L	n/v	<0.00020	0.00024	-	-	-	-	<0.00020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silicon	mg/L	n/v	0.66	2.4	-	-	-	-	0.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	mg/L	0.00025	<0.00010	<0.00010	-	-	-	-	<0.00010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	n/v	270	810	-	-	-	-	860	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	mg/L	n/v	0.89	1.6	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur	mg/L	n/v	130	32	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/L	0.0008	<0.00020	<0.00020	-	-	-	-	<0.00020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/L	n/v	<0.0010	<0.0010	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	mg/L	n/v	0.0014	0.0017	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	mg/L	0.015	0.00067	0.0011	-	-	-	-	0.00040	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	mg/L	n/v	<0.0010	<0.0010	-	-	-	-	<0.0010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/L	0.033$_{pH7+}$^{A}	<0.0030	0.0050	-	-	-	-	<0.0030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BTEX and Petroleum Hydrocarbons																											
Benzene	µg/L	370	<0.40	<0.40	-	-	<0.40	-	<0.40	-	-	<0.40	<0.40	<0.40	<0.40	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Toluene	µg/L	2	<0.40	<0.40	-	-	<0.40	-	<0.40	-	-	<0.40	<0.40	<0.40	<0.40	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Ethylbenzene	µg/L	90	<0.40	<0.40	-	-	<0.40	-	<0.40	-	-	<0.40	<0.40	<0.40	<0.40	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Xylene, m & p-	µg/L	n/v	<0.80	<0.80	-	-	<0.80	-	<0.80	-	-	<0.80	<0.80	<0.80	<0.80	-	-	-	-	-	-	-	-	<0.80	<0.80	<0.80
Xylene, o-	µg/L	n/v	<0.40	<0.40	-	-	<0.40	-	<0.40	-	-	<0.40	<0.40	<0.40	<0.40	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Xylenes, Total	µg/L	n/v	<0.89	<0.89	-	-	<0.80	-	<0.89	-	-	<0.89	<0.89	<0.89	<0.89	-	-	-	-	-	-	-	-	<0.89	<0.89	<0.89
PHC F1 (C6-C10 range)	µg/L	n/v	<100	<100	-	-	<100	-	<100	-	-	<100	<100	<100	<100	-	-	-	-	-	-	-	-	<100	<100	<100
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	<100	<100	-	-	<100	-	<100	-	-	<100	<100	<100	<100	-	-	-	-	-	-	-	-	<100	<100	<100
PHC F2 (>C10-C16 range)	mg/L	n/v	<0.10	<0.10	-	-	<0.13 VV	-	<0.10	-	-	<0.10	<0.10	<0.10	<0.100	-	-	-	-	-	-	-	-	<0.10	<0.10	<0.10
Polycyclic Aromatic Hydrocarbons																											
Acenaphthene	µg/L	5.8	-	-	-	-	<0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	µg/L	n/v	-	-	-	-	<0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acridine	µg/L	4.4	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	µg/L	0.012	-	-	-	-	***<0.013***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	µg/L	0.018	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	µg/L	0.015	-	-	-	-	<0.0099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene Total Potency Equivalents	µg/L	n/v	-	-	-	-	0.012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)pyridine (Quinoline)	µg/L	3.4	-	-	-	-	<0.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	µg/L	n/v	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(c)phenanthrene	µg/L	n/v	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(e)pyrene	µg/L	n/v	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	µg/L	n/v	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	µg/L	n/v	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	µg/L	n/v	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzo(a,h)anthracene	µg/L	n/v	-	-	-	-	<0.0099	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	µg/L	0.04	-	-	-	-	<0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	µg/L	3	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	µg/L	n/v	-	-	-	-	<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylnaphthalene, 2-	µg/L	n/v	-	-	-	-	<0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	µg/L	1.1	-	-	-	-	<0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perylene	µg/L	n/v	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	µg/L	0.4	-	-	-	-	<0.066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	µg/L	0.025	-	-	-	-	***<0.026***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B.3
Langley K-30 Sump Area
Summary of Water Analytical Results
MGM Energy

Sample Location			**K30-WS24-02**
Sample Date			**19-Sep-24**
Sample ID			**K30-WS24-02**
Sampling Company			**STANTEC**
Laboratory			**BV**
Laboratory Work Order			**C475537**
Laboratory Sample ID	**Units**	**CCME**	**CWF060**
General Chemistry			
Alkalinity (P as CaCO3)	mg/L	n/v	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	290
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<1.0
Alkalinity, Total (as CaCO3)	mg/L	n/v	240
Anion Sum	meq/L	n/v	-
Cation Sum	meq/L	n/v	-
Chloride	mg/L	120	**1,100**[A]
Electrical Conductivity, Lab	µS/cm	n/v	3,900
Hardness (as CaCO3)	mg/L	n/v	720
Ion Balance	none	n/v	-
Ion Balance % Difference	%	n/v	1.9
Nitrate	mg/L	13	<1.1
Nitrate (as N)	mg/L	3.0	<0.25
Nitrate + Nitrite (as N)	mg/L	n/v	<0.25 MI
Nitrite	mg/L	0.197_{nl}	<0.033
Nitrite (as N)	mg/L	0.06	<0.010
pH, lab	S.U.	6.5-9.0	7.57
Sulfate	mg/L	n/v	110
Total Dissolved Solids	mg/L	n/v	2,100
Metals - Dissolved			
Calcium	mg/L	n/v	150
Iron	mg/L	n/v	0.10
Magnesium	mg/L	n/v	83
Manganese	mg/L	0.46_{SO4}	**0.48**[A]
Potassium	mg/L	n/v	32
Sodium	mg/L	n/v	480
Metals - Total			
Aluminum	mg/L	0.100_{pH5}	**0.11**[A]
Antimony	mg/L	n/v	<0.00060
Arsenic	mg/L	n/v	0.00094
Barium	mg/L	n/v	0.27
Beryllium	mg/L	n/v	<0.0010
Boron	mg/L	1.5	0.20
Cadmium	mg/L	0.00037_{hTO}	0.000041
Calcium	mg/L	n/v	150
Chromium	mg/L	n/v	<0.0010
Cobalt	mg/L	n/v	0.00057
Copper	mg/L	0.004_{SCI+}	0.0028
Iron	mg/L	0.3	**0.77**[A]
Lead	mg/L	$0.007_{hSCI\ \#}$	<0.00020
Lithium	mg/L	n/v	0.026
Magnesium	mg/L	n/v	82
Manganese	mg/L	n/v	0.61
Molybdenum	mg/L	0.073	0.0011
Nickel	mg/L	0.150_{hCrT+}[A]	0.0031
Phosphorus	mg/L	n/v	<0.10
Potassium	mg/L	n/v	31
Selenium	mg/L	n/v	0.00020
Silicon	mg/L	n/v	1.2
Silver	mg/L	0.00025	<0.00010
Sodium	mg/L	n/v	470
Strontium	mg/L	n/v	0.91
Sulfur	mg/L	n/v	37
Thallium	mg/L	0.0008	<0.00020
Tin	mg/L	n/v	<0.0010
Titanium	mg/L	n/v	0.0037
Uranium	mg/L	0.015	0.00090
Vanadium	mg/L	n/v	<0.0010
Zinc	mg/L	0.033_{pH7}[A]	<0.0030
BTEX and Petroleum Hydrocarbons			
Benzene	µg/L	370	<0.40
Toluene	µg/L	2	<0.40
Ethylbenzene	µg/L	90	<0.40
Xylene, m & p-	µg/L	n/v	<0.80
Xylene, o-	µg/L	n/v	<0.40
Xylenes, Total	µg/L	n/v	<0.89
PHC F1 (C6-C10 range)	µg/L	n/v	<100
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	<100
PHC F2 (>C10-C16 range)	mg/L	n/v	<0.10
Polycyclic Aromatic Hydrocarbons			
Acenaphthene	µg/L	5.8	-
Acenaphthylene	µg/L	n/v	-
Acridine	µg/L	4.4	-
Anthracene	µg/L	0.012	-
Benzo(a)anthracene	µg/L	0.018	-
Benzo(a)pyrene	µg/L	0.015	-
Benzo(a)pyrene Total Potency Equivalents	µg/L	n/v	-
Benzo(b)pyridine (Quinoline)	µg/L	3.4	-
Benzo(b/j)fluoranthene	µg/L	n/v	-
Benzo(c)phenanthrene	µg/L	n/v	-
Benzo(e)pyrene	µg/L	n/v	-
Benzo(g,h,i)perylene	µg/L	n/v	-
Benzo(k)fluoranthene	µg/L	n/v	-
Chrysene	µg/L	n/v	-
Dibenzo(a,h)anthracene	µg/L	n/v	-
Fluoranthene	µg/L	0.04	-
Fluorene	µg/L	3	-
Indeno(1,2,3-cd)pyrene	µg/L	n/v	-
Methylnaphthalene, 2-	µg/L	n/v	-
Naphthalene	µg/L	1.1	-
Perylene	µg/L	n/v	-
Phenanthrene	µg/L	0.4	-
Pyrene	µg/L	0.025	-

Table B.3
Langley K-30 Sump Area
Summary of Water Analytical Results
MGM Energy

Notes:

CCME	Canadian Council of Ministers of the Environment
A	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
6.5[A]	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/quideline value.
-	Parameter not analyzed / not available.
EQ2	The long-term CWQG is for dissolved zinc and is calculated using the following equation: CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). The zinc guideline was derived using of a mean hardness of 392 mg CaCO3·L−1 and mean pH of 7.81 and DOC of 0.5 mg·L−1. The mean values are from the background reference chemistry.
FC14	The long-term CWQG for dissolved manganese is found using the look-up table (see Table 5) or the CWQG and benchmark calculator is Appendix B of CCME (2019). The guideline was derived using a mean hardness of 392 mg/L. The mean values are from the background reference chemistry.
LTG	The CWQG for cadmium (i.e. long-term guideline) of 0.09 µg·L-1 is for waters of 50 mg CaCO3·L-1 hardness. The CWQG for cadmium is related to water hardness (as CaCO3): When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L; at hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation (CWQG (µg/L) = 10^[0.83(log[hardness]) – 2.46]); At hardness > 280 mg/L, the CWQG is 0.37 µg/L. A mean hardness of 392 mg/L was used. The mean values are from the background reference chemistry.
n1	Guideline is expressed as Nitrite (as N) in ug/L. This value is equivalent to 197 ug/L for Nitrite.
TR11,8	The CWQG for lead is related to water hardness. When the hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L. At hardness >60 to ≤180 mg/L the CWQG is calculated using this equation: CWQG (µg/L)= e∥.273[ln(hardness)]4.705∖. At hardness >180 mg/L, the CWQG is 7 µg/L. A mean hardness of392 mg/L was used. The mean values are from the background reference chemistry.
TEC1,7	The CWQG for copper and nickel is related to water hardness. A mean hardness of 392 mg/L was used. The mean values are from the background reference chemistry.
VAR5	Variable, 5 µg/L if pH < 6.5 and 100 µg/L if pH > 6.5. A mean pH of 7.81 was used. The mean values are from the background reference chemistry.
CD	Detection limits raised due to dilution to bring analyte within the calibrated range.
MI	Detection limits raised due to matrix interference.
MSE	Matrix spike exceeds acceptance limits due to probable matrix interference.
VV	Detection limit raised based on sample volume used for analysis.
XQ	Sample was analyzed after holding time expired.
RPD	Relative Percent Difference.
61%	RPD exceeds data quality objective of 40%.
nc	RPD is not calculated if one or more values is non detect or if one or more values is less than five times the reportable detection limit.

