Yukon Energy Corporation

Marsh Lake Fall-Winter Storage Concept: 2010 Geomorphology Study Report

Report

Environment AECOM

Yukon Energy Corporation

Marsh Lake Fall-Winter Storage Concept: 2010 Geomorphology Study Report

Prepared by:

AECOM
2251 2nd Avenue 867 633 6474 tel
Whitehorse, YT, Canada Y1A 5W1 867 633 6321 fax
www.aecom.com

Project Number:

60146345 Task 2.2

Date:

May 2011

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AECOM
2251 2nd Avenue
Whitehorse, YT, Canada Y1A 5W1
www.aecom.com

867 633 6474 tel
867 633 6321 fax

May 13th, 2011

Hector Campbell
Director, Resource Planning
Yukon Energy Corporation
#2 Mile Canyon Rd
Whitehorse, YT Y1A 6S7

Dear Hector:

Project No: 60146345

Regarding: **Marsh Lake Fall-Winter Storage Concept: 2010 Geomorphology Study Report**

I am pleased to present the 2010 Geomorphology Study Report regarding the Marsh Lake Fall-Winter Storage Concept. This report outlines the data collected, modeling results and analyses of these results. Feel free to contact me should you have any questions or comments

Sincerely,
AECOM Canada Ltd.

Jena Gilman P.E., P.Eng
Principal Technical Specialist
Jena.gilman@aecom.com

JG:aj

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Report Prepared By:

Jena F. Gilman, P.Eng.
Principal Technical Specialist

Report Reviewed By:

Chad Davey, M.Sc.
Fluvial Geomorphologist

Executive Summary

This report summarizes the geomorphology work completed for the Marsh Lake Fall-Winter Storage Concept in 2010 and early 2011. This work included aerial overflights of Marsh Lake and portions of Tagish and Bennett Lakes, ground-based shoreline inspection of several sites on Marsh and Tagish Lakes, bathymetry data collection along various shorelines of Marsh Lake and Tagish River, and beach sediment grab samples.

A numerical wave model for the examination of wind-waves on Marsh Lake was also developed in order to establish pre-project wind-wave conditions and to simulate approximate post-project wind-wave conditions for comparison. The analysis was confined to the October-November period because those months experience increasingly stormier conditions while the lake level is still relatively high, thus posing the most risk to shorelines. Preliminary results from the numerical model results suggest that post-project wind-wave conditions are only marginally greater than pre-project conditions. The model does indicate that the extreme southern and northern ends of Marsh Lake (North M'Clintock, also known as Swan Haven Drive) and the area around Tagish River may experience higher wind-waves post-project.

For North M'Clintock, the shallow water over the mudflats tends to limit the growth of wind-waves. So, even though the 5-year significant wave heights could increase up to 21% over pre-project conditions, the 50-year wave results indicate only a 4% increase. In addition, the 5-yr. wave height and the 50-year wave height are very similar: 0.47 m. versus 0.54 m. Again, this is due to the shallow water, which limits how high waves can be sustained.

The wind-wave conditions at the Southern end of Marsh Lake near Tagish River will be much higher on a percentage basis. However, the amplitude of these waves is still quite small (0.30 m for a 50-year event) for the conditions modeled. This is due primarily to the prevailing southern winds and lower frequency of northern winds as well as the shallow conditions at this end of the lake.

Finally, this report offers recommendations for resolving some of the remaining uncertainties concerning the effect of the project concept on lakeshore geomorphology for the 2011 study year.

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1. Terms of Reference

This report is submitted in fulfillment of the 2010 Detailed Work Plan Marsh Lake Fall-Winter Storage Project Task 2.2.4 – Geomorphology Report Assessment, prepared by AECOM for Yukon Energy Corporation on January 25th, 2010. This task includes a report describing and analyzing all data collected on the geomorphology of the study area and a study of potential effects.

2. Project Overview

Yukon Energy Corporation (YEC) has engaged AECOM to assist with implementation of key energy development and enhancement projects as identified in YEC's 20-Year Resource Plan. One of the projects identified for YEC's Resource Plan is the Marsh Lake Fall-Winter Storage Project. The project concept envisions raising the licensed Full Supply Level (FSL) on Marsh Lake. The result of the raised FSL would be high lake levels during fall and early winter months, allowing more water to be held in storage for the winter hydro electric generation at Whitehorse generating station.

3. 2010 Work Plan

The work completed during 2010 included the following two primary elements:

- air and ground reconnaissance to identify areas potentially prone to shoreline erosion; and
- hydrodynamic modeling of Marsh Lake to estimate wave height increases due to the proposed project.

