MGM ENERGY CORP.
KELLY LAKE NWT 2007
LONGLINE GRAVITY SURVEY
FINAL REPORT
Norman Wells, Northwest Territories
September 23 to September 29, 2006
August 23 to September 27, 2007

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UNDER SEPARATE 11” X 17” COVER

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INTRODUCTION

The following report describes the Kelly Lake longline gravity survey conducted by *Excel Geophysics Inc.* (*Excel*) for *MGM Energy Corp (MGM).* The gravity survey covered a total area of 4,301 km^2 in the Northwest Territories, Canada, specifically northeast of Norman Wells, and was conducted in two phases. National Energy Board (NEB) approval was obtained prior to commencement of the gravity program. Phase one has an NEB operation ID of 9222-P255-001E and phase two has an operation ID of 9222-M276-001E. Phase one of the survey was conducted from September 23 to September 29, 2006 and phase two was conducted from August 23 to September 27, 2007. The area is comprised of scattered, sparse forests and barren lands which were accessed and surveyed via helicopter. Figure 1 shows the location of the project.

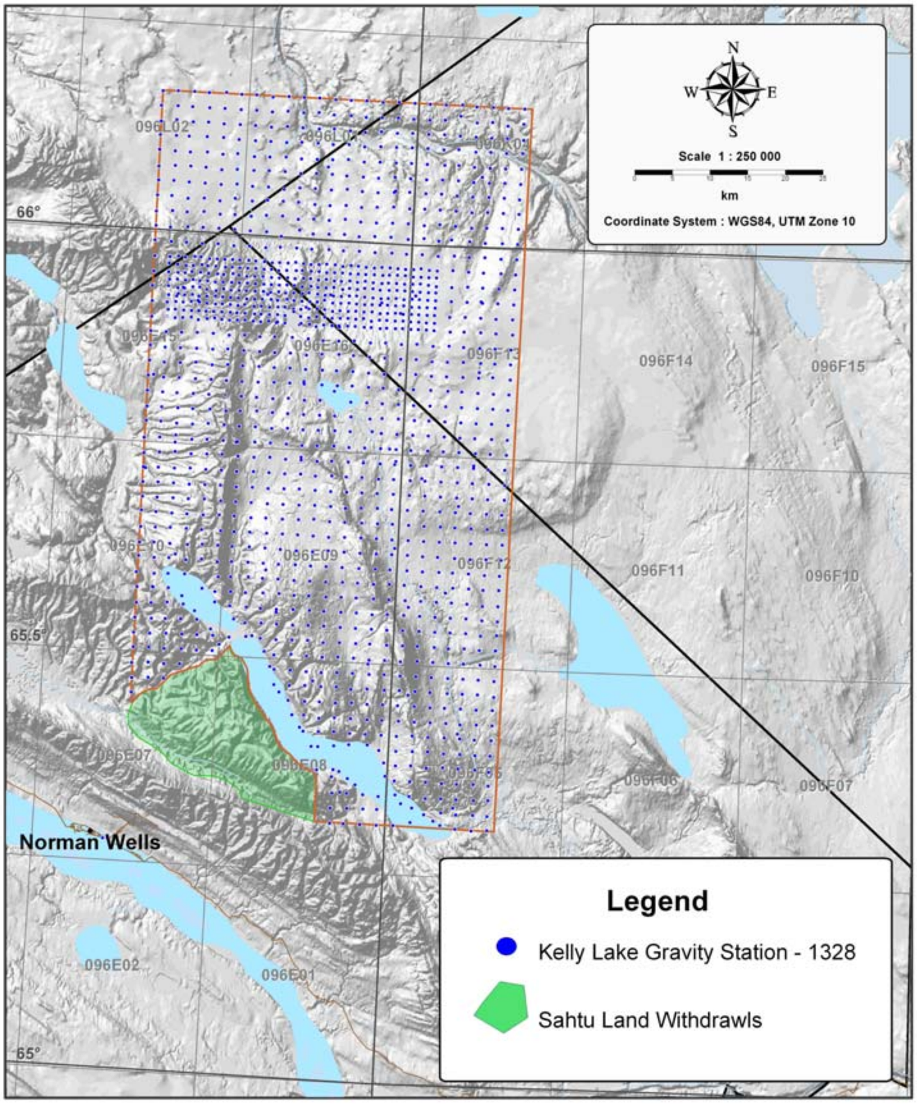

Figure 1. Kelly Lake 2006/2007 Longline Gravity Program.