Table B.4
Summary of Wellsite Soil Sample Analytical Results: Reference Samples and Statistical Calculations
Langley K-30 Wellsite
MGM Energy Corporation

Location		CCME		AENV SCARG Rating Categories	K-30 Wellsite		Statistical Calculations													
Sample Date					17-Aug-17	17-Aug-17														
Sample ID					K30_WELLSS1	K30_WELLSS2														
Sampling Company					STANTEC	STANTEC														
Laboratory		Residential/Parkland Use			MAXX	MAXX														
Laboratory Work Order					B773981	B773981														
Laboratory Sample ID		Fine	Coarse	Table 2.2 Topsoil	RV7298	RV7297														
Sample Type	Units	A	B	C			Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	Exceed	95 UCLM
General Chemistry																				
Soluble (CaCl2) pH	S.U.	6-8	6-8	n/v	7.67	7.81	7.67	7.81	7.73	7.73	7.7	7.68	log	log	7.74	2	2	0	0	NC
Soluble Conductivity	dS/m	2	2	Fair	**2.3**[AB]	**2.8**[AB]	2.3	2.8	2.6	2.6	2.7	2.8	0.4	0.2	2.5	2	2	0	2	2.992
Sodium Adsorption Ratio (SAR)	none	5	5	Fair	**6.0**[AB]	**8.2**[AB]	6	8.2	7.1	7.1	7.6	8.1	1.6	1.1	7	2	2	0	2	9.256
Calcium	mg/kg	n/v	n/v	n/v	58	70	58	70	64	64	67	69.4	8.5	6	63.7	2	2	0	0	75.76
Calcium	mg/L	n/v	n/v	n/v	120	140	120	140	130	130	135	139	14.1	10	129.6	2	2	0	0	149.6
Cation/EC Ratio	none	n/v	n/v	n/v	10	9.8	9.8	10	9.9	9.9	10	10	0.1	0.1	9.9	2	2	0	0	10.096
Chloride	mg/kg	n/v	n/v	n/v	240	340	240	340	290	290	315	335	70.7	50	285.7	2	2	0	0	388
Chloride	mg/L	n/v	n/v	n/v	490 CD	680 CD	490	680	585	585	632.5	670.5	134.4	95	577.2	2	2	0	0	771.2
Ion Balance	none	n/v	n/v	n/v	1.3	1.1	1.1	1.3	1.2	1.2	1.2	1.3	0.1	0.1	1.2	2	2	0	0	1.396
Magnesium	mg/kg	n/v	n/v	n/v	20	14	14	20	17	17	18.5	19.7	4.2	3	16.7	2	2	0	0	22.88
Magnesium	mg/L	n/v	n/v	n/v	41	27	27	41	34	34	37.5	40.3	9.9	7	33.3	2	2	0	0	47.72
Moisture Content	%	n/v	n/v	n/v	26	35	26	35	30.5	30.5	32.8	34.6	6.4	4.5	30.2	2	2	0	0	39.32
Percent Saturation	%	n/v	n/v	n/v	48	50	48	50	49	49	49.5	49.9	1.4	1	49	2	2	0	0	50.96
Potassium	mg/kg	n/v	n/v	n/v	13	3.8	3.8	13	8.4	8.4	10.7	12.5	6.5	4.6	7	2	2	0	0	17.416
Potassium	mg/L	n/v	n/v	n/v	26	7.7	7.7	26	16.8	16.8	21.4	25.1	12.9	9.1	14.1	2	2	0	0	34.636
Sodium	mg/kg	n/v	n/v	n/v	140	200	140	200	170	170	185	197	42.4	30	167.3	2	2	0	0	228.8
Sodium	mg/L	n/v	n/v	n/v	300	410	300	410	355	355	382.5	404.5	77.8	55	350.7	2	2	0	0	462.8
Sulphate	mg/kg	n/v	n/v	n/v	79	110	79	110	94.5	94.5	102.2	108.4	21.9	15.5	93.2	2	2	0	0	124.88
Sulphate	mg/L	n/v	n/v	n/v	170	220	170	220	195	195	207.5	217.5	35.4	25	193.4	2	2	0	0	244
Theoretical Gypsum Requirement	tons/ha	n/v	n/v	n/v	0.92	2.5	0.92	2.5	1.71	1.71	2.1	2.42	1.12	0.79	1.52	2	2	0	0	3.2584
Physical Properties																				
Percent Sand	%	n/v	n/v	n/v	11	11	11	11	11	11	11	11	0	0	11	2	2	0	0	11
Percent Silt	%	n/v	n/v	n/v	81	82	81	82	81.5	81.5	81.8	82	0.7	0.5	81.5	2	2	0	0	82.48
Percent Clay	%	n/v	n/v	n/v	8.1	7.8	7.8	8.1	8	8	8	8.1	0.2	0.1	7.9	2	2	0	0	8.196
Texture	none	n/v	n/v	n/v	SILT	SILT														
Sieve - Pan	%	n/v	n/v	n/v	98	98	98	98	98	98	98	98	0	0	98	2	2	0	0	98
Sieve - #200 (>0.075mm)	%	n/v	n/v	n/v	1.8	2.0	1.8	2	1.9	1.9	2	2	0.1	0.1	1.9	2	2	0	0	2.096
Grain Size	%	n/v	n/v	n/v	FINE	FINE														

Notes:

CCME — Canadian Council of Ministers of the Environment

[A] Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and fine grained soil

[B] Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and coarse grained soil

AENV — Alberta Environment Salt Contamination Assessment and Remediation Guidelines, May 2001

[C] Table 2.2. Soil Quality Guidelines for Unrestricted Land Use

	Rating Category	Good	Fair	Poor	Unsuitable
Topsoil	EC	<2	2 to 4	4 to 8	>8
	SAR	<4	4 to 8	8 to 12	>12

6.5[A] Concentration exceeds the indicated standard.

15.2 Measured concentration did not exceed the indicated standard.

<0.50 Laboratory reporting limit was greater than the applicable standard.

<0.03 Analyte was not detected at a concentration greater than the laboratory reporting limit.

n/v No standard/guideline value.

\- Parameter not analyzed / not available.

CD Detection limits raised due to dilution to bring analyte within the calibrated range.

Table B.5
Summary of Sump Soil Sample Analytical Results: Reference Samples and Statistical Calculations - Organic Soils
Kumak I-25 Sump
MGM Energy Corporation

Location					I-25 / M-45 Sump															
Sample Date		CCME		AENV SCARG Rating Categories	15-Aug-17	15-Aug-17	Statistical Calculations													
Sample ID					I25_SUMP_AUG_SS1	I25_SUMP_AUG_SS2														
Sample Depth		Residential/Parkland Use			0 - 0.25 m	0 - 0.25 m														
Sampling Company					STANTEC	STANTEC														
Laboratory					MAXX	MAXX														
Laboratory Work Order					B771691	B771691														
Laboratory Sample ID		Fine	Coarse	Table 2.2 Topsoil [C]	RU4428	RU4429														
Sample Type	Units	[A]	[B]				Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	#REF!	95 UCLM
General Chemistry																				
Soluble (CaCl2) pH	S.U.	6-8	6-8	n/v	**4.92 HV[AB]**	**3.97 HV[AB]**	3.97	4.92	4.22485	4.22485	4.07899	3.98972	log	log	4.445	2	2	0	2	NC
Soluble Conductivity	dS/m	2	2	Good	0.24	0.14	0.14	0.24	0.19	0.19	0.22	0.24	0.07	0.05	0.18	2	2	0	0	0.288
Sodium Adsorption Ratio (SAR)	none	5	5	Good	0.69	0.71	0.69	0.71	0.7	0.7	0.7	0.71	0.01	0.01	0.7	2	2	0	0	0.7196
Calcium	mg/kg	n/v	n/v	n/v	110	71	71	110	90.5	90.5	100.2	108	27.6	19.5	88.4	2	2	0	0	128.72
Calcium	mg/L	n/v	n/v	n/v	20	8.1	8.1	20	14	14	17	19.4	8.4	6	12.7	2	2	0	0	25.76
Cation/EC Ratio	none	n/v	n/v	n/v	13	13	13	13	13	13	13	13	0	0	13	2	2	0	0	13
Chloride	mg/kg	n/v	n/v	n/v	110	110	110	110	110	110	110	110	0	0	110	2	2	0	0	110
Chloride	mg/L	n/v	n/v	n/v	20	12	12	20	16	16	18	19.6	5.7	4	15.5	2	2	0	0	23.84
Ion Balance	none	n/v	n/v	n/v	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	0	0	2.6	2	2	0	0	2.6
Magnesium	mg/kg	n/v	n/v	n/v	57	43	43	57	50	50	53.5	56.3	9.9	7	49.5	2	2	0	0	63.72
Magnesium	mg/L	n/v	n/v	n/v	10	4.9	4.9	10	7.4	7.4	8.7	9.7	3.6	2.6	7	2	2	0	0	12.496
Moisture Content	%	n/v	n/v	n/v	73	88	73	88	80.5	80.5	84.2	87.2	10.6	7.5	80.1	2	2	0	0	95.2
Organic Matter	%	n/v	n/v	n/v	55	67	55	67	61	61	64	66.4	8.5	6	60.7	2	2	0	0	72.76
Percent Saturation	%	n/v	n/v	n/v	550	880	550	880	715	715	797.5	863.5	233.3	165	695.7	2	2	0	0	1038.4
Potassium	mg/kg	n/v	n/v	n/v	110	130	110	130	120	120	125	129	14.1	10	119.6	2	2	0	0	139.6
Potassium	mg/L	n/v	n/v	n/v	21	15	15	21	18	18	19.5	20.7	4.2	3	17.7	2	2	0	0	23.88
Sodium	mg/kg	n/v	n/v	n/v	84	91	84	91	87.5	87.5	89.2	90.6	4.9	3.5	87.4	2	2	0	0	94.36
Sodium	mg/L	n/v	n/v	n/v	15	10	10	15	12.5	12.5	13.8	14.8	3.5	2.5	12.2	2	2	0	0	17.4
Sulphate	mg/kg	n/v	n/v	n/v	160	130	130	160	145	145	152.5	158.5	21.2	15	144.2	2	2	0	0	174.4
Sulphate	mg/L	n/v	n/v	n/v	30	15	15	30	22.5	22.5	26.2	29.2	10.6	7.5	21.2	2	2	0	0	37.2
Theoretical Gypsum Requirement	tons/ha	n/v	n/v	n/v	<0.20	<0.20	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0.2	2	0	2	0	0.2
Total Organic Carbon	%	n/v	n/v	n/v	32	39	32	39	35.5	35.5	37.2	38.6	4.9	3.5	35.3	2	2	0	0	42.36
Physical Properties																				
Sieve - Pan	%	n/v	n/v	n/v	65	21	21	65	43	43	54	62.8	31.1	22	36.9	2	2	0	0	86.12
Sieve - #200 (>0.075mm)	%	n/v	n/v	n/v	35	79	35	79	57	57	68	76.8	31.1	22	52.6	2	2	0	0	100.12
Grain Size	%	n/v	n/v	n/v	FINE	COARSE														

Notes:

CCME — Canadian Council of Ministers of the Environment

[A] Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and fine grained soil

[B] Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and coarse grained soil

AENV — Alberta Environment Salt Contamination Assessment and Remediation Guidelines, May 2001

[C] Table 2.2. Soil Quality Guidelines for Unrestricted Land Use

	Rating Category	Good	Fair	Poor	Unsuitable
Topsoil	EC	<2	2 to 4	4 to 8	>8
	SAR	<4	4 to 8	8 to 12	>12

6.5[A] Concentration exceeds the indicated standard.

15.2 Measured concentration did not exceed the indicated standard.

<0.50 Laboratory reporting limit was greater than the applicable standard.

<0.03 Analyte was not detected at a concentration greater than the laboratory reporting limit.

n/v No standard/guideline value.

\- Parameter not analyzed / not available.