4. Air and Ground Reconnaissance – Marsh, Tagish and Bennett Lakes

AECOM performed a helicopter reconnaissance of the project area, approximately 60 m in elevation above the shoreline, of Marsh Lake, the Tagish River, and Tagish Lake to the British Columbia border, and Bennett Lake in early June 2010. With Marsh Lake's surface elevation at approximately 654.3 m above Mean Sea Level (MSL) during these surveys, it was possible to observe the lower regions of the beach. Areas of potential erosion or instability were noted for future study. A ground survey of portions of the study area was also conducted by the AECOM geomorphology team in early June. Figure 1 indicates several of the locations that were visited and subsequently included in the hydrodynamic modeling analysis.

The air and ground field reconnaissance is described in Appendix A, Marsh Lake Shoreline Erosion Reconnaissance dated 8 June 2010. Appendix A includes locations of the soil grab samples and photographs illustrating some of the sites discussed below. The following shoreline sites were walked, soil grab samples collected, and photographed.

4.1 North M'Clintock (Swan Haven)

The bluff in the vicinity of the Swan Haven public observation deck (Figure 1) is very actively eroding and residents have adopted a number of measures to try to protect the toe of the bluff including adding rock at the toe, dumping dirt and logs over the face of the bluff, as well as some bulkheading. The bluff here is approximately 3 to 4.5 m high (10 to 15 ft.). At the west end of this stretch of beach, the bluff is lower but is also heavily vegetated and not evidently eroding. The bluff disappears near the outlet of the lake and the beginning of a marsh area. At the east end of this stretch of beach is a rocky point. The bluff is low just west of this point, but still evidently suffering from some erosion. The beach here is shallowly sloped. Beyond the rocky point to the east, the bluff is also suffering erosion. There have been some attempts at a soil bioengineering approach to erosion control in this area. Appendix B, Minutes of Meeting dated 5 October 2010, is a record of a site visit and discussion with two North M'Clintock residents concerning erosion issues.

4.2 Army Beach

Army Beach (Figure 1) is very wide and shallowly sloped. The bank at the top of the beach is low, less than 0.6 m high (2 ft.) in most cases. Developed areas are closer to the water's edge at the west end than to the east. The bulkheading is more significant in the west as well. Bulkheading includes cement blocks, large rock, small rock, timber, and concrete.

4.3 Alaska Highway

Alaska Highway at the northeast corner of Marsh Lake (Figure 1) is very close to the water's edge though well above it. Large rock has been placed here for erosion control. The narrow beach consists of washed out rock from the highway embankment and native cobbles.

4.4 Public Boat Ramp (M'Clintock Place)

The public boat ramp located just south of M'Clintock Place (halfway between Army Beach and Judas Creek) (Figure 1) is located at the southern end of an area of cottages sitting atop a somewhat actively eroding bluff. South of the boat ramp there is no bluff and the upper part of beach is dominated by dense vegetation with no obvious near-shore development.

4.5 Tagish River Bridge

There is no noticeable erosion at the northern end of the Tagish River.

4.6 California Beach

While most of the surficial material at California Beach is sand, it changes to cobbles near the east end of the beach where the Tagish River begins. The upper beach consisted of sand dunes on top of which are cottages. There was noticeable accretion of sand at base of the dunes, burying the lower 0.3 to 0.6 m (1-2 ft.) of the small trees growing here. Near the Tagish River channel, the upper beach changes to steep bluff which is showing severe erosion.

On the western shore of the northwest corner of Tagish Lake, just south of California Beach (between lots 38 to 58, Taku Subdivision), several residents pointed out erosion issues subsequent to the ground reconnaissance of June 2010. An AECOM geomorphologist examined the site and spoke with the owner of one of the affected lots which exhibited significant erosion. The resident prepared a letter dated 25 June 2010 entitled "Potential Impact of Marsh Lake Fall Storage Concept on Tagish Beach Erosion", which is included in Appendix C.

Map Sources/Notes:
Basedata (250,000 and 50,000 scales) from Natural Resources Canada, Province of British Columbia and Yukon Territorial Government, 2010. All Rights Reserved.

N
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km
0 1 2 3 4

1:100,000

UTM Zone 8N, NAD 83

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Legend

Geomorph Sampling Sites

Transportation

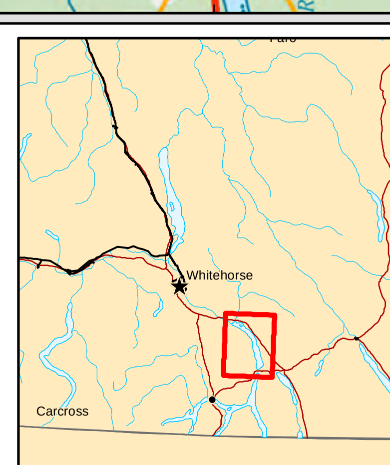
Highway

Road; Limited-used road; Railway

Water Features

Watercourse

Waterbody



YUKON ENERGY CORPORATION
MARSH LAKE FALL-WINTER STORAGE

Marsh Lake

Geomorphology Sampling Locations

May 2011
Project 60146345
Task 2.2

AECOM

Figure 1

Path: W:\GIS\Large Projects\YukonEnergy\Marsh Lake Fall-Winter Storage\2-Environment\2.2 Geomorphology\MXD\60146345_Sampling_Sites_11x17_20110512.mxd