SAFETY

Each *Excel* crew member held valid safety certificates in Emergency First Aid, H_2S Awareness, and WHMIS. An emergency response plan containing contact numbers and emergency procedures was distributed and explained to all field staff, and posted in an accessible location. Safety meetings were held by the field staff on a regular basis to help identify any potential safety hazards. There were no injuries during this survey.

Excel ensured that each member of the crew was equipped with appropriate outdoor wear, two-way radio, satellite phone, and emergency first-aid kit. Helicopters were maintained on a regularly scheduled basis by *Sahtu Helicopters* and were equipped with satellite phone, first-aid supplies, fire extinguishers, and emergency beacons.

Two helicopters were on site for the duration of the survey and the field crews had a regular check in schedule with the other helicopter or the field camp. Daily flight routes were discussed in advance to ensure that everyone on the crew knew the location of the helicopters in the event of an emergency. Within the survey area, the topography was open enough to provide landing spots in the event of an accident requiring evacuation.

GRAVITY SURVEY PARAMETERS

The following two tables outline the main details of the gravity survey as well as the people involved with this project.

Table 1. Gravity Survey Prameters

Gravity Survey Parameters	
General Survey Location	North of Norman Wells, NWT Latitude: 65° 18’ N – 66° 10’ N Longitude: 126° 45’ W – 125° 41’ W
Survey Duration	Phase 1: Sept 23 to Sept 29, 2006 Phase 2: Aug 23 to Sept 27, 2007
Gravity Station Spacing	2,000 m grid with 1,000 m infill
Gravity Stations Acquired	1,328
Terrain Corrections	to 40 km
Methods of Transportation	2 Hughes 500 Helicopters, provided by *Sahtu Helicopters*
Longline Gravity Meters Used	LaCoste and Romberg U-27 (387)
Land Gravity Meter Used	LaCoste and Romberg G-239 LaCoste and Romberg G-181

Table 2. Project Personnel

Project Personnel		
***Excel* Operations Manager**	Jessica Wright	
Gravity Field Crew	Rob Folkersen	Jessica Wright
	Andrew Beefus	Janelle Kaprowski
	James Beechey	Tiffany Taggart
	Lincoln Weller	Mitch Jackson
Data Processors	Nicole Trenholm	Sheldon Kasper

***Sahtu Helicopter* Pilots**	James Forward	Malcolm Cross
	Paul Bisaillon	Dave Depouter
	Barrett Soroka	Eric Petrunia
	Brad Lillow	
***Sahtu Helicopter* Engineer**	Tory Lewis	

GRAVITY SURVEY PROCEDURE

The survey crew consisted of eight *Excel* geophysical operators, along with seven pilots and two helicopter engineers from *Sahtu Helicopters*. A Bell 204 from *Sahtu Helicopters* slung fuel from Norman Wells, NWT to seven remote fuel caches within the project area. Figure 2 shows the location of the fuel caches as red diamonds on the map. Two Hughes 500 helicopters from *Sahtu Helicopters* conducted the longline portion of the survey as well as set up GPS base stations. These helicopters also slung empty and unused fuel drums from the field to Norman Wells to clean up all fuel caches.

Excel had a supervisor on site for the duration of the project to coordinate all aspects of the operation including data quality control, client communications, aviation fuel placement, staffing, environmental compliance and adherence to safety guidelines. Operations were based out of the Mackenzie Valley Hotel, Norman Wells, NWT. The lodge was equipped with a kitchen, sleeping accommodations, laundry facilities, phone, and internet access. Transportation of personnel and equipment from the Motel to the airport each day was provided by a truck rented from the Norman Wells Transportation Ltd.