HV Due to high absorbtivity of the sample, the water soil extraction ratio has changed from 2:1 to 10:1

Table B.6
Summary of Water Analytical Results: Reference Samples and Statistical Calculations
Kumak I-25 Sump
MGM Energy

			I-25																	
			Sump Reference Sample																	
Sample Location			I-25_REF_RW18-01	I-25_REF_RW18-02																
Sample Date			26-Aug-18	26-Aug-18																
Sample ID			I25S-RW18-01	I25S-RW18-02																
Sampling Company			STANTEC	STANTEC																
Laboratory			MAXX	MAXX																
Laboratory Work Order			B874000	B874000																
Laboratory Sample ID	**Units**	**CCME**	UE9379	UE9380	**Statistical Calculations**															
					Minimum	**Maximum**	**Mean**	**Median**	**5th**	**25th**	**75th**	**90th**	**95th**	**Std. Dev.**	**Std. Err.**	**Geo. Mean**	**Count**	**Detect**	**ND**	**Exceed**
General Chemistry																				
Alkalinity (P as CaCO3)	mg/L	n/v	<1.0	<1.0	1	1	1	1	1	1	1	1	1	0	0	1	2	0	2	0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	4.0	1.9	1.9	4	3	3	2	2.4	3.5	3.8	3.9	1.5	1	2.8	2	2	0	0
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<1.0	<1.0	1	1	1	1	1	1	1	1	1	0	0	1	2	0	2	0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<1.0	<1.0	1	1	1	1	1	1	1	1	1	0	0	1	2	0	2	0
Alkalinity, Total (as CaCO3)	mg/L	n/v	3.3	1.6	1.6	3.3	2.4	2.4	1.7	2	2.9	3.1	3.2	1.2	0.9	2.3	2	2	0	0
Anion Sum	meq/L	n/v	0.23	0.15	0.15	0.23	0.19	0.19	0.15	0.17	0.21	0.22	0.23	0.06	0.04	0.19	2	2	0	0
Cation Sum	meq/L	n/v	0.56	0.47	0.47	0.56	0.52	0.52	0.47	0.49	0.54	0.55	0.56	0.06	0.04	0.51	2	2	0	0
Chloride	mg/L	120[A]	4.6	4.3	4.3	4.6	4.4	4.4	4.3	4.4	4.5	4.6	4.6	0.2	0.1	4.4	2	2	0	0
Electrical Conductivity, Lab	µS/cm	n/v	46	37	37	46	41.5	41.5	37.4	39.2	43.8	45.1	45.6	6.4	4.5	41.3	2	2	0	0
Hardness (as CaCO3)	mg/L	n/v	18	16	16	18	17	17	16.1	16.5	17.5	17.8	17.9	1.4	1	17	2	2	0	0
Ion Balance	none	n/v	42	51	42	51	46.5	46.5	42.4	44.2	48.8	50.1	50.6	6.4	4.5	46.3	2	2	0	0
Nitrate	mg/L	13[A]	<0.044	<0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0	0	0.044	2	0	2	0
Nitrate (as N)	mg/L	3.0[A]	<0.010	<0.010	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01	2	0	2	0
Nitrate + Nitrite (as N)	mg/L	n/v	<0.014	<0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0	0	0.014	2	0	2	0
Nitrite	mg/L	0.20_{n1}[A]	<0.033	<0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0	0	0.033	2	0	2	0
Nitrite (as N)	mg/L	0.06[A]	<0.010	<0.010	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01	2	0	2	0
pH, lab	S.U.	6.5-9.0[A]	**5.27[A]**	**5.10[A]**	5.1	5.27	5.18	5.18	5.26	5.22	5.14	5.11	5.11	log	log	5.18	2	2	0	2
Sulfate	mg/L	n/v	1.5	<1.0	1	1.5	1.2	1.2	1	1.1	1.4	1.4	1.5	0.4	0.3	1.2	2	1	1	0
Total Dissolved Solids	mg/L	n/v	19	14	14	19	16.5	16.5	14.2	15.2	17.8	18.5	18.8	3.5	2.5	16.3	2	2	0	0
Metals - Dissolved																				
Calcium	mg/L	n/v	3.7	3.2	3.2	3.7	3.4	3.4	3.2	3.3	3.6	3.6	3.7	0.4	0.3	3.4	2	2	0	0
Iron	mg/L	n/v	2.3	1.2	1.2	2.3	1.8	1.8	1.3	1.5	2	2.2	2.2	0.8	0.5	1.7	2	2	0	2
Magnesium	mg/L	n/v	2.2	1.9	1.9	2.2	2	2	1.9	2	2.1	2.2	2.2	0.2	0.1	2	2	2	0	0
Manganese	mg/L	0.19_{EQ4}[A]	0.016	0.0095	0.0095	0.016	0.0127	0.0127	0.0098	0.0111	0.0144	0.0154	0.0157	0.0046	0.0033	0.0123	2	2	0	0
Potassium	mg/L	n/v	<0.30	<0.30	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0	0	0.3	2	0	2	0
Sodium	mg/L	n/v	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0	0	2.4	2	2	0	0

Notes:

CCME	Canadian Council of Ministers of the Environment
A	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
6.5[A]	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
EQ4	The long-term dissolved manganese CWQG is found using the look-up table (see Table 5) or the CWQG and benchmark calculator in Appendix B of CCME (2019). The guideline was derived using a mean hardness of 17 mg/L and mean pH of 5.18.
n1	Guideline is expressed as Nitrite (as N) in ug/L. This value is equivalent to 197 ug/L for Nitrite.

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

Sample Location			Sump (location unknown)	Sump East Depression													
Sample Date			I-25_M45	I-25_WS01	I-25_15-02	I-25_15-04	I-25_W2	I-25_W3	I-25_WS3	I-25_W19-2	I-25_WS21-01	I-25-WS22-01	I25-WS23-03	I25-WS24-01	I25-WS24-01		I-25_WS02
Sample ID			11-Jul-14	7-Sep-12	17-Aug-15	17-Aug-15	21-Aug-16	21-Aug-16	15-Aug-17	17-Jul-19	24-Aug-21	23-Aug-22	27-Aug-23	20-Sep-24	20-Sep-24		7-Sep-12
Sampling Company			14 M45-1	Kumok 2012 WS 01	KUMAK-15-02	KUMAK-15-04	I25_SUMP_W2_AUG2016	I25_SUMP_W3_AUG2016	I25_SUMP_AUG_WS3	I-25_W19_2	I25-WS21-01	I25-WS22-01	I25-WS23-03	I25-WS24-01	I25-QC24-DUP1		Kumok 2012 WS 02
Laboratory			PRIDDIS	PRIDDIS	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC		PRIDDIS
Laboratory Work Order			AGAT	AGAT	MAXX	MAXX	MAXX	MAXX	MAXX	BV	BV	BV	BV	BV	BV		AGAT
Laboratory Sample ID			14E863491	12E642298	B573450	B573450	B673175	B673175	B771691	B958579	C163716	C264837	C367991	C475556	C475556		12E642298
Sample Type	Units	CCME	5573898	3712089	MZ0234	MZ0236	PJ3130	PJ3131	RU4425	WD1117	AEU770	BAP398	BXY214	CWF141	CWF143 Field Duplicate	RPD (%)	3712090
General Chemistry																	
Alkalinity (P as CaCO3)	mg/L	n/v	<5	<5	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	nc	<5
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	364	439	420	310	140	550	300	400	550	410	360	310	310	0%	17
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<5	<5	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	nc	<5
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<5	<5	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	nc	<5
Alkalinity, Total (as CaCO3)	mg/L	n/v	298	360	340	250	120	450	250	330	450	340	290	250	260	4%	12
Anion Sum	meq/L	n/v	-	-	38	52	2.7	58	24	46	-	-	-	-	-	-	-
Cation Sum	meq/L	n/v	-	-	36	54	3.2	62	27	49	-	-	-	-	-	-	-
Chloride	mg/L	120	8	3	1.6	<1.0	9.6	2.0	2.5	1.6	2.1	6.6	3.8	8.2	8.3	1%	4
Electrical Conductivity, Lab	µS/cm	n/v	3,730	3,960	2,500	3,400	280	3,800	1,900	3,200	2,900	2,100	2,900	2,000	2,100	5%	63
Fluoride	mg/L	0.12	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	-	<0.05
Hardness (as CaCO3)	mg/L	n/v	2,800	3,160	1,700	2,600	140	2,900	1,300	2300	2000	1300	2000	1300	1,400	7%	29
Ion Balance	%	n/v	-	-	-	-	-	-	-	3.1	-	-	-	-	-	-	-
Ion Balance	none	n/v	100	111	0.95	1.0	1.2	1.1	5.2	-	-	-	-	-	-	-	167
Ion Balance % Difference	%	n/v	-	-	-	-	-	-	-	-	1.0	5.5	0.19	0.39	0.72	nc	-
Nitrate	mg/L	13	<0.5	<0.5	<0.044	<0.044	<0.044	<0.044	<0.044	<0.044	<0.22	1.5	0.24	<0.22	<0.044	nc	<0.5
Nitrate (as N)	mg/L	3.0	<0.02	<0.113	<0.010 HX	<0.010 HX	<0.010	<0.010	<0.010	<0.010	<0.050	0.33	0.054	<0.050	<0.010	nc	<0.113
Nitrate + Nitrite (as N)	mg/L	n/v	<0.02	<0.01	<0.020	<0.020	<0.020	<0.020	<0.014	<0.014	<0.050 MI	0.33 MI	0.054 MI	<0.050 MI	<0.010	nc	<0.01
Nitrite	mg/L	0.197_{n1}	<0.05	<0.05	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	nc	<0.05
Nitrite (as N)	mg/L	0.06	<0.01	<0.015	<0.010 HX	<0.010 HX	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	nc	<0.015
pH, lab	S.U.	6.5-9.0	7.74	7.73	7.39 XQ	7.44 XQ	7.42	7.58	7.73	7.56	8.02	7.54	7.92	7.97	8.07	nc	**6.16[A]**
Sodium Adsorption Ratio (SAR)	none	n/v	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	n/v	2,540	2,580	1,500 CD	2,200 CD	4.9	2,300 CD	910 CD	1,900 CD	1,600	1,100	1,800	1,100	1,100	0%	4
Total Dissolved Solids	mg/L	n/v	3,710	3,890	2,300	3,300	140	3,600	1,500	2,900	2,600	1,800	2,700	1,700	1,800	6%	29
Metals - Dissolved																	
Calcium	mg/L	n/v	564	550	450	550 CD	29	550 CD	300	480 CD	450	290	490	300	310	3%	6
Iron	mg/L	n/v	<0.1	<0.1	<0.060	0.35	1.1	0.12	0.20	0.38	0.18	0.28	0.13	0.078	0.071	nc	0.7
Magnesium	mg/L	n/v	338	434	150	300	16	380	130	280	210	140	200	140	140	0%	3.3
Manganese	mg/L	0.19_{EQ4}[A]	<0.005	**0.646[A]**	<0.0040	**1.1[A]**	0.0043	**1.4[A]**	**1.3[A]**	**1.2[A]**	**1.1[A]**	**0.89[A]**	**2.0[A]**	<0.0040	<0.0040	nc	0.116
Potassium	mg/L	n/v	18.4	10.2	5.4	5.1	4.6	8.3	6.9	7.0	2.0	15	13	8.0	8.5	6%	1.1
Sodium	mg/L	n/v	61.7	95.1	27	42	7.1	71	24	55	36	25	40	26	26	0%	3.5
Metals - Total																	
Aluminum	mg/L	0.005_{VAR1}	-	-	-	-	-	-	-	-	-	-	**0.029[A]**	0.0038	**0.0066[A]**	nc	-
Antimony	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.00060	<0.00060	<0.00060	nc	-
Arsenic	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.0030	0.00086	0.00097	nc	-
Barium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.018	<0.010	<0.010	nc	-
Beryllium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	nc	-
Boron	mg/L	1.5	-	-	-	-	-	-	-	-	-	-	0.10	0.078	0.078	nc	-
Cadmium	mg/L	0.00004_{LTG}	-	-	-	-	-	-	-	-	-	-	0.000034	<0.000020	<0.000020	nc	-
Calcium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	480	280	260	7%	-
Chromium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	nc	-
Cobalt	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.0016	<0.00030	<0.00030	nc	-
Copper	mg/L	$0.0020_{TBC1,*}$	-	-	-	-	-	-	-	-	-	-	0.0010	<0.0010	<0.0010	nc	-
Iron	mg/L	0.3	-	-	-	-	-	-	-	-	-	-	**1.1[A]**	0.24	0.29	nc	-
Lead	mg/L	$0.0010_{TBC1,\#}$	-	-	-	-	-	-	-	-	-	-	<0.00020	<0.00020	<0.00020	nc	-
Lithium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.064	0.036	0.032	nc	-
Magnesium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	200	120	120	0%	-
Manganese	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	3.5	0.20	0.22	10%	-
Molybdenum	mg/L	0.073	-	-	-	-	-	-	-	-	-	-	<0.00020	0.00022	0.00064	nc	-
Nickel	mg/L	0.025_{TBC1}[A]	-	-	-	-	-	-	-	-	-	-	0.0036	0.0016	0.0020	nc	-
Phosphorus	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.64	0.20	0.17	nc	-
Potassium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	14	7.3	7.0	4%	-
Selenium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.00031	<0.00020	<0.00020	nc	-
Silicon	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	4.5	2.1	2.3	nc	-
Silver	mg/L	0.00025	-	-	-	-	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	nc	-
Sodium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	40	25	23	8%	-
Strontium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	0.90	0.49	0.49	0%	-
Sulfur	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	570	320	330	3%	-
Thallium	mg/L	0.0008	-	-	-	-	-	-	-	-	-	-	<0.00020	<0.00020	<0.00020	nc	-