Date Revised: May 12, 2011 Prepared by: DL Project: 60146345

4.7 Carcross

The near-shore water along the north shore was full of suspended silt, likely from the Watson River to the north. The Bennett Lake beach at Carcross was narrow and more sloped than at the Tagish or Marsh Lake sites visited. However, there was no evidence of erosion near the structures as there was a dense belt of shrubs and small trees between them and the beach.

5. Wind and Wave Analysis of Marsh Lake Shoreline Sites

In order to better understand the effects of the YEC proposal on Marsh Lake shorelines, AECOM undertook a numerical model to compare pre-project wave energy with post-project wave energy at specific sites around Marsh Lake. Wave heights at several sites around the lake were calculated and compared for both high and low operating lake levels over a range of wind frequencies (2-, 5-, 10- and 50-yr recurrence intervals). To focus the current study, the months of October and November were chosen for detailed analysis due to the increasing frequency of high winds in the fall and also the proposed retention of higher water levels during this period of time. The numerical model provides a direct comparison for a typical October or November so that the effects of the project can be approximately quantified. The model set-up and results are discussed further in Appendix D. The balance of this report deals with the input data (such as wind speed, lake levels, temperatures, etc.) needed for the model, how values for the input were selected, and a summary of model results.

6. Extreme Wind Speed and Water Level Analysis

The purpose of estimating the wind speeds and water levels is to obtain input data for the wave model known by its acronym STWAVE, Steady-State Spectral Wave Model. STWAVE is a widely used and robust model used for the simulation of near-shore wind-wave growth and propagation and produced by the US Army Corps of Engineers (2001). It is a steady-state finite-difference model based on the wave action balance equation. STWAVE simulates depth-induced wave refraction and shoaling, current-induced refraction and shoaling, depth and steepness-induced wave breaking, diffraction, wind-wave growth, and wave-wave interaction and white-capping that redistributes and dissipates energy in a growing wave field.

An extreme wind speed analysis was carried out to estimate wind frequencies with reoccurrence intervals of 2, 5, 10, 25 and 50-years for Marsh Lake. The data for this analysis was obtained from the Canadian National Climate Data and Information Archive (NCDIA) for the Whitehorse Weather Station located 22 miles from the lake (Environment Canada, 2010). The data record includes complete wind record for the years 1956 to 1995. The analysis was carried out for three sectors across the lake which were identified as the most crucial directions for sites located around the lake:

- 120° - 150°
- 150° - 180°
- 300° - 340°

The first two sectors are important for sites exposed to the south and south-southeast (i.e., Judas Creek, Army Beach and North M’Clintock). The third sector is important for those sites exposed to winds and waves from the north-northwest, such as the Marsh Lake Marina and Tagish Marina (Figure 1).

From the data series, the maximum monthly wind gust for October and November for each year and sector was calculated and used for further analysis. For years which lacked monthly maximum 5 second-wind gust data, the average monthly wind speed was used. 5 second-wind gust is the highest five second average wind speed measured in the last ten minutes of the observation time. Average wind speed is the speed recorded in the last two minutes before the observation time. The wind speeds were adjusted for the one hour average wind speed according to Figure 3-13 of the Shore Protection Manual (SPM 1984). The equation for this is given by:

$$\frac{U_t}{U_{3600}} = 1.277 + 0.296\, tanh\left\{0.9 \log_{10} \frac{45}{t}\right\} \; for\ 1 < t < 3600\ s$$

Equation 1

For the five second average wind gusts R_T becomes, $\frac{U_t}{U_{3600}} = 1.48$ and for the two minute average wind speeds R_T equals, $\frac{U_t}{U_{3600}} = 1.17$. The respective wind speeds were divided by this factor to obtain the one hour average wind speed.