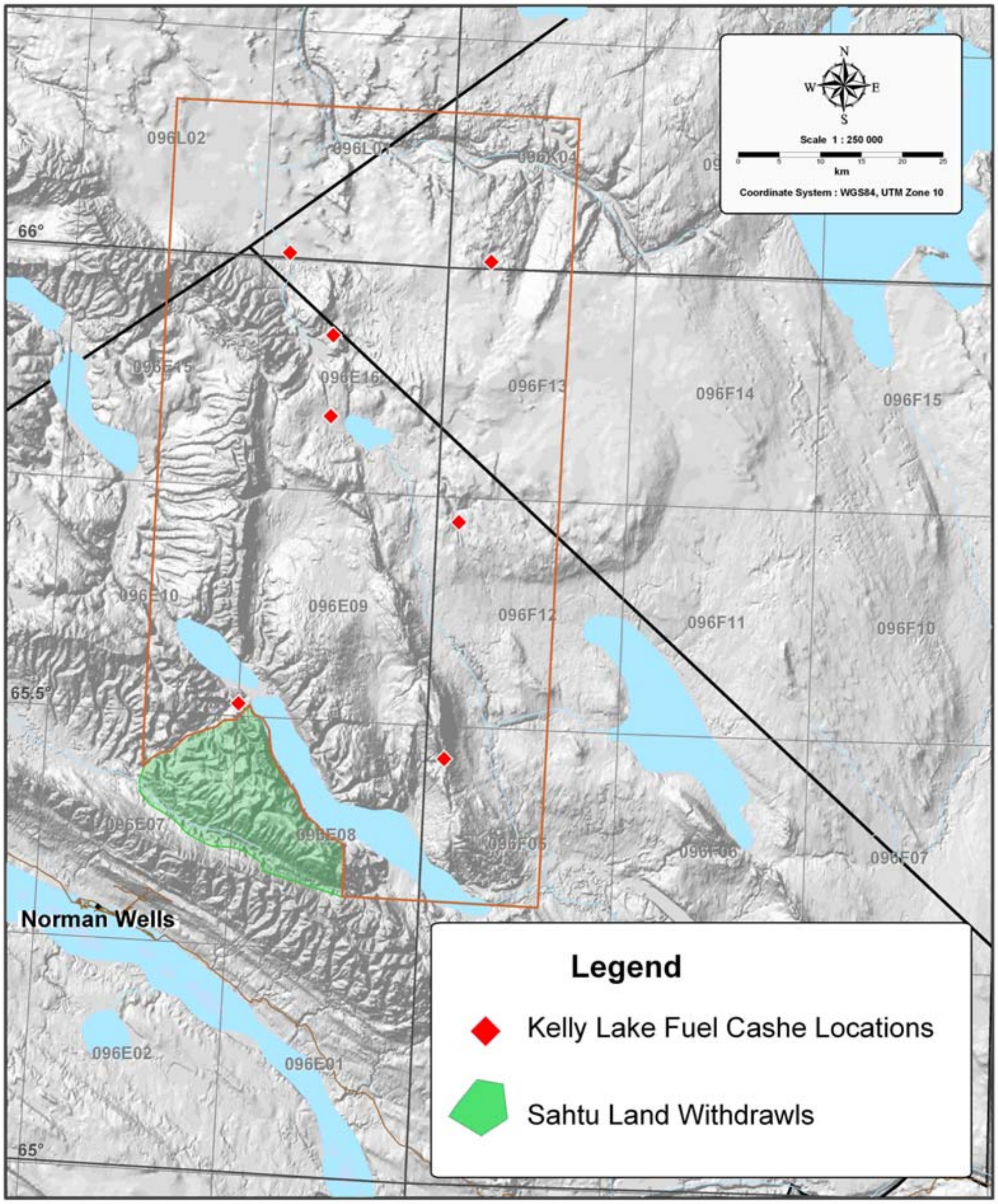

Figure 2. Fuel Cache Locations.

The entire project area was surveyed by helicopter. A longline gravity meter was slung under the helicopter on a 150-foot longline. Figure 3 shows an example of the Hughes 500 helicopter and Figure 4 shows the longline gravity apparatus as it appeared in the air. Gravity readings were spaced at 2,000 m with an infill of 1,000 m in a grid pattern through the project area. A DynaNav GPS navigation system was used for navigation to each gravity station using a pre-programmed set of coordinates. The precise location of the helicopter and gravity meter at each station was determined using geodetic grade dual frequency Leica GPS receivers. This aspect of the survey is described in detail under GPS survey procedure and processing.

Figure 3. Example of a Hughes 500 Helicopter

Gravity data acquisition was conducted by the operator in the helicopter using a laptop computer linked via data cable to the suspended gravity meter. At each station, the pilot and operator would choose a location to place the meter such that the local topography features were not significant, and could be properly modeled with available digital elevation data. The pilot would then lower the suspended meter to the ground and lay out a few feet of slack in the cable to reduce the transfer of helicopter vibration to the gravity meter. The pilot then maintained a hovering position nearby. During this hovering phase a gravity reading was acquired. On average, a gravity reading was obtained every ten minutes.