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

Sample Location			Sump (location unknown)	Sump East Depression													
Sample Date			I-25_M45	I-25_WS01	I-25_15-02	I-25_15-04	I-25_W2	I-25_W3	I-25_WS3	I-25_W19-2	I-25_WS21-01	I-25-WS22-01	I25-WS23-03	I25-WS24-01	I25-WS24-01		I-25_WS02
Sample ID			11-Jul-14	7-Sep-12	17-Aug-15	17-Aug-15	21-Aug-16	21-Aug-16	15-Aug-17	17-Jul-19	24-Aug-21	23-Aug-22	27-Aug-23	20-Sep-24	20-Sep-24		7-Sep-12
Sampling Company			14 M45-1	Kumok 2012 WS 01	I25_SUMP_W2_AUG2016	I25_SUMP_W3_AUG2016	I25_SUMP_AUG_WS3	I-25_W19_2	I25-WS21-01	I25-WS22-01	I25-WS23-03	I25-WS24-01	I25-QC24-DUP1		Kumok 2012 WS 02		
Laboratory			PRIDDIS	PRIDDIS	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC		PRIDDIS
Laboratory Work Order			AGAT	AGAT	MAXX	MAXX	MAXX	MAXX	MAXX	BV	BV	BV	BV	BV	BV		AGAT
Laboratory Sample ID			14E863491	12E642298	B573450	B573450	B673175	B673175	B771691	B958579	C163716	C264837	C367991	C475556	C475556		12E642298
Sample Type	Units	CCME	5573898	3712089	MZ0234	MZ0236	PJ3130	PJ3131	RU4425	WD1117	AEU770	BAP398	BXY214	CWF141	CWF143 Field Duplicate	RPD (%)	3712090
Tin	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	nc	-
Titanium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	nc	-
Uranium	mg/L	0.015	-	-	-	-	-	-	-	-	-	-	0.0034	0.0010	0.0013	26%	-
Vanadium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	nc	-
Zinc	mg/L	0.0082_{EQ2} [A]	-	-	-	-	-	-	-	-	-	-	**0.034** [A]	<0.0030	**0.096** [A]	nc	-
BTEX and Petroleum Hydrocarbons																	
Benzene	µg/L	370	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	<0.40	<0.40	nc	-
Toluene	µg/L	2	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	<0.40	<0.40	nc	-
Ethylbenzene	µg/L	90	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	<0.40	<0.40	nc	-
Xylene, m & p-	µg/L	n/v	-	-	-	-	-	-	-	-	<0.80	<0.80	<0.80	<0.80	<0.80	nc	-
Xylene, o-	µg/L	n/v	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	<0.40	<0.40	nc	-
Xylenes, Total	µg/L	n/v	-	-	-	-	-	-	-	-	<0.89	<0.89	<0.89	<0.89	<0.89	nc	-
PHC F1 (C6-C10 range)	µg/L	n/v	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100	nc	-
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100	nc	-
PHC F2 (>C10-C16 range)	mg/L	n/v	-	-	-	-	-	-	-	-	<0.10	<0.10	<0.100	<0.10	<0.10	nc	-

See notes on the last page

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

			I-25												
			Sump South Depression												
Sample Location			**I-25_15-01**	**I-25_W1**	**I-25_W4**	**I-25_SSD_WS1**	**I-25_SSD_WS2**	**I-25_SSD_WS4**	**I-25_SSD_SW18-01**	**I-25_SSD_SW18-01**	**I-25_SSD_SW18-03**	**I-25_SSD_W19-1**	**I-25_SSD_WS21-02**	**I-25-WS22-02**	**I25-WS23-01**
Sample Date			**17-Aug-15**	**21-Aug-16**	**21-Aug-16**	**15-Aug-17**	**15-Aug-17**	**15-Aug-17**	**26-Aug-18**	**27-Aug-18**	**26-Aug-18**	**17-Jul-19**	**24-Aug-21**	**23-Aug-22**	**27-Aug-23**
Sample ID			**KUMAK-15-01**	**I25_SUMP_W1_AUG2016**	**I25_SUMP_W4_AUG2016**	**I25_SUMP_AUG_WS1**	**I25_SUMP_AUG_WS2**	**I25_SUMP_AUG_WS4**	**I25S-SW18-01**	**I25S-QCW18-01**	**I25S-SW18-03**	**I-25_W19_1**	**I25-WS21-02**	**I25-WS22-02**	**I25-WS23-01**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**BV**	**BV**	**BV**	**BV**
Laboratory Work Order			**B573450**	**B673175**	**B673175**	**B771691**	**B771691**	**B771691**	**B874000**	**B874000**	**B874000**	**B958579**	**C163716**	**C264837**	**C367991**
Laboratory Sample ID			**MZ0233**	**PJ3129**	**PJ3132**	**RU4423**	**RU4424**	**RU4426**	**UE9376**	**UE9383**	**UE9378**	**WD1116**	**AEU771**	**BAP399**	**BXY212**
Sample Type	**Units**	**CCME**													
General Chemistry															
Alkalinity (P as CaCO3)	mg/L	n/v	<0.50 SZ	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	18 SZ	120	440	55	110	79	63	64	420	36	280	150	210
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<0.50 SZ	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<0.50 SZ	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity, Total (as CaCO3)	mg/L	n/v	14 SZ	98	360	45	93	65	52	53	340	30	230	120	180
Anion Sum	meq/L	n/v	0.48 SZ	2.5	56	3.5	27	2.0	4.8	4.9	40	8.7	-	-	-
Cation Sum	meq/L	n/v	0.88 SZ	3.1	58	3.8	30	2.5	4.9	5.0	43	8.8	-	-	-
Chloride	mg/L	120	6.6 SZ	11	3.4	2.9	4.8	8.8	5.7	5.9	<1.0	7.8	7.4	4.9	5.9
Electrical Conductivity, Lab	µS/cm	n/v	76 SZ	240	3,700	350	2,100	210	480	480	3,000	800	500	310	350
Fluoride	mg/L	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (as CaCO3)	mg/L	n/v	34 SZ	130	2,700	180	1,400	110	220	230	2,100	410	230	200	180
Ion Balance	%	n/v	-	-	-	-	-	-	-	-	-	0.76	-	-	-
Ion Balance	none	n/v	1.8 SZ	1.3	1.0	4.5	6.1	12	1.1	1.7	2.9	-	-	-	-
Ion Balance % Difference	%	n/v	-	-	-	-	-	-	-	-	-	-	10	13	2.6
Nitrate	mg/L	13	<0.044 SZ	0.070	<0.044	<0.044	<0.044	<0.044	<0.044	<0.044	<0.044	<0.044	<0.22	<0.22	<0.044
Nitrate (as N)	mg/L	3.0	<0.010 HX	0.016	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.050	<0.050	<0.010
Nitrate + Nitrite (as N)	mg/L	n/v	<0.020 SZ	<0.020	<0.020	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.050 MI	<0.050 MI	<0.010
Nitrite	mg/L	0.197_{n1}	<0.033 SZ	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
Nitrite (as N)	mg/L	0.06	<0.010 HX	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
pH, lab	S.U.	6.5-9.0	**6.12 XQ[A]**	7.23	7.73	7.29	7.58	6.97	6.61	6.79	7.35	6.63	7.36	7.30	6.86
Sodium Adsorption Ratio (SAR)	none	n/v	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	n/v	<1.0 SZ	11	2,300 CD	120	1,200 CD	22	170	170	1,600 CD	380 CD	66	39	7.7
Total Dissolved Solids	mg/L	n/v	31 SZ	140	3,500	220	1,800	110	300	300	2,500	550	300	190	190
Metals - Dissolved															
Calcium	mg/L	n/v	7.1 SZ	27	490	51	330	22	45	46	470	79	41	40	37
Iron	mg/L	n/v	0.77 SZ	1.8	0.074	0.11	0.083	1.5	1.1	1.2	0.18	0.13	0.62	0.36	0.32
Magnesium	mg/L	n/v	3.9 SZ	16	360	13	150	12	27	27	220	51	31	24	22
Manganese	mg/L	0.19_{EQ4}[A]	0.18 SZ	0.18	<0.0040	0.0092	0.023	**0.29[A]**	**1.1[A]**	**1.1[A]**	**0.31[A]**	**0.24[A]**	**0.59[A]**	**0.30[A]**	<0.0040
Potassium	mg/L	n/v	0.68 SZ	4.2	8.7	4.7	5.1	3.2	2.6	2.6	2.8	5.9	3.0	3.3	2.6
Sodium	mg/L	n/v	3.4 SZ	7.5	69	2.3	31	5.9	8.0	7.9	37	13	8.1	6.4	6.7
Metals - Total															
Aluminum	mg/L	0.005_{VAR1}	-	-	-	-	-	-	-	-	-	-	-	-	**0.10[A]**
Antimony	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.00060
Arsenic	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.0016
Barium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.091
Beryllium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.0010
Boron	mg/L	1.5	-	-	-	-	-	-	-	-	-	-	-	-	<0.020
Cadmium	mg/L	0.00004_{LTG}	-	-	-	-	-	-	-	-	-	-	-	-	**0.00030[A]**
Calcium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	36
Chromium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.0010
Cobalt	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.00065
Copper	mg/L	$0.0020_{TBC1,*}$	-	-	-	-	-	-	-	-	-	-	-	-	**0.0027[A]**
Iron	mg/L	0.3	-	-	-	-	-	-	-	-	-	-	-	-	**0.89[A]**
Lead	mg/L	$0.0010_{TBC1,\#}$	-	-	-	-	-	-	-	-	-	-	-	-	0.00026
Lithium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.020
Magnesium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	22
Manganese	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.37
Molybdenum	mg/L	0.073	-	-	-	-	-	-	-	-	-	-	-	-	0.00026
Nickel	mg/L	0.025_{TBC1}[A]	-	-	-	-	-	-	-	-	-	-	-	-	0.0036
Phosphorus	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.14
Potassium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	3.0
Selenium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.00040
Silicon	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Silver	mg/L	0.00025	-	-	-	-	-	-	-	-	-	-	-	-	<0.00010
Sodium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	6.6
Strontium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.082
Sulfur	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	4.9
Thallium	mg/L	0.0008	-	-	-	-	-	-	-	-	-	-	-	-	<0.00020

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

			I-25												
			Sump South Depression												
Sample Location			**I-25_15-01**	**I-25_W1**	**I-25_W4**	**I-25_SSD_WS1**	**I-25_SSD_WS2**	**I-25_SSD_WS4**	**I-25_SSD_SW18-01**	**I-25_SSD_SW18-01**	**I-25_SSD_SW18-03**	**I-25_SSD_W19-1**	**I-25_SSD_WS21-02**	**I-25-WS22-02**	**I25-WS23-01**
Sample Date			**17-Aug-15**	**21-Aug-16**	**21-Aug-16**	**15-Aug-17**	**15-Aug-17**	**15-Aug-17**	**26-Aug-18**	**27-Aug-18**	**26-Aug-18**	**17-Jul-19**	**24-Aug-21**	**23-Aug-22**	**27-Aug-23**
Sample ID			**KUMAK-15-01**	**I25_SUMP_W1_AUG2016**	**I25_SUMP_W4_AUG2016**	**I25_SUMP_AUG_WS1**	**I25_SUMP_AUG_WS2**	**I25_SUMP_AUG_WS4**	**I25S-SW18-01**	**I25S-QCW18-01**	**I25S-SW18-03**	**I-25_W19_1**	**I25-WS21-02**	**I25-WS22-02**	**I25-WS23-01**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**BV**	**BV**	**BV**	**BV**
Laboratory Work Order			**B573450**	**B673175**	**B673175**	**B771691**	**B771691**	**B771691**	**B874000**	**B874000**	**B874000**	**B958579**	**C163716**	**C264837**	**C367991**
Laboratory Sample ID			**MZ0233**	**PJ3129**	**PJ3132**	**RU4423**	**RU4424**	**RU4426**	**UE9376**	**UE9383**	**UE9378**	**WD1116**	**AEU771**	**BAP399**	**BXY212**
Sample Type	**Units**	**CCME**													
Tin	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.0010
Titanium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	0.0013
Uranium	mg/L	0.015	-	-	-	-	-	-	-	-	-	-	-	-	<0.00010
Vanadium	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	-	-	<0.0010
Zinc	mg/L	0.0082_{EQ2} [A]	-	-	-	-	-	-	-	-	-	-	-	-	**0.035** [A]
BTEX and Petroleum Hydrocarbons															
Benzene	µg/L	370	-	-	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Toluene	µg/L	2	-	-	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Ethylbenzene	µg/L	90	-	-	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Xylene, m & p-	µg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.80	<0.80	<0.80
Xylene, o-	µg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40
Xylenes, Total	µg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.89	<0.89	<0.89
PHC F1 (C6-C10 range)	µg/L	n/v	-	-	-	-	-	-	-	-	-	-	<100	<100	<100
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	-	-	-	-	-	-	-	-	-	-	<100	<100	<100
PHC F2 (>C10-C16 range)	mg/L	n/v	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	<0.100