In the next step wind speeds have to be adjusted for an elevation of 10 m, in case the wind measurements were not taken at 10 m. Because the height of the Whitehorse weather station varied over the years, a height adjustment was made. For the years 1956-1963, 1964-1972 and 1973-1995 the height of airport anemometer varied: 17.3 m, 13.1 m and 10 m. The height adjustment was done in accordance with the SPM, Chapter 3. Since all the wind measurement heights were less than 20 m, Equation 2 is valid and was used for the height adjustment.

$$U(10) = U(z)\left(\frac{10}{z}\right)^{\frac{1}{7}}$$

Equation 2

The wind data was collected over land and had to be adjusted to get representative overwater wind conditions. A correction coefficient, R_L was applied. When adjusting the wind speed for fetch it should be noted that the fetches for the three sectors of interest were all less than 16 km (10 miles). For fetches less than 16 km, the value of R_L is to be taken as 1.2 (SPM 1984).

The wind speed also has to be adjusted to take into account the effects of air-sea temperature difference. This is included in the final wind speed adjustment as the amplification ratio, R_T. The average temperature difference between air and lake water temperature for the months of October and November were -9.4 °C and -13.4 °C, respectively. The value of R_T was found as 1.15 for October and 1.2 for November (SPM 1984). Figure 2 shows a schematic of the adjustment process described above.

Wind Gust / Average Wind Speed from archived wind data

↓ ADJUSTMENT FOR HOURLY AVERAGE

$$\frac{U_t}{U_{3600}} = 1.277 + 0.296\,tanh\left\{0.9\log_{10}\frac{45}{t}\right\} \quad for\ 1 < t < 3600\ s$$

↓ ADJUSTMENT FOR THE HEIGHT

$$U(10) = U_{3600}(z)\left(\frac{10}{z}\right)^{\frac{1}{7}}$$

↓ ADJUSTMENT FOR FETCH AND TEMP

$$U(10) \times R_L \times R_T$$

↓ FINAL WIND SPEED FOR ANALYSIS

Final adjusted wind speed used for the extreme wind analysis

Figure 2 Schematic of wind speed adjustment process.

These adjusted wind speeds were used to obtain the extreme wind speeds for specified return periods using a generalized extreme value distribution (GEV) method, also referred to as the annual maximum method. The GEV method was used to find the extreme wind speeds. GEVs can be used to fit the maxima of long sequences of independent and identically distributed random variables. The cumulative distribution function (CDF) for this is given by Equation 3.

$$F(x) = \exp\left[-(1-ky)^{\frac{1}{k}}\right]$$

Equation 3

A Gumbel distribution is a generalized extreme value distribution of Type I, in which k=0. This simplifies Equation 3 to Equation 4.

$$F(x) = \exp\left[-\exp(-y)\right]$$

Equation 4

In Equation 4, the standard variant, y, is given by Equation 5.

$$y = \frac{x - \beta}{\alpha}$$

Equation 5

In Equation 5, β is the mode of the extreme value distribution (location parameter) and α is the dispersion (scale parameter).

The extreme wind speeds are most commonly expressed in terms of the quantile value X_T, the maximum wind speed which is exceeded on average, once every T years, the return period. X_T in reference to Palutikof et. al., 1999, is given by the formulation:

$$X_T = \beta - \alpha \ \ln\left[-\ln\left(1 - \frac{1}{T}\right)\right]$$

Equation 6

In order to estimate the extreme wind speeds for different return periods, the values of the mode (β) and dispersion (α) must be calculated. The maximum wind speeds for each year in the epoch in consideration is used to estimate the value of Gumbel reduced variate given by:

$$y_{Gumbel} = -\ln\{-\ln[F(x)]\}$$

Equation 7

In Equation 7, *F(x)* is the probability that an annual maximum wind speed is less than *x*. To estimate the values of *F(x),* the observed annual maxima is ranked in ascending order. Then an empirical $F(x_m)$ is calculated for the position x_m, and is given by:

$$F(x_m) = \frac{m}{N + 1}$$

Equation 8

In Equation 8, N is the sample size and m is the rank of the given maximum speed.

Once the values of y_{gumble} are calculated, a plot of y_{gumble} (ordinate) and the ranked annual maxima (abscissa) are plotted. A linear fit through the points gives the values of mode (β) and dispersion (α). Knowing these two values, Equation 6 can be used to find the extreme wind speed for a given return period.

Figure 3 shows a typical Gumbel plot for the month of November, for sector 120° – 150°. As seen from Figure 3, a linear fit through the points gives an estimation of mode (β) and dispersion (α). Gumbel plots were generated for all the sectors for October and November and corresponding mode (β) and dispersion (α) were used to find the extreme wind speeds for the different return periods. The results of this analysis are summarized in Table 1 and Table 2.