Figure 4. Hughes 500 helicopter and gravity meter suspended by 150 ft longline

GRAVITY BASE STATIONS

The Kelly Lake 2006/2007 longline gravity survey was tied to a local gravity base from the Canadian Gravity Standardization Network (CGSN). The gravity base 9002-1992 is located inside the MOT multiple services building in Norman Wells. CGSN base 9002-1992 is shown in Figure 5. In 2005, *Excel* established a gravity base at the MacKenzie Valley Hotel (base 9263) from the CGSN base 9002-1992. Figure 6 shows the gravity and GPS base established at MacKenzie Valley Hotel. This base was used to tie in the two gravity bases located at the Sahtu hangar in Norman Wells, where the longline meters based in and out each day (Base 3571 and 3572). Table 3 shows the coordinates and gravity values for all of the Kelly Lake 2007 gravity bases.

Figure 5. CGSN Gravity Base 9002-1992, Norman Wells, NWT.

Figure 6. Gravity and GPS Control Base 357 09263, MacKenzie Valley Hotel.

Table 3. Norman Wells Gravity Bases (NAD83, UTM zone 10)

Base Name	UTMx (m)	UTMy (m)	Observed Gravity (mGal)
CGSN 9002-1992; Norman Wells, NWT	323312.526	7244782.928	982229.001
MacKenzie Valley Hotel Base 9263	322890.258	7244510.023	982229.77
Norman Wells Airport Longline Base 3571	323462.528	7244528.906	982229.20
Norman Wells Airport Longline Base 3572	323490.038	7244517.357	982229.33

GPS SURVEY PROCEDURE AND PROCESSING

Excel established a GPS control base at the MacKenzie Valley Hotel in Norman Wells, NWT. The base was tied into the Canadian Spatial Reference System, Primary Vertical Bench Mark Level 1 (PVBMC1) network, at base 519017, which is located at the airport in Norman Wells at the end of the runway with a marker set in concrete. The coordinates for both bases are shown in Table 4. The MacKenzie Valley Hotel control base was reoccupied each day in order to solve the network of field bases setup each day in the survey area.

Table 4. Norman Wells GPS Bases

Base Name	NAD 83 Latitude	NAD 83 Longitude	Ellipsoidal Elevation (m)	Orthometric Elevation (m)
Benchmark 519017	65° 16’ 37.238” N	126° 46’ 44.102” W	64.24	71.60
MacKenzie Valley Hotel 357 09263	65° 16’ 32.385” N	126° 47’ 48.238” W	53.26	60.60

Prior to gravity data acquisition each day, an *Excel* operator set up three or four Leica 500 series dual frequency geodetic quality GPS receivers as field bases. These field bases created a GPS base network to solve the data from our roving GPS units on the helicopters. A helicopter was used to access suitable sites in the survey area to set up the GPS base stations, and a G-series LaCoste and Romberg land gravity meter was used to obtain a reading at each of these sites. To ensure ample GPS coverage, the field base stations were positioned so the distance to the roving GPS unit on the helicopter was no more than ten kilometers.

Excel's operator in the longline helicopter was responsible for recording multiple instantaneous readings with the dual frequency Leica 500 GPS receiver on board. Multiple GPS readings were collected at each station to provide better accuracy for final results. A GPS reading was collected when the gravity meter was on the ground and the helicopter was positioned directly above it with the longline cable fully extended. In this position, the distance from the gravity meter to the helicopter mounted GPS antenna can be treated as a constant, measurable value. GPS readings were recorded when the meter was being lowered to the ground and when it was being picked up after a gravity reading. This provided two opportunities to obtain a GPS location, reducing or eliminating the need to repeat a gravity station due to a poor GPS solution.

The Leica 500 series GPS technology was chosen for longline gravity application because of its reliability, fast satellite acquisition, ease of operation, and small size. It also has advanced kinematic operational modes that are well suited to a non-stationary recording platform, such as a hovering helicopter.

GPS data were processed each evening using Leica Geosystem's post-processing software. Field base locations were solved from the control base, 357 10211, in Norman Wells (See Figure 6). Appropriate field bases were then used to calculate solutions for the GPS rover units on the helicopter. Factors such as satellite position, signal strength, and topography affect the results and the highest quality solutions were selected for each station.

GRAVITY DATA REDUCTION

The LaCoste and Romberg land gravity meter (G-series) is operated manually and is capable of reliable and repeatable gravity readings to an accuracy of better than 0.02 mGal by experienced operators. The operator must ensure that the meter is operated at the recommended regulated temperature and is level during the reading.