See notes on the last page

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

				Sump Southwest Depression							
Sample Location			**I25-WS24-02**	**I-25_SWD_15-03**	**I-25_SWD_W5**	**I-25_SWD_WS5**	**I-25_SWD_SW18-02**	**I-25_SWD_WS21-03**	**I-25-WS22-03**	**I25-WS23-02**
Sample Date			**20-Sep-24**	**17-Aug-15**	**21-Aug-16**	**15-Aug-17**	**26-Aug-18**	**24-Aug-21**	**23-Aug-22**	**27-Aug-23**
Sample ID			**I25-WS24-02**	**KUMAK-15-03**	**I25_SUMP_W5_AUG2016**	**I25_SUMP_AUG_WS5**	**I25S-SW18-02**	**I25-WS21-03**	**I25-WS22-03**	**I25-WS23-02**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**BV**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**BV**	**BV**	**BV**
Laboratory Work Order			**C475556**	**B573450**	**B673175**	**B771691**	**B874000**	**C163716**	**C264837**	**C367991**
Laboratory Sample ID			**CWF142**	**MZ0235**	**PJ3133**	**RU4427**	**UE9377**	**AEU772**	**BAP400**	**BXY213**
Sample Type	**Units**	**CCME**								
General Chemistry										
Alkalinity (P as CaCO3)	mg/L	n/v	<1.0	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	130	10	3.7	15	17	110	51	27
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<1.0	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<1.0	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Alkalinity, Total (as CaCO3)	mg/L	n/v	100	8.5	3.0	12	14	88	42	22
Anion Sum	meq/L	n/v	-	5.9	8.0	6.7	7.4	-	-	-
Cation Sum	meq/L	n/v	-	6.6	9.0	7.7	8.2	-	-	-
Chloride	mg/L	120	5.8	8.2	9.4	9.5	6.0	5.6	4.3	4.3
Electrical Conductivity, Lab	µS/cm	n/v	310	620	810	660	760	800	730	560
Fluoride	mg/L	0.12	-	-	-	-	-	-	-	-
Hardness (as CaCO3)	mg/L	n/v	160	300	410	360	380	380	430	260
Ion Balance	%	n/v	-	-	-	-	-	-	-	-
Ion Balance	none	n/v	-	1.1	1.1	7.5	4.8	-	-	-
Ion Balance % Difference	%	n/v	1.4	-	-	-	-	6.8	4.2	1.5
Nitrate	mg/L	13	<0.089	<0.044	<0.044	<0.044	<0.044	<0.22	<0.22	0.81
Nitrate (as N)	mg/L	3.0	<0.020	<0.010 HX	<0.010	<0.010	<0.010	<0.050	<0.050	0.18
Nitrate + Nitrite (as N)	mg/L	n/v	<0.020 MSE MI	<0.020	<0.020	<0.014	<0.014	<0.050 MI	<0.050 MI	0.18
Nitrite	mg/L	0.197_{n1}	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033
Nitrite (as N)	mg/L	0.06	<0.010	<0.010 HX	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
pH, lab	S.U.	6.5-9.0	6.87	**5.56 XQ[A]**	**5.33[A]**	**6.04[A]**	**5.96[A]**	**6.35[A]**	**6.43[A]**	**6.31[A]**
Sodium Adsorption Ratio (SAR)	none	n/v	-	-	-	-	-	-	-	-
Sulfate	mg/L	n/v	57	260 CD	370 CD	290 CD	330 CD	360	360	250
Total Dissolved Solids	mg/L	n/v	180	390	530	440	490	550	540	370
Metals - Dissolved										
Calcium	mg/L	n/v	32	59	79	70	75	76	85	55
Iron	mg/L	n/v	0.46	2.5	2.6	0.41	0.31	1.9	1.3	0.25
Magnesium	mg/L	n/v	19	37	51	44	46	45	52	30
Manganese	mg/L	0.19_{EQ4}[A]	<0.0040	**1.2[A]**	**1.4[A]**	**0.49[A]**	**0.78[A]**	**1.1[A]**	**1.0[A]**	**0.30[A]**
Potassium	mg/L	n/v	2.3	3.7	4.2	3.9	3.6	2.6	2.7	2.0
Sodium	mg/L	n/v	5.5	9.5	13	11	12	10	11	8.5
Metals - Total										
Aluminum	mg/L	0.005_{VAR1}	**0.17[A]**	-	-	-	-	-	-	**0.31[A]**
Antimony	mg/L	n/v	<0.00060	-	-	-	-	-	-	<0.00060
Arsenic	mg/L	n/v	0.0011	-	-	-	-	-	-	0.0011
Barium	mg/L	n/v	0.050	-	-	-	-	-	-	0.037
Beryllium	mg/L	n/v	<0.0010	-	-	-	-	-	-	<0.0010
Boron	mg/L	1.5	0.028	-	-	-	-	-	-	0.021
Cadmium	mg/L	0.00004_{LTG}	<0.000020	-	-	-	-	-	-	**0.000089[A]**
Calcium	mg/L	n/v	30	-	-	-	-	-	-	56
Chromium	mg/L	n/v	<0.0010	-	-	-	-	-	-	<0.0010
Cobalt	mg/L	n/v	0.00043	-	-	-	-	-	-	0.0032
Copper	mg/L	$0.0020_{TBC1,*}$	0.0018	-	-	-	-	-	-	**0.0053[A]**
Iron	mg/L	0.3	**0.65[A]**	-	-	-	-	-	-	**0.97[A]**
Lead	mg/L	$0.0010_{TBC1,\#}$	<0.00020	-	-	-	-	-	-	0.00023
Lithium	mg/L	n/v	<0.020	-	-	-	-	-	-	<0.020
Magnesium	mg/L	n/v	16	-	-	-	-	-	-	32
Manganese	mg/L	n/v	0.11	-	-	-	-	-	-	0.44
Molybdenum	mg/L	0.073	0.00033	-	-	-	-	-	-	<0.00020
Nickel	mg/L	0.025_{TBC1}[A]	0.0034	-	-	-	-	-	-	0.012
Phosphorus	mg/L	n/v	0.13	-	-	-	-	-	-	0.15
Potassium	mg/L	n/v	2.2	-	-	-	-	-	-	1.8
Selenium	mg/L	n/v	0.00028	-	-	-	-	-	-	0.00047
Silicon	mg/L	n/v	1.7	-	-	-	-	-	-	2.7
Silver	mg/L	0.00025	<0.00010	-	-	-	-	-	-	<0.00010
Sodium	mg/L	n/v	5.2	-	-	-	-	-	-	8.6
Strontium	mg/L	n/v	0.062	-	-	-	-	-	-	0.085
Sulfur	mg/L	n/v	15	-	-	-	-	-	-	79
Thallium	mg/L	0.0008	<0.00020	-	-	-	-	-	-	<0.00020

Table B.7
Summary of Water Analytical Results
Kumak I-25 Sump
MGM Energy

				Sump Southwest Depression						
Sample Location			**I25-WS24-02**	**I-25_SWD_15-03**	**I-25_SWD_W5**	**I-25_SWD_WS5**	**I-25_SWD_SW18-02**	**I-25_SWD_WS21-03**	**I-25-WS22-03**	**I25-WS23-02**
Sample Date			**20-Sep-24**	**17-Aug-15**	**21-Aug-16**	**15-Aug-17**	**26-Aug-18**	**24-Aug-21**	**23-Aug-22**	**27-Aug-23**
Sample ID			**I25-WS24-02**	**KUMAK-15-03**	**I25_SUMP_W5_AUG2016**	**I25_SUMP_AUG_WS5**	**I25S-SW18-02**	**I25-WS21-03**	**I25-WS22-03**	**I25-WS23-02**
Sampling Company			**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**	**STANTEC**
Laboratory			**BV**	**MAXX**	**MAXX**	**MAXX**	**MAXX**	**BV**	**BV**	**BV**
Laboratory Work Order			**C475556**	**B573450**	**B673175**	**B771691**	**B874000**	**C163716**	**C264837**	**C367991**
Laboratory Sample ID			**CWF142**	**MZ0235**	**PJ3133**	**RU4427**	**UE9377**	**AEU772**	**BAP400**	**BXY213**
Sample Type	**Units**	**CCME**								
Tin	mg/L	n/v	<0.0010	-	-	-	-	-	-	<0.0010
Titanium	mg/L	n/v	0.0014	-	-	-	-	-	-	0.0028
Uranium	mg/L	0.015	<0.00010	-	-	-	-	-	-	<0.00010
Vanadium	mg/L	n/v	<0.0010	-	-	-	-	-	-	<0.0010
Zinc	mg/L	0.0082_{EQ2} [A]	0.0060	-	-	-	-	-	-	**0.036^**
BTEX and Petroleum Hydrocarbons										
Benzene	µg/L	370	<0.40	-	-	-	-	<0.40	<0.40	<0.40
Toluene	µg/L	2	<0.40	-	-	-	-	<0.40	<0.40	<0.40
Ethylbenzene	µg/L	90	<0.40	-	-	-	-	<0.40	<0.40	<0.40
Xylene, m & p-	µg/L	n/v	<0.80	-	-	-	-	<0.80	<0.80	<0.80
Xylene, o-	µg/L	n/v	<0.40	-	-	-	-	<0.40	<0.40	<0.40
Xylenes, Total	µg/L	n/v	<0.89	-	-	-	-	<0.89	<0.89	<0.89
PHC F1 (C6-C10 range)	µg/L	n/v	<100	-	-	-	-	<100	<100	<100
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	<100	-	-	-	-	<100	<100	<100
PHC F2 (>C10-C16 range)	mg/L	n/v	<0.10	-	-	-	-	<0.10	<0.10	<0.100

See notes on the last page

Table B.8
Summary of Wellsite Soil Sample Analytical Results: Reference Samples and Statistical Calculations - Organic Soils
Kumak I-25 Wellsite
MGM Energy