Figure 3 A Typical Gumbel Plot for November, Sector 120°-150°

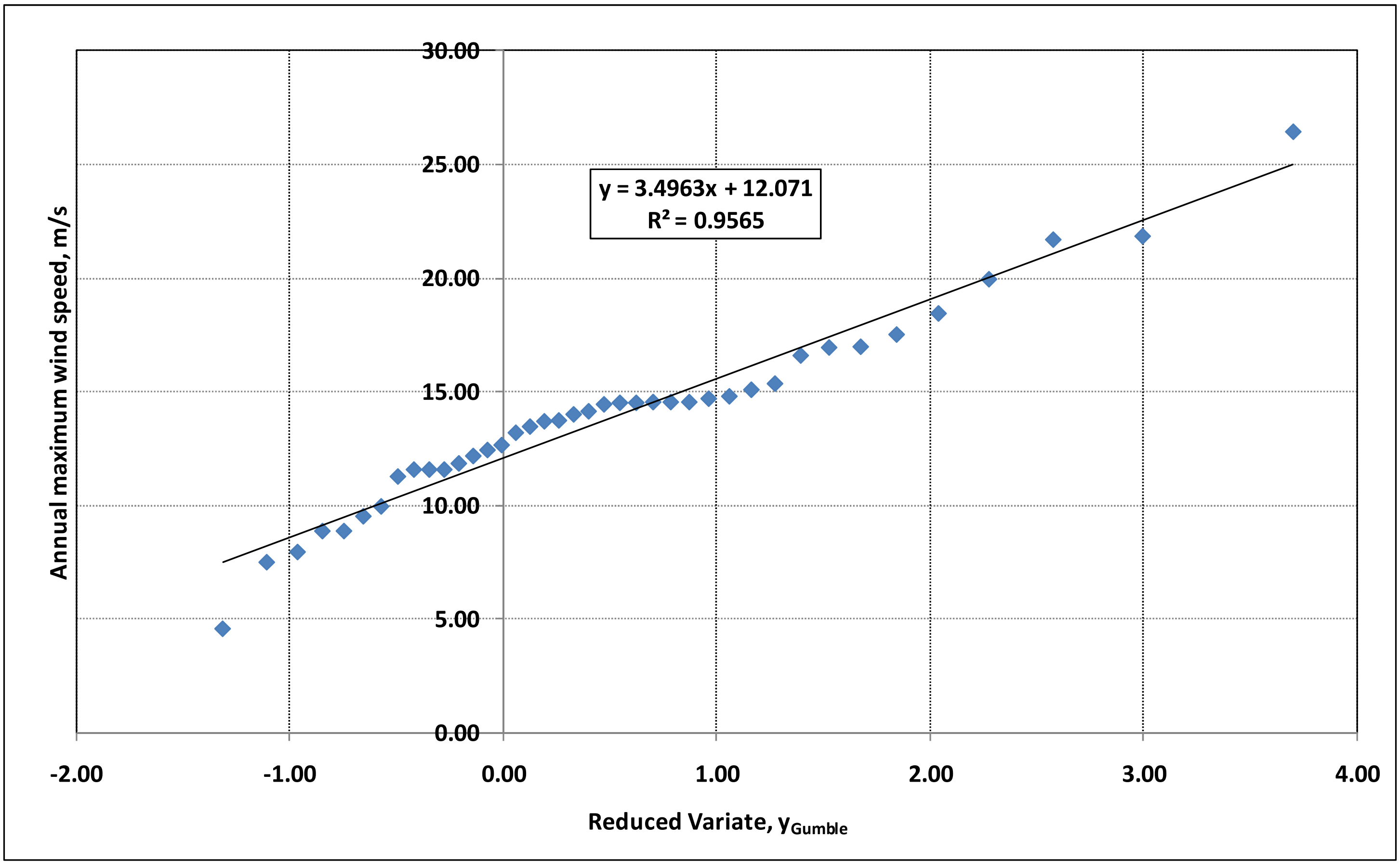


Table 1 Extreme wind speeds for October

	Sector		
	120°-150°	150°-180°	300°-340°
Return Period (Yr)	**Wind Speed (m/s)**		
2	13.3	15.6	8.55
5	16.8	18.6	12.1
10	19.1	20.6	14.5
25	22.1	23.2	17.5
50	24.3	25.1	19.7
100	26.5	27.0	21.9

Table 2 Extreme wind speeds for November

	Sector		
	120°-150°	150°-180°	300°-340°
Return Period (Yr)	**Wind Speed (m/s)**		
2	13.3	16.7	9.4
5	17.3	19.7	13.9
10	20.0	21.6	16.9
25	23.3	24.1	20.7
50	25.8	26.0	23.5
100	28.2	27.8	26.2

Data for estimating water levels for Marsh Lake was obtained from the Water Survey of Canada (from Environment Canada). The years that were considered for the Marsh Lake water level estimates were 1957-2010. Even though the data was available from 1957, it was decided that data prior to 1984 was not applicable, because Marsh Lake was operated differently before 1984. The data is given in metres above sea level (m ASL). Table 3 shows the average lake water levels for the period of 1957-1983 and for 1984-2010. The difference between these two epochs varied from 0.05 m ASL in August to 0.39 m ASL in November.