The date, time, station, dial reading and instrument height are recorded in a field notebook at each land gravity station. A gravity base is measured at the beginning and end of each day to correctly account for meter drift. Each evening the field data are entered into a portable notebook computer and corrected for sun/moon tidal effects, instrument height, and instrument drift to obtain the observed gravity. Refer to the *Observed Land Gravity Data Listing* (under separate cover) for the raw data, observed gravity and intermediate reduction values for each day.

The LaCoste and Romberg longline gravity meter (U-series) works on the same principles and basic mechanics as the land gravity meter and under field conditions is capable of reliable and repeatable gravity readings from the helicopter of better than 0.05 mGal by experienced operators. A laptop computer in the helicopter is linked to the longline meter through a data cable, enabling an operator to control the meter remotely using servomotors. Temperature is monitored on the screen and leveling is done automatically. When a reading is taken the date, time, station, dial reading and cheat voltage are written to a file to later be exported for processing. As with the land gravity meter, a gravity base station is recorded with the longline meter at the beginning and end of the day. In addition, a gravity reading is recorded at each helicopter refueling to confirm daily meter drift. Refer to the *Observed Longline Gravity Data Listing* (under separate cover) for the raw data, observed gravity and intermediate data reduction values for each day.

After the GPS data are processed, coordinates and elevations are merged with the observed gravity for each station. Standard corrections are applied to the observed gravity to yield final Bouguer anomaly values. See Table 5 for the formulae used to determine the intermediate corrections and Bouguer gravity values. The Bouguer gravity was calculated using variable density Bouguer and Terrain Corrections. Density values were assigned to each station by locating the station on a Surface Geology map based on the Tectonic Assemblage Map of the Canadian Cordillera (Wheeler and McFeely, 1991). The average elevation of surveyed stations in this project was 273 m. Based on this value, an elevation datum of 250 m was chosen to minimize the effect of the Variable Density Bouguer Correction. Refer to the *Variable Density Bouguer Gravity Data Listing* (under separate cover) for the Bouguer values and all intermediate corrections.

Table 5. Gravity Correction Formulae

Gravity Corrections	Description
Latitude Correction	Standard latitude correction adopted by the International Association of Geodesy, 1967. = 978031.85 * (1+0.005278895 $\sin^2$(latitude) + 0.000023462 $\sin^4$(latitude))
Free Air Correction	= (elevation (m) – datum (m)) * 0.3068 mGal/m
Bouguer Correction	= - (elevation (m) – datum (m))* density (g/cm^3) * (2.0 * pi * 0.006672) (note: density values vary depending on surface geology)
Terrain Corrections	Terrain corrections (50m to 40km) with variable densities computed with proprietary software.
Final Bouguer Values	Bouguer anomaly (mGal) = observed gravity – latitude correction + free air correction + Bouguer correction + terrain corrections

DATA QUALITY

The gravity survey was of excellent quality. A critical examination of the residual gravity maps reveals that the survey is clearly within an error envelope of 0.05 mGal. Relative station elevations were determined to better than 5 cm. Absolute elevations are probably better than 50 cm. Horizontal locations were determined to better than 1 m. Single point anomalies on the smallest residual map are likely caused by near surface gravity anomalies that are aliased due to the relatively sparse grid spacing of 2 km.

WILDLIFE

The Sahtu area is habitat for an abundant variety of animals. A wildlife monitor from either Norman Wells or Deline Renewable Resource Council worked with our crew during this survey. The wildlife monitor went out in the morning with the GPS base station helicopter to look for and record wildlife sightings, assess fuel cache locations, and identify any heritage sites or other areas that the field crew should avoid. When wildlife was sighted during longline data collection, the gravity station was skidded to avoid interaction. At the completion of the survey, no environmental damage had been done and no trace of our presence remained. Appendix C gives a detailed listing of the wildlife sightings during this survey.

REFERENCES

Wheeler, J.O. and McFeely, P. (comp), 1991. Tectonic Assemblage Map of the Canadian Cordillera and adjacent parts of the United States of America. Geological Survey of Canada Map 1712A

APPENDIX A - UTM Zone 10 Coordinate System Parameters

The coordinate system used for mapping purposes is UTM Zone 10 (NAD 83). Parameters for the coordinate system are shown in Table 6.

Table 6. UTM Zone 10 Mapping Parameters

Project Mapping System	
Datum	NAD 83
Ellipsoid	WGS 84
Latitude of Origin	Equator, 0º
Central Meridian	123º W
Grid Projection	UTM Zone 10
Scale Factor	0.9996
False Easting	500,000.0 m
False Northing	0.0 m

Ellipsoids:	WGS 84
Semi-major axis	6,378,137.0 m
Semi-minor axis	6,356,752.3 m

APPENDIX B - Data Listing Format of Reports in 11 x 17 binder

Observed Land Gravity Data

The *Observed Land Gravity Data Listing* (under separate cover) contains a listing of all land gravity data collected by the crew during the survey period. The data is presented in chronological order.