Locaiton		CCME		AENV SCARG Rating Categories	I-25 Wellsite			Statistical Calculations												
Sample Date					18-Aug-17	18-Aug-17	18-Aug-17													
Sample ID					I25_WELL_SS1	I25_WELL_SS2	I25_WELL_SS2 Lab-Dup													
Sample Depth					0 - 0.25 m	0 - 0.25 m	0 - 0.25 m													
Sampling Company					STANTEC	STANTEC	STANTEC													
Laboratory		Residential/Parkland Use			MAXX	MAXX	MAXX													
Laboratory Work Order					B771667	B771667	B771667													
Laboratory Sample ID		Fine	Coarse	Table 2.2 Topsoil	RU4325	RU4326	RU4326													
Sample Type	Units	A	B	C			Lab Replicate	Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	Exceed	95 UCLM
General Chemistry																				
Soluble (CaCl2) pH	S.U.	6-8	6-8	n/v	**4.21 HV[AB]**	**5.45 HV[AB]**	-	4.21	5.45	4.48673	4.48673	4.32669	4.23096	log	log	4.83	2	2	0	2	NC
Soluble Conductivity	dS/m	2	2	Good	0.32	0.22	-	0.22	0.32	0.27	0.27	0.3	0.32	0.07	0.05	0.27	2	2	0	0	0.368
Sodium Adsorption Ratio (SAR)	none	5	5	Good	0.83	0.80	-	0.8	0.83	0.82	0.82	0.82	0.83	0.02	0.01	0.81	2	2	0	0	0.8396
Calcium	mg/kg	n/v	n/v	n/v	170	110	-	110	170	140	140	155	167	42.4	30	136.7	2	2	0	0	198.8
Calcium	mg/L	n/v	n/v	n/v	32	24	-	24	32	28	28	30	31.6	5.7	4	27.7	2	2	0	0	35.84
Cation/EC Ratio	none	n/v	n/v	n/v	15	14	-	14	15	14.5	14.5	14.8	15	0.7	0.5	14.5	2	2	0	0	15.48
Chloride	mg/kg	n/v	n/v	n/v	270	98	-	98	270	184	184	227	261.4	121.6	86	162.7	2	2	0	0	352.56
Chloride	mg/L	n/v	n/v	n/v	51	22	-	22	51	36.5	36.5	43.8	49.6	20.5	14.5	33.5	2	2	0	0	64.92
Ion Balance	none	n/v	n/v	n/v	2.5	2.9	-	2.5	2.9	2.7	2.7	2.8	2.9	0.3	0.2	2.7	2	2	0	0	3.092
Magnesium	mg/kg	n/v	n/v	n/v	110	47	-	47	110	78.5	78.5	94.2	106.8	44.5	31.5	71.9	2	2	0	0	140.24
Magnesium	mg/L	n/v	n/v	n/v	21	10	-	10	21	15.5	15.5	18.2	20.4	7.8	5.5	14.5	2	2	0	0	26.28
Moisture Content	%	n/v	n/v	n/v	76	34	40	34	76	50	40	58	72.4	22.7	13.1	46.9	3	3	0	0	75.676
Percent Saturation	%	n/v	n/v	n/v	530	460	-	460	530	495	495	512.5	526.5	49.5	35	493.8	2	2	0	0	563.6
Potassium	mg/kg	n/v	n/v	n/v	84	61	-	61	84	72.5	72.5	78.2	82.8	16.3	11.5	71.6	2	2	0	0	95.04
Potassium	mg/L	n/v	n/v	n/v	16	13	-	13	16	14.5	14.5	15.2	15.8	2.1	1.5	14.4	2	2	0	0	17.44
Sodium	mg/kg	n/v	n/v	n/v	130	85	-	85	130	107.5	107.5	118.8	127.8	31.8	22.5	105.1	2	2	0	0	151.6
Sodium	mg/L	n/v	n/v	n/v	24	19	-	19	24	21.5	21.5	22.8	23.8	3.5	2.5	21.4	2	2	0	0	26.4
Sulphate	mg/kg	n/v	n/v	n/v	130	110	-	110	130	120	120	125	129	14.1	10	119.6	2	2	0	0	139.6
Sulphate	mg/L	n/v	n/v	n/v	24	24	-	24	24	24	24	24	24	0	0	24	2	2	0	0	24
Theoretical Gypsum Requirement	tons/ha	n/v	n/v	n/v	<0.20	<0.20	-	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0.2	2	0	2	0	0.2
Physical Properties																				
Sieve - Pan	%	n/v	n/v	n/v	47	84	-	47	84	65.5	65.5	74.8	82.2	26.2	18.5	62.8	2	2	0	0	101.76
Sieve - #200 (>0.075mm)	%	n/v	n/v	n/v	53	16	-	16	53	34.5	34.5	43.8	51.2	26.2	18.5	29.1	2	2	0	0	70.76
Grain Size	%	n/v	n/v	n/v	COARSE	FINE	-													

Notes:

CCME — Canadian Council of Ministers of the Environment

A — Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and fine grained soil

B — Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, on-line summary table, for Residential/Parkland land use and coarse grained soil

AENV — Alberta Environment Salt Contamination Assessment and Remediation Guidelines, May 2001

C — Table 2.2. Soil Quality Guidelines for Unrestricted Land Use

	Rating Category	Good	Fair	Poor	Unsuitable
Topsoil	EC	<2	2 to 4	4 to 8	>8
	SAR	<4	4 to 8	8 to 12	>12

6.5[A] Concentration exceeds the indicated standard.

15.2 Measured concentration did not exceed the indicated standard.

<0.50 Laboratory reporting limit was greater than the applicable standard.

<0.03 Analyte was not detected at a concentration greater than the laboratory reporting limit.

n/v No standard/guideline value.

- Parameter not analyzed / not available.

HV Due to high absorbtivity of the sample, the water soil extraction ratio has changed from 2:1 to 10:1

Table B.9
Summary of Wellsite Water Sample Analytical Results: Reference Samples and Statistical Calculations
Kumak I-25 Wellsite
MGM Energy

Location			I-25 Wellsite												Statistical Calculations												
Sample Date		CCME	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	18-Aug-17	18-Aug-17	18-Aug-17	18-Aug-17													
Sample ID			I25_WELL_W2	I25_WELL_W2 Lab-Dup	I25_WELL_W3	I25_WELL_W4	I25_WELL_W5	I25_WELL_W6	I25_WELL_W7	I25_WELL_W7 Lab-Dup	I25_WELL_WS1	I25_WELL_QA1	I25_WELL_WS3	I25_WELL_WS4/5													
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC													
Laboratory		Freshwater	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX													
Laboratory Work Order		Aquatic Life	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B771667	B771667	B771667	B771667													
Laboratory Sample ID		Long Term [A]	PJ3137	PJ3137	PJ3138	PJ3139	PJ3140	PJ3141	PJ3142	PJ3142	RU4320	RU4321	RU4322	RU4323													
Sample Type	Units			Lab Replicate						Lab Replicate		Field Duplicate			Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	Exceed	95 UCLM
General Chemistry																											
Alkalinity (P as CaCO3)	mg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	9	0	9	0	0.5
Alkalinity, Bicarbonate (as CaCO3)	mg/L	n/v	16	-	27	13	29	43	26	-	53	25	35	-	13	53	29.7	27	35	49	12.5	4.2	27.3	9	9	0	0	37.932
Alkalinity, Carbonate (as CaCO3)	mg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	9	0	9	0	0.5
Alkalinity, Hydroxide (as CaCO3)	mg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	9	0	9	0	0.5
Alkalinity, Total (as CaCO3)	mg/L	n/v	13	-	22	11	24	35	21	-	44	21	29	-	11	44	24.4	22	29	40.4	10.3	3.4	22.5	9	9	0	0	31.064
Chloride	mg/L	120	12	12	13	11	14	15	12	-	13	14	11	-	11	15	12.7	12.5	13.8	14.6	1.3	0.4	12.6	10	10	0	0	13.484
Electrical Conductivity, Lab	µS/cm	n/v	90	-	97	83	100	130	93	-	130	97	94	-	83	130	101.6	97	100	130	16.8	5.6	100.4	9	9	0	0	112.576
Hardness (as CaCO3)	mg/L	n/v	48	-	56	45	57	72	54	-	72	53	53	-	45	72	56.7	54	57	72	9.5	3.2	56	9	9	0	0	62.972
Ion Balance	none	n/v	2.0	-	1.7	2.2	1.7	1.6	1.8	-	18	25	19	-	1.6	25	8.1	2	18	22.6	9.6	3.2	4.1	9	9	0	0	14.372
Nitrate	mg/L	13	<0.044	-	<0.044	<0.044	<0.044	0.10	<0.044	-	<0.044	<0.044	<0.044	-	0.044	0.1	0.05	0.044	0.044	0.078	0.019	0.006	0.048	9	1	8	0	0.06176
Nitrate (as N)	mg/L	3.0	<0.010	-	<0.010	<0.010	<0.010	0.023	<0.010	<0.010	<0.010	<0.010	<0.010	-	0.01	0.023	0.011	0.01	0.01	0.017	0.004	0.001	0.011	10	1	9	0	0.01296
Nitrate + Nitrite (as N)	mg/L	n/v	<0.020	-	<0.020	<0.020	<0.020	0.023	<0.020	-	<0.014	<0.014	<0.014	-	0.014	0.023	0.018	0.02	0.02	0.022	0.003	0.001	0.018	9	1	8	0	0.01996
Nitrite	mg/L	0.197	<0.033	-	<0.033	<0.033	<0.033	<0.033	<0.033	-	<0.033	<0.033	<0.033	-	0.033	0.033	0.033	0.033	0.033	0.033	0	0	0.033	9	0	9	0	0.033
Nitrite (as N)	mg/L	0.06	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01	10	0	10	0	0.01
pH, lab	S.U.	6.5-9.0	**6.27** [A]	-	**6.40** [A]	**5.97** [A]	**6.19** [A]	**6.07** [A]	6.54	-	6.76	**6.07** [A]	6.78	-	5.97	6.78	6.26	6.27	6.07	6.61	log	log	6.34	9	9	0	6	NC
Sulphate	mg/L	n/v	0.62	-	<0.50	2.2	1.7	1.6	1.8	-	<0.50	<0.50	<0.50	-	0.5	0.62	0.51	0.5	0.5	0.57	0.04	0.01	0.51	9	1	8	0	0.5296
Total Dissolved Solids	mg/L	n/v	43	-	51	38	54	70	49	-	72	51	51	-	38	72	53.2	51	54	71.2	11.2	3.7	52.2	9	9	0	0	60.452
Total Suspended Solids	mg/L	SN	19	-	130 VV	6.0	57	77	1.3	-	-	-	-	-	1.3	130	48.4	38	72	116.8	49.9	20.4	21	6	6	0	0	88.384
Metals, Dissolved																											
Aluminum	mg/L	0.005_{VAR1}	**0.20** [A]	**0.20** [A]	**0.22 DX** [A]	**0.18** [A]	**0.16** [A]	**0.49** [A]	**0.19** [A]	-	-	-	-	-	0.16	0.49	0.23429	0.2	0.21	0.409	0.11429	0.0432	0.21826	7	7	0	7	0.318962
Antimony	mg/L	n/v	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	-	-	-	-	-	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0	0	0.0006	7	0	7	0	0.0006
Arsenic	mg/L	0.005	0.00088 DX	0.00079	0.00093	0.00094	0.0010	0.0011	0.00064	-	-	-	-	-	0.00064	0.0011	0.00089714	0.00093	0.00097	0.00107	0.00014863	5.62E-05	0.00088578	7	7	0	0	0.001007253
Barium	mg/L	n/v	0.048 DX	0.048	0.037	0.034	0.069	0.054	0.030	-	-	-	-	-	0.03	0.069	0.045714	0.048	0.051	0.0645	0.013425	0.005074	0.044092	7	7	0	0	0.05565904
Beryllium	mg/L	n/v	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0	0	0.001	7	0	7	0	0.001
Boron	mg/L	1.5	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0.02	7	0	7	0	0.02
Cadmium	mg/L	0.00009_{TG}	0.000038	0.000036	0.000039	0.000057	0.000031	0.000049	0.000044	-	-	-	-	-	3.10E-05	5.70E-05	4.20E-05	3.90E-05	4.60E-05	5.50E-05	9.00E-06	3.00E-06	4.10E-05	7	7	0	0	0.00004788
Calcium	mg/L	n/v	11 DX	11	12 DX	9.5 DX	12	16 DX	11 DX	-	20	11	12	-	9.5	20	12.55	11.5	12	18.2	3.1131	0.9845	12.2631	10	10	0	0	14.47962
Chromium	mg/L	n/v	0.0011	0.0010	0.0011	<0.0010	<0.0010	0.0018	<0.0010	-	-	-	-	-	0.001	0.0018	0.0011	0.001	0.0011	0.0016	0.0003	0.0001	0.0011	7	4	3	0	0.001296
Cobalt	mg/L	n/v	0.0012 DX	0.0011	0.00038	0.00069	0.0024	0.0018	<0.00030	-	-	-	-	-	0.0003	0.0024	0.0011243	0.0011	0.0015	0.00222	0.0007651	0.0002892	0.0008918	7	6	1	0	0.001691132
Copper	mg/L	0.002_{TBC1}	0.0014	0.0014	0.0014	0.0017	0.0017	0.0010	**0.0021 DX** [A]	-	-	-	-	-	0.001	0.0021	0.0015286	0.0014	0.0017	0.00198	0.000345	0.0001304	0.0014945	7	7	0	1	0.001784184
Iron	mg/L	0.3	**1.3 DX** [A]	**1.3** [A]	**0.84** [A]	**1.2** [A]	**2.1** [A]	**2.9** [A]	**0.94 DX** [A]	-	**2.0** [A]	**0.61** [A]	**0.41** [A]	-	0.41	2.9	1.36	1.25	1.825	2.54	0.76546	0.24206	1.17172	10	10	0	10	1.8344376
Lead	mg/L	0.001_{TBC1}	<0.00020	<0.00020	<0.00020	<0.00020	0.00028	<0.00020	<0.00020	-	-	-	-	-	0.0002	0.00028	0.00021	0.0002	0.0002	0.00026	3.00E-05	1.00E-05	0.00021	7	1	6	0	0.0002296
Lithium	mg/L	n/v	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020 DX	-	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0.02	7	0	7	0	0.02
Magnesium	mg/L	n/v	5.0	5.0	6.1 DX	5.2 DX	6.3 DX	7.8 DX	6.2 DX	-	5.3	6.0	5.8	-	5	7.8	5.87	5.9	6.175	7.125	0.842	0.2663	5.8196	10	10	0	0	6.391948
Manganese	mg/L	n/v	0.12 RD	0.12	0.047	0.15	0.14	0.043 DX	<0.0040	-	0.0040	0.11	<0.0040	-	0.004	0.15	0.0742	0.0785	0.12	0.1455	0.059675	0.018871	0.036591	10	8	2	0	0.11118716
Molybdenum	mg/L	0.073	0.00034	0.00031	0.00034	0.00036	0.00038	<0.00020	0.00033	-	-	-	-	-	0.0002	0.00038	0.00032	0.00034	0.00035	0.00037	6.00E-05	2.00E-05	0.00032	7	6	1	0	0.0003592
Nickel	mg/L	0.025_{TBC1}	0.0038	0.0035	0.0041 DX	0.0032 DX	0.0035	0.0063 DX	0.0041	-	-	-	-	-	0.0032	0.0063	0.0040714	0.0038	0.0041	0.00564	0.0010372	0.000392	0.0039784	7	7	0	0	0.00483972
Phosphorus	mg/L	n/v	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	0.64	0.35	<0.30	-	0.1	0.1	0.1	0.1	0.1	0.1	0	0	0.1	7	0	7	0	0.1
Potassium	mg/L	n/v	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	-	0.64	0.35	<0.30	-	0.3	0.64	0.34	0.3	0.3	0.51	0.11	0.03	0.33	10	2	8	0	0.3988
Selenium	mg/L	0.001	0.00024	0.00022	0.00029	0.00023	0.00025	0.00033	0.00024	-	-	-	-	-	0.00022	0.00033	0.00026	0.00024	0.00027	0.00032	4.00E-05	1.00E-05	0.00025	7	7	0	0	0.0002796
Silicon	mg/L	n/v	1.8	1.8	0.92	1.4 DX	1.5	2.6	2.6 DX	-	-	-	-	-	0.92	2.6	1.8029	1.8	2.2	2.6	0.6197	0.2342	1.7075	7	7	0	0	2.261932
Silver	mg/L	0.00025	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	-	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0	0	0.0001	7	0	7	0	0.0001
Sodium	mg/L	n/v	5.0	5.0	5.0	4.6	5.5	6.9	5.7	-	5.6	5.7	5.0	-	4.6	6.9	5.4	5.2	5.7	6.4	0.6	0.2	5.4	10	10	0	0	5.792
Strontium	mg/L	n/v	0.033 DX	0.033	0.031	0.026 DX	0.035	0.039 DX	0.025 DX	-	-	-	-	-	0.025	0.039	0.031714	0.033	0.034	0.0378	0.004923	0.001861	0.031379	7	7	0	0	0.03536156
Sulphur	mg/L	n/v	0.54	0.60	0.62	0.63 DX	0.65	0.67	0.55	-	-	-	-	-	0.54	0.67	0.60857	0.62	0.64	0.664	0.0488	0.01844	0.60686	7	7	0	0	0.6447124
Thallium	mg/L	0.0008	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-	-	-	-	-	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0	0	0.0002	7	0	7	0	0.0002
Tin	mg/L	n/v	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0	0	0.001	7	0	7	0	0.001
Titanium	mg/L	n/v	0.0012	0.0011	0.0012	0.0010	0.0015	0.0072 DX	0.0019 DX	-	-	-	-	-	0.001	0.0072	0.0021571	0.0012	0.0017	0.00561	0.0022441	0.0008482	0.0016443	7	7	0	0	0.003819572
Uranium	mg/L	0.015	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	-	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0	0	0.0001	7	0	7	0	0.0001
Vanadium	mg/L	n/v	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0014	<0.0010	-	-	-	-	-	0.001	0.0014	0.0011	0.001	0.001	0.0013	0.0002	0.0001	0.001	7	1	6	0	0.001296
Zinc	mg/L	EQ2	0.014	0.014	0.026 DX	0.031	0.016	0.028 DX	0.024	-	-	-	-	-	0.014	0.031	0.021857	0.024	0.027	0.0301	0.007081	0.002676	0.020825	7	7	0	0	0.02710196