The future operating conditions (with the proposed raise of 0.3 m of the Full Supply Level) were simulated by Northwest Hydraulic Consultants (NHC) with the HEC-ResSim software. The model uses the historical data series for the inflows to the Southern Lakes and simulates the operation at Marsh Lake with the new proposed operational scheme. The future proposed average monthly water levels that are presented in Table 3 and 4 were retrieved from the Marsh Lake Hydrology Assessment Report (AECOM, 2011). The results of this simulation are shown in Table 3 and 4 under HEC-ResSim model. The difference between the simulated lake water levels and data series 1984-2010 lake water levels ranged from 0.07 to 0.51 m ASL.

STWAVE model results are also found in Table 4. The results illustrate the significant wave height in mid-transitional water depths (depth over wave length equal or greater than 0.25) for seven locations around Marsh Lake for each of four recurrence intervals. The 2-yr. recurrence interval would be more or less indicative of the worst storm waves on a year to year basis. The 50-yr. recurrence interval would indicate an extreme condition, and may or may not be the condition for which to design shore protection features, such as revetments.

In general the pre- and post-project significant wave heights increase by 4% or less for all but the North M'Clintock and Tagish River locations, at the extreme northern and southern sections of the lakeshore, respectively.

At North M'Clintock, a large shallow mudflat dominates the foreshore. Waves diffracting around the island near the north end of the lake and the point at the south end of South M'Clintock Road and then shoaling on the shallow area account for unusual situation of waves actually being 6-10% smaller for two of the cases, while being up to 17-21% larger for the 5-yr. chance of recurrence scenario for winds blowing from the southwest (120-150 degree sector). For that same sector, the 2-yr. recurrence interval experiences an 8% increase in wave heights for a typical November and for the 50-yr. event, wave heights are 4% higher for November. Note that the design wave for North M'Clintock, even for the 50-yr event is relatively small (0.54 m) due to the effect the shallow water has on wave transformation as it approaches the area.

The higher model waves resulting from the post-project condition for the area of Marsh Lake north of the Tagish River outlet are sizable on a percentage basis, doubling in size for the 2-yr. and 5-yr. recurrence intervals in November and nowhere less than 63% larger post-project versus pre-project. Part of the explanation is due to the small magnitude of the waves. Even the 50-yr. wave is only 0.30 m. in height for a typical post-project November scenario. Small effects due to lake geometry and bathymetry have a much larger influence when the waves in question have such small initial amplitude.

Table 3 Marsh Lake Water Levels

Month	1957-1983 Lake Level (m)	1984-2010 Lake Level (m)	∆ between 1957-1983 and 1984-1995 series
August	656.19	656.23	0.05
September	656.13	656.22	0.09
October	655.91	656.14	0.23
November	655.65	656.04	0.39
December	655.49	655.86	0.37
HEC-ResSim model (proposed lake level)		**∆ between after and before increase in lake level**	
Month	**Lake Level (m)**	**HEC-ResSim Model - 1984 to 2010 series**	
August	656.30	0.07	
September	656.52	0.30	
October	656.53	0.39	
November	656.51	0.48	
December	656.36	0.51	

7. Recommendations for 2011 Geomorphology Program

There are several specific areas which are recommended for further study to better define the hydrodynamic and geomorphologic effects of the proposal on Marsh, Tagish and Bennett Lakes and their associated shorelines. Based on the work to date, further study is recommended as follows:

1. Residents Historical Anecdotal Observations – Collate residents' anecdotal observations of ice freeze-up and break-up timing to better anticipate the initiation of the 2011 field season.
2. Ice Stability Analysis – Assessment of potential lake ice integrity due to changes in lake levels to better understand how this may affect the resident's activities on the ice during winter months.
3. Ice Cover Freeze-up and Break-up Timing Model – Model potential changes in timing for freeze-up and break-up based on YEC proposal.
4. 2011 Break-up Observations – Field observations of 2011 break-up to determine significant areas prone to gouging and plucking.
5. M'Clintock Bay Modeling – Combination erosion and accretion model necessary to look at erosion of the North M'Clintock bluff properties while also examining effects of accretion and erosion on bottom sediments important for swan habitat. Model will probably require additional hydrographic surveys.
6. Tagish Lake Erosion – More detailed observations of erosion potential on Tagish Lake, including California Beach, the northeast corner of Tagish Lake and those shorelines of Tagish Lake south of the BC boundary that were not examined in detail in 2010.
7. Bennett Lake Erosion – More detailed observations of erosion potential at Bennett Lake, particularly WP&YR and Carcross.
8. Judas Creek – More detailed assessment of erosion potential at Judas Creek.
9. Marsh Lake - Tagish Lake Interaction – Detailed review of interaction of Marsh and Tagish Lake and effects on river and lake geomorphology.
10. Mapping Potential Erosion Site – Mapping of high and moderate potential areas of erosion on Southern Lakes.
11. Develop Preliminary Erosion Mitigation Concepts – Concept drawings and order of magnitude costs for potential erosion mitigation, including soil bioengineering options.
12. Yukon River Erosion Model – Model post-project velocities and erosive potential at representative river site in Whitehorse.
13. Additional Soils and Sediments Sampling and Testing – To support the above-listed assessments.