The LaCoste and Romberg G-series land gravity meter uses a zero length spring supporting a mass on a beam as is standard in all modern gravity meters. While the meter is level, a counter dial is turned to adjust the position of the beam until the force of gravity is balanced by the mechanical force of the zero length spring. A calibration table is used to convert the counter reading value to a value in mGal. While the zero length spring system is prone to drift during a day, this drift can be accurately identified and corrected by reoccupying a known gravity station one or more times during the day.

Each land gravity loop is separated by a blank row. On a longline gravity project, land gravity stations are collected at fuel caches and GPS field base locations, and are named accordingly. The primary gravity base is always assigned a line number of 0 to distinguish it from other readings, and can be seen at the start and end of each gravity loop. The date, time, Greenwich Mean offset, and project location (latitude and longitude) are used to compute the sun/moon gravity tide correction.

The relative gravity is computed by summing all of the terms:

Relative Gravity = calibrated counter reading + Instrument Height (HI) correction
+ tide correction - drift

Gravity base values can be seen in Table 3.

Observed Longline Gravity Data

The *Observed Longline Gravity Data Listing* (under separate cover) contains a listing of all longline gravity data collected by the crew during the survey period. The data are presented in chronological order.

Each longline gravity loop is separated by a blank row. Station numbers were assigned in a row-column format during the initial layout phase of the project. The airfield gravity base was always assigned a line number 0 and is typically found at the start and end of each day. Fuel caches were assigned a line number of 55, and are frequently used to minimize the effects of system drift during a day of data collection. The longline gravity meters work under the same principle as the land gravity meters, with the addition of a capacitance plate on the end of the moving beam and two fixed plates above and below the beam. These plates are used to apply an electrostatic force to the beam which combines with the mechanical force of the zero length spring to balance the force of gravity. As with the land gravity meters, a calibration table is used to convert the counter reading to a value in mGal. The electrostatic force, known more commonly as the cheat voltage, is converted to mGal via a conversion function unique to each meter.

The relative gravity for a longline meter is computed by summing all of these terms:

Relative Gravity = calibrated counter reading + calibrated cheat value + tide correction – drift

Bouguer Gravity Data

The *Variable Density Bouguer Gravity Data Listing* (under separate cover) displays the observed gravity and coordinate data with intermediate corrections and variable density Bouguer gravity values. The table summarizes all of the collected data including the survey coordinates, elevation, and observed gravity at each station. Latitude and longitude values are given as well as UTM zone 10 coordinates in NAD 83. The elevations shown are orthometric height above mean sea level, calculated using the GSD95 geoid model. The intermediate corrections include the latitude, free air, variable density Bouguer, bathymetry, and variable density terrain corrections. The variable density Bouguer gravity values were computed using density values determined from surface geology which range from 2.40 g/cm^3 to 2.73 g/cm^3. Terrain corrections were calculated for all stations using the most accurate digital elevation data available in the area. For the Kelly Lake 2006/2007 longline gravity survey, the digital elevation grid was created by integrating Canadian Digital Elevation Data, Level 1 (CDED1) and National Topographic Data Base (NTDB) data from the Centre for Topographic Information (CTI) at Natural Resources Canada.

APPENDIX C – Wildlife Sightings

Table 7. Wildlife Sightings

Date (mm/dd/yyyy)	Location	Type of Sighting	Number of Animals
8/23/2007			
8/24/2007			
8/25/2007			
8/26/2007			
8/27/2007			
8/28/2007			
8/29/2007			
8/30/2007	1543	Muskox	1
8/31/2007			
09/01/2007			
09/02/2007			
09/03/2007			
09/04/2007			
09/05/2007		Cow Moose Bull Moose	
09/06/2007			
09/07/2007			
09/08/2007			
09/09/2007			
09/10/2007		Moose	1
09/11/2007			
09/12/2007			
9/13/2007			
9/14/2007			
9/15/2007			
9/16/2007			
9/17/2007			
9/18/2007			
9/19/2007			
9/20/2007	Lennie Lake Ridge	Muskox	30
9/21/2007			
9/22/2007			
9/23/2007	Southcud Dorton	Moose	3
9/24/2007			
9/25/2007			
9/26/2007			
9/27/2007			