See notes on last page.

Table B.9
Summary of Wellsite Water Sample Analytical Results: Reference Samples and Statistical Calculations
Kumak I-25 Wellsite
MGM Energy

Location			I-25 Wellsite												Statistical Calculations												
Sample Date		CCME	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	18-Aug-17	18-Aug-17	18-Aug-17	18-Aug-17													
Sample ID			I25_WELL_W2	I25_WELL_W2 Lab-Dup	I25_WELL_W3	I25_WELL_W4	I25_WELL_W5	I25_WELL_W6	I25_WELL_W7	I25_WELL_W7 Lab-Dup	I25_WELL_WS1	I25_WELL_QA1	I25_WELL_WS3	I25_WELL_WS4/5													
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC													
Laboratory		Freshwater	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX													
Laboratory Work Order		Aquatic Life	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B771667	B771667	B771667	B771667													
Laboratory Sample ID		Long Term [A]	PJ3137	PJ3137	PJ3138	PJ3139	PJ3140	PJ3141	PJ3142	PJ3142	RU4320	RU4321	RU4322	RU4323													
Sample Type	Units			Lab Replicate						Lab Replicate		Field Duplicate			Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	Exceed	95 UCLM
Metals, Total																											
Aluminum	mg/L	0.005_{VAR1}	**0.23[A]**	-	**0.21[A]**	**0.20[A]**	**0.32[A]**	**0.49[A]**	**0.20[A]**	-	-	-	-	-	0.2	0.49	0.27	0.22	0.3	0.45	0.11	0.05	0.26	6	6	0	6	0.368
Antimony	mg/L	n/v	<0.00060	-	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	-	-	-	-	-	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0	0	0.0006	6	0	6	0	0.0006
Arsenic	mg/L	0.005	0.00087	-	0.0012	0.0011	0.0020	0.0012	0.00079	-	-	-	-	-	0.00079	0.002	0.00119	0.00115	0.0012	0.0018	0.00043	0.00018	0.00114	6	6	0	0	0.0015428
Barium	mg/L	n/v	0.046	-	0.043	0.034	0.16	0.059	0.031	-	-	-	-	-	0.031	0.16	0.062	0.044	0.056	0.135	0.049	0.02	0.052	6	6	0	0	0.1012
Beryllium	mg/L	n/v	<0.0010	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0	0	0.001	6	0	6	0	0.001
Boron	mg/L	1.5	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0.02	6	0	6	0	0.02
Cadmium	mg/L	0.00009_{LTG}	0.000030	-	0.000037	0.000063	0.000080	0.000043	0.000036	-	-	-	-	-	3.00E-05	8.00E-05	4.80E-05	4.00E-05	5.80E-05	7.60E-05	1.90E-05	8.00E-06	4.50E-05	6	6	0	0	0.00006368
Calcium	mg/L	n/v	9.7	-	11	8.6	13	15	10	-	-	-	-	-	8.6	15	11.2	10.5	12.5	14.5	2.4	1	11	6	6	0	0	13.16
Chromium	mg/L	n/v	0.0013	-	0.0012	0.0010	0.0017	0.0020	0.0011	-	-	-	-	-	0.001	0.002	0.0014	0.0012	0.0016	0.0019	0.0004	0.0002	0.0013	6	6	0	0	0.001792
Cobalt	mg/L	n/v	0.0010	-	0.00081	0.0014	0.0049	0.0018	<0.00030	-	-	-	-	-	0.0003	0.0049	0.0017	0.0012	0.0017	0.00412	0.00165	0.00067	0.0012	6	5	1	0	0.0030132
Copper	mg/L	0.002_{TBC1}	0.0015	-	0.0018	0.0020	**0.0042[A]**	0.0015	0.0018	-	-	-	-	-	0.0015	0.0042	0.0021	0.0018	0.002	0.0036	0.001	0.0004	0.002	6	6	0	1	0.002884
Iron	mg/L	0.3	**1.1[A]**	-	**1.1[A]**	**1.2[A]**	**7.2[A]**	**3.5[A]**	**0.89[A]**	-	-	-	-	-	0.89	7.2	2.5	1.15	2.92	6.28	2.5	1.02	1.79	6	6	0	6	4.4992
Lead	mg/L	0.001_{TBC1}	<0.00020	-	<0.00020	<0.00020	**0.0028[A]**	0.00033	<0.00020	-	-	-	-	-	0.0002	0.0028	0.00066	0.0002	0.0003	0.00218	0.00105	0.00043	0.00034	6	2	4	1	0.0015028
Lithium	mg/L	n/v	<0.020	-	<0.020	<0.020	<0.020	<0.020	<0.020	-	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0.02	6	0	6	0	0.02
Magnesium	mg/L	n/v	4.6	-	5.9	4.8	6.2	7.3	6.0	-	-	-	-	-	4.6	7.3	5.8	6	6.2	7	1	0.4	5.7	6	6	0	0	6.584
Manganese	mg/L	n/v	0.063	-	0.067	0.24	0.27	0.040	<0.0040	-	-	-	-	-	0.004	0.27	0.114	0.065	0.1967	0.2625	0.1119	0.0457	0.0594	6	5	1	0	0.203572
Molybdenum	mg/L	0.073	0.00066	-	0.00047	0.00044	0.0032	0.00049	0.00036	-	-	-	-	-	0.00036	0.0032	0.00094	0.00048	0.00062	0.00256	0.00111	0.00045	0.00065	6	6	0	0	0.001822
Nickel	mg/L	0.025_{TBC1}	0.0039	-	0.0040	0.0031	0.0050	0.0062	0.0045	-	-	-	-	-	0.0031	0.0062	0.0044	0.0042	0.0049	0.0059	0.0011	0.0004	0.0043	6	6	0	0	0.005184
Phosphorus	mg/L	n/v	<0.10	-	<0.10	<0.10	0.33	0.12	<0.10	-	-	-	-	-	0.1	0.33	0.14	0.1	0.12	0.28	0.09	0.04	0.13	6	2	4	0	0.2184
Potassium	mg/L	n/v	<0.30	-	<0.30	<0.30	<0.30	<0.30	<0.30	-	-	-	-	-	0.3	0.3	0.3	0.3	0.3	0.3	0	0	0.3	6	0	6	0	0.3
Selenium	mg/L	0.001	0.00030	-	0.00029	0.00027	0.00039	0.00037	0.00027	-	-	-	-	-	0.00027	0.00039	0.00032	0.0003	0.00035	0.00038	5.00E-05	2.00E-05	0.00031	6	6	0	0	0.0003592
Silicon	mg/L	n/v	1.9	-	0.96	1.3	1.9	2.6	2.5	-	-	-	-	-	0.96	2.6	1.86	1.9	2.35	2.58	0.65	0.26	1.76	6	6	0	0	2.3696
Silver	mg/L	0.00025	<0.00010	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	-	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0	0	0.0001	6	0	6	0	0.0001
Sodium	mg/L	n/v	5.7	-	5.7	5.3	6.2	7.5	6.4	-	-	-	-	-	5.3	7.5	6.1	6	6.4	7.2	0.8	0.3	6.1	6	6	0	0	6.688
Strontium	mg/L	n/v	0.031	-	0.031	0.025	0.043	0.036	0.024	-	-	-	-	-	0.024	0.043	0.032	0.031	0.035	0.041	0.007	0.003	0.031	6	6	0	0	0.03788
Sulphur	mg/L	n/v	0.55	-	0.63	0.57	0.88	0.71	0.55	-	-	-	-	-	0.55	0.88	0.65	0.6	0.69	0.84	0.13	0.05	0.64	6	6	0	0	0.748
Thallium	mg/L	0.0008	<0.00020	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-	-	-	-	-	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0	0	0.0002	6	0	6	0	0.0002
Tin	mg/L	n/v	<0.0010	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0	0	0.001	6	0	6	0	0.001
Titanium	mg/L	n/v	0.0024	-	0.0017	0.0020	0.028	0.0069	0.0014	-	-	-	-	-	0.0014	0.028	0.0071	0.0022	0.0058	0.0227	0.0105	0.0043	0.0036	6	6	0	0	0.015528
Uranium	mg/L	0.015	<0.00010	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	-	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0	0	0.0001	6	0	6	0	0.0001
Vanadium	mg/L	n/v	0.0012	-	0.0010	0.0012	0.0042	0.0021	<0.0010	-	-	-	-	-	0.001	0.0042	0.0018	0.0012	0.0019	0.0037	0.0013	0.0005	0.0015	6	5	1	0	0.00278
Zinc	mg/L	n/v	0.017	-	0.024	0.032	0.028	0.026	0.025	-	-	-	-	-	0.017	0.032	0.025	0.026	0.028	0.031	0.005	0.002	0.025	6	6	0	0	0.02892
BTEX and Petroleum Hydrocarbons																											
Benzene	µg/L	370	<0.40	-	<0.40	<0.40	<0.40	<0.40	<0.40	-	-	-	-	<0.40	0.4	0.4	0.4	0.4	0.4	0.4	0	0	0.4	7	0	7	0	0.4
Toluene	µg/L	2	<0.80 EC	-	<0.40	<0.40	<0.60 EC	<0.40	<0.40	-	-	-	-	0.70	0.4	0.8	0.528571	0.4	0.65	0.77	0.170434	0.064418	0.506921	7	1	6	0	0.65483028
Ethylbenzene	µg/L	90	<0.40	-	<0.40	<0.40	<0.40	<0.40	<0.40	-	-	-	-	<0.40	0.4	0.4	0.4	0.4	0.4	0.4	0	0	0.4	7	0	7	0	0.4
Xylene, m & p-	µg/L	n/v	<0.80	-	<0.80	<0.80	<0.80	<0.80	<0.80	-	-	-	-	<0.80	0.8	0.8	0.8	0.8	0.8	0.8	0	0	0.8	7	0	7	0	0.8
Xylene, o-	µg/L	n/v	<0.40	-	<0.40	<0.40	<0.40	<0.40	<0.40	-	-	-	-	<0.40	0.4	0.4	0.4	0.4	0.4	0.4	0	0	0.4	7	0	7	0	0.4
Xylenes, Total	µg/L	n/v	<0.80	-	<0.80	<0.80	<0.80	<0.80	<0.80	-	-	-	-	<0.80	0.8	0.8	0.8	0.8	0.8	0.8	0	0	0.8	7	0	7	0	0.8
PHC F1 (C6-C10 range)	µg/L	n/v	<100	-	<100	<100	<100	<100	<100	-	-	-	-	<100	100	100	100	100	100	100	0	0	100	7	0	7	0	100
PHC F1 (C6-C10 range) minus BTEX	µg/L	n/v	<100	-	<100	<100	<100	<100	<100	-	-	-	-	<100	100	100	100	100	100	100	0	0	100	7	0	7	0	100
PHC F2 (>C10-C16 range)	mg/L	n/v	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-	-	<0.10	0.1	0.1	0.1	0.1	0.1	0.1	0	0	0.1	7	0	7	0	0.1
PHC F3 (>C16-C34 range)	mg/L	n/v	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0.2	6	0	6	0	0.2
PHC F4 (>C34-C50 range)	mg/L	n/v	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0.2	6	0	6	0	0.2
Chromatogram to baseline at C50	none	n/v	YES	-	YES	YES	YES	YES	YES	-	-	-	-	-														0