Significant Wave Height (meters)
Marsh Lake
March 21, 2011

Table 4. Summary of Wave Height (m) / Wave Period (s) Pre and Post-Project

Return Period (Yr)	Month	Historical or Projected Lake Level	Location / Wind Direction (deg.)									
			Tagish River		Judas Creek						Marsh Lake Marina	
			300-330	*% Change*	*120-150*	*% Change*	*150-180*	*% Change*	*300-330*	*% Change*	*300-330*	*% Change*
2	Oct	*historical*	0.05		0.24		0.73		0.34		0.35	
		projected	0.09	80%	0.24	0%	0.73	0%	0.36	6%	0.36	3%
	Nov	*historical*	0.05		0.24		0.78		0.37		0.38	
		projected	0.10	100%	0.25	4%	0.79	1%	0.38	3%	0.39	3%
5	Oct	*historical*	0.09		0.34		0.88		0.48		0.49	
		projected	0.15	67%	0.35	3%	0.89	1%	0.49	2%	0.50	2%
	Nov	*historical*	0.09		0.35		0.93		0.55		0.55	
		projected	0.18	100%	0.36	3%	0.94	1%	0.56	2%	0.56	2%
10	Oct	*historical*	0.11		0.34		0.98		0.57		0.58	
		projected	0.19	73%	0.34	0%	0.99	1%	0.58	2%	0.59	2%
	Nov	*historical*	0.12		0.35		1.02		0.66		0.67	
		projected	0.22	83%	0.36	3%	1.03	1%	0.68	3%	0.68	1%
50	Oct	*historical*	0.16		0.49		1.20		0.77		0.79	
		projected	0.26	63%	0.50	2%	1.21	1%	0.79	3%	0.80	1%
	Nov	*historical*	0.17		0.52		1.24		0.90		0.93	
		projected	0.30	76%	0.53	2%	1.26	2%	0.93	3%	0.95	2%

Return Period (Yr)	Month	Historical or Projected Lake Level	Location / Wind Direction (deg.)																	
			Boat Ramp (M'Clinktock Place)						North M'Clintock				Alaska Highway near Army Beach				Army Beach			
			120-150	*% Change*	*150-180*	*% Change*	*300-330*	*% Change*	*120-150*	*% Change*	*150-180*	*% Change*	*120-150*	*% Change*	*150-180*	*% Change*	*120-150*	*% Change*	*150-180*	*% Change*
2	Oct	*historical*	0.28		0.74		0.30		0.38		0.29		0.45		0.66		0.57		0.60	
		projected	0.29	4%	0.75	1%	0.30	0%	0.40	5%	0.29	0%	0.46	2%	0.67	2%	0.58	2%	0.61	2%
	Nov	*historical*	0.28		0.79		0.33		0.37		0.31		0.45		0.71		0.57		0.64	
		projected	0.29	4%	0.80	1%	0.34	3%	0.40	8%	0.32	3%	0.46	2%	0.73	3%	0.58	2%	0.66	3%
5	Oct	*historical*	0.33		0.87		0.44		0.39		0.36		0.57		0.80		0.73		0.72	
		projected	0.34	3%	0.88	1%	0.44	0%	0.47	21%	0.36	0%	0.59	4%	0.81	1%	0.74	1%	0.74	3%
	Nov	*historical*	0.35		0.92		0.51		0.41		0.38		0.58		0.84		0.76		0.75	
		projected	0.36	3%	0.94	2%	0.52	2%	0.48	17%	0.39	3%	0.59	2%	0.86	2%	0.77	1%	0.77	3%
10	Oct	*historical*	0.41		0.98		0.53		0.42		0.41		0.65		0.88		0.84		0.79	
		projected	0.42	2%	1.00	2%	0.53	0%	0.38	-10%	0.41	0%	0.67	3%	0.90	2%	0.85	1%	0.82	4%
	Nov	*historical*	0.42		1.03		0.64		0.40		0.43		0.67		0.92		0.84		0.83	
		projected	0.43	2%	1.05	2%	0.65	2%	0.44	10%	0.44	2%	0.69	3%	0.94	2%	0.85	1%	0.86	4%
50	Oct	*historical*	0.45		1.17		0.73		0.49		0.47		0.81		1.08		1.08		0.95	
		projected	0.47	4%	1.19	2%	0.74	1%	0.51	4%	0.47	0%	0.83	2%	1.10	2%	1.10	2%	0.99	4%
	Nov	*historical*	0.52		1.19		0.87		0.52		0.48		0.86		1.11		1.14		0.98	
		projected	0.54	4%	1.22	3%	0.89	2%	0.54	4%	0.45	-6%	0.88	2%	1.13	2%	1.15	1%	1.02	4%