See notes on last page.

Table B.9
Summary of Wellsite Water Sample Analytical Results: Reference Samples and Statistical Calculations
Kumak I-25 Wellsite
MGM Energy

Location			I-25 Wellsite												Statistical Calculations													
Sample Date		CCME	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	21-Aug-16	18-Aug-17	18-Aug-17	18-Aug-17	18-Aug-17														
Sample ID			I25_WELL_W2	I25_WELL_W2 Lab-Dup	I25_WELL_W3	I25_WELL_W4	I25_WELL_W5	I25_WELL_W6	I25_WELL_W7	I25_WELL_W7 Lab-Dup	I25_WELL_WS1	I25_WELL_QA1	I25_WELL_WS3	I25_WELL_WS4/5														
Sampling Company			STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC	STANTEC														
Laboratory		Freshwater	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX	MAXX														
Laboratory Work Order		Aquatic Life	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B673175	B771667	B771667	B771667	B771667														
Laboratory Sample ID		Long Term [A]	PJ3137	PJ3137	PJ3138	PJ3139	PJ3140	PJ3141	PJ3142	PJ3142	RU4320	RU4321	RU4322	RU4323														
Sample Type	Units			Lab Replicate						Lab Replicate		Field Duplicate			Minimum	Maximum	Mean	Median	75th	95th	Std. Dev.	Std. Err.	Geo. Mean	Count	Detect	ND	Exceed	95 UCLM
Volatile Organic Compounds																												
Bromodichloromethane	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Bromoform (Tribromomethane)	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Bromomethane (Methyl bromide)	µg/L	n/v	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	2	2	2	2	2	2	0	0	2	6	0	6	0	2
Carbon Tetrachloride (Tetrachloromethane)	µg/L	13.3	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Chlorobenzene (Monochlorobenzene)	µg/L	1.3	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Chloroethane (Ethyl Chloride)	µg/L	n/v	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-	1	1	1	1	1	1	0	0	1	6	0	6	0	1
Chloroform (Trichloromethane)	µg/L	1.8	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Chloromethane	µg/L	n/v	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	2	2	2	2	2	2	0	0	2	6	0	6	0	2
Dibromochloromethane	µg/L	n/v	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-	1	1	1	1	1	1	0	0	1	6	0	6	0	1
Dichlorobenzene, 1,2-	µg/L	0.7	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichlorobenzene, 1,3-	µg/L	150	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichlorobenzene, 1,4-	µg/L	26	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloroethane, 1,1-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloroethane, 1,2-	µg/L	100	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloroethene, 1,1-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloroethene, cis-1,2-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloroethene, trans-1,2-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloropropane, 1,2-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloropropene, cis-1,3-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Dichloropropene, trans-1,3-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Ethylene Dibromide (Dibromoethane, 1,2-)	µg/L	n/v	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0.2	6	0	6	0	0.2
Methyl Methacrylate	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Methyl tert-butyl ether (MTBE)	µg/L	10,000	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Methylene Chloride (Dichloromethane)	µg/L	98.1	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	2	2	2	2	2	2	0	0	2	6	0	6	0	2
Styrene	µg/L	72	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Tetrachloroethane, 1,1,1,2-	µg/L	n/v	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-	1	1	1	1	1	1	0	0	1	6	0	6	0	1
Tetrachloroethane, 1,1,2,2-	µg/L	n/v	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	2	2	2	2	2	2	0	0	2	6	0	6	0	2
Tetrachloroethene (PCE)	µg/L	110	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trichlorobenzene, 1,2,3-	µg/L	8	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-	1	1	1	1	1	1	0	0	1	6	0	6	0	1
Trichlorobenzene, 1,2,4-	µg/L	24	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-	1	1	1	1	1	1	0	0	1	6	0	6	0	1
Trichlorobenzene, 1,3,5-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trichloroethane, 1,1,1-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trichloroethane, 1,1,2-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trichloroethene (TCE)	µg/L	21	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trichlorofluoromethane (Freon 11)	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trihalomethanes	µg/L	n/v	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	-	-	-	-	2	2	2	2	2	2	0	0	2	6	0	6	0	2
Trimethylbenzene (mixed isomers)	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Trimethylbenzene, 1,3,5-	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5
Vinyl Chloride	µg/L	n/v	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	6	0	6	0	0.5

Notes:

CCME	Canadian Council of Ministers of the Environment
A	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term
6.5[A]	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
EQ2	The long-term CWQG is for dissolved zinc and is calculated using the following equation: CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). The value in the table is for surface water of 50 mg CaCO3·L−1 hardness, pH of 7.5 and 0.5 mg·L−1 DOC. The CWQG equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1.
LTG	The CWQG for cadmium (i.e. long-term guideline) of 0.09 µg·L-1 is for waters of 50 mg CaCO3·L-1 hardness. The CWQG for cadmium is related to water hardness (as CaCO3): At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation (CWQG (µg/L) = 10(0.83(log[hardness]) – 2.46)); At hardness > 280 mg/L, the CWQG is 0.37 µg/L.
SN	see Narrative
TBC1	Value is minimum value available. Sample-specific value to be calculated (equation).
VAR1	Variable, 5 µg/L if pH < 6.5 and 100 µg/L if pH > 6.5
DX	Dissolved greater than total. Results within acceptable limits of precision.
EC	Detection limit raised due to interferent.
RD	Dissolved greater than total. Reanalysis yields similar results.
VV	Detection limit raised based on sample volume used for analysis.

Appendix C Reclamation Materials

Table C.1 Native Grass Seed Mix Recommended for E-07, K-30, and I-25 Wellsite Revegetation

Species- Common Name	Species- Scientific Name	Percent by Weight
violet wheatgrass	(*Agropyron violaceum/Elymus alaskanus*)	75
polargrass	(*Arctagrostis latifolia*)	12.5
tufted hairgrass	(*Deschampsia caespitosa*)	12.5
	Total:	**100**

Notes:

1. Species or percent proportion changes may be required due to seed stock availability or seed prices at time of ordering.
2. Seed mix will be ordered from a reputable supplier and will be a minimum of Canada No. 1 Forage Mix grading.
3. This native grass seed mix was applied in previous reclamation treatments on MGM ISR sites and has successfully established. Due to this proven establishment success, it is proposed to use this mix for these sites. The mix includes species that are native to the region and adapted to a range of ground conditions such as flooding/high soil moisture, high salt conditions, low/high soil pH, and drought.
4. MGM will consider the feasibility of incorporating other native forb and shrub species that are endemic to the Mackenzie Delta region into the reclamation seed mix through consultations with seed suppliers and arctic vegetation experts (e.g., Aurora Research Institute). Potential native forb and shrub species include: green alder (*Alnus viridis*), red bearberry (*Arctous rubra*), glandular birch (*Betula glandulosa*), sedges (*Carex* sp.), fireweed (*Chamerion angustifolium*), black crowberry (*Empetrum nigrum*), cottongrass (*Eriophorum* sp.), Arctic sweet coltsfoot (*Petasites frigidus*), narrow-leaved Labrador tea (*Rhododendron tomentosum*), cloudberry (*Rubus chamaemorus*), willows (*Salix* sp.), bog cranberry (*Vaccinium vitis-idaea*).
5. Additional candidate native grass species for the seed mix that are adapted to high salt conditions and flooding/high soil moisture:
   - slender wheatgrass (*Agropyron pauciflorum/Elymus trachycaulus*)
   - ticklegrass (*Agrostis scabra*)
   - American sloughgrass (*Beckmannia syzigachne*)
   - bluejoint reedgrass (*Calamagrostis canadensis*)
   - red fescue (*Festuca rubra*)
   - alpine bluegrass (*Poa alpina*)
   - fowl bluegrass (*Poa palustris*)
   - spike trisetum (*Trisetum spicatum*)
6. Certificates of seed analysis may be requested from the supplier for each of the species.