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Appendix A

Marsh Lake Shoreline Erosion Reconnaissance Memo

AECOM
2251 2nd Avenue
Whitehorse, YT, Canada Y1A 5W1
www.aecom.com
867 633 6474 tel
867 633 6321 fax

Memorandum

To	Hector Campbell – Yukon Energy Corporation	Page	1
Subject	Marsh Lake Shoreline Erosion Reconnaissance		
From	Chad Davey – AECOM		
Date	June 8th, 2010	Project Number	60146345

On May 31st, and June 1st, 2010, Chad Davey and Jena Gilman of AECOM conducted a shoreline erosion reconnaissance of the Yukon River (confluence of Takhini River to Lewes control structure) and the Southern Lakes, including: Marsh Lake, Tagish Lake, and Bennet Lake. A helicopter survey was conducted for the shoreline perimeter of the Yukon River and Southern Lakes on May 31st. Areas of concern with respect to shoreline erosion identified by the helicopter survey were visited on foot June 1st. This field memo outlines the work that was completed, the data collected, and photos of the sites visited.

The purpose of the field visit was to identify areas of concern with respect to shoreline erosion along the Southern lakes under the proposed water level changes by YEC. The proposed water level changes along the Southern lakes would result in a ~30 cm higher water level for fall storage (September to January).

On May 31st, the Marsh Lake level was at 654.24 msl, on June 1st, the lake level was at 654.29 msl. Table 1 outlines the location of each sediment grab sample that was collected along various beaches within the Southern Lakes. A photo log is attached to this memo.

Sample ID	Location	Easting	Northing	Comment
SS1	McClintock Beach	527,142	6,712,485	Sample taken from exposed cliff w/erosion
SS2	McClintock Beach	526,966	6,712,315	Sample taken from exposed cliff w/erosion
SS3	Army Beach	529,574	6,713,053	Sample taken from beach near toe of slope
SS4	Alaska Highway	531,385	6,713,311	Sample taken from beach adjacent to hwy
SS5	California Beach	539,552	6,680,463	Sample taken from exposed cliff w/erosion
SS6	California Beach	539,511	6,680,430	Sample taken from beach in front of eroding cliff

SS7	California Beach	539,392	6,680,512	Sample taken from beach in front of Aeolian dunes
SS8	Bennet Beach	516,164	6,669,757	Sample taken from beach
SS9	Boat Launch – Marsh Lake	536,908	6,708,649	Beach too coarse to grab sample, median sediment size estimated at 9 cm in diameter.

Estimates of velocity along Tagish and Bennet River were estimated (float method). Velocity was estimated in tagish River to be 0.83 m/s, whereas velocity on Bennet River was estimated at 1.25 m/s.

The following observations during the field reconnaissance of the Southern Lakes were made:

Yukon River

- Some evidence of erosion (leaning trees, slumps, recent small fans) on west side of river than east side. Even where there are higher bluffs on east side, there seems to be vegetation of at least a few years old. There is some minor slumping on the east side.

Marsh Lake

- Higher bluff, some evidence of erosion either from wind waves or from McClintock R along the McClintok beach.
- Less evident erosion problems on McClintock Point
- At Army Beach, much evidence of erosion problems – lots of different kinds of erosion control measures in evidence: rock gabions, rock revetments, timber bulkheads, concrete block bulkheads and old tires. Some homes have no erosion control.
- Spots of fallen trees on low bluffs in the south. Increasing going north. Across from McClintock Point area of “drunken” forest on shoreline.
- Some potential for erosion of Alaska Highway just south of Army Beach.

Tagish Lake

- Some evidence of erosion or erosion potential on west bank along Tagish River, not much on east bank.
- Majority of Tagish Lake is very stable.
- California Beach is stable except for a small silt bluff adjacent to outlet of Tagish River.
- Windy Arm is stable except for 200-300 m south of tramway on west side right adjacent to the South Klondike Highway.
- South Side on Bove Island has a section of vulnerable bluff.

Bennet Lake

- White Pass & Yukon Railway line vulnerable due to low elevation and proximity to lake.

- West side of Bennett Lake – no discernible erosion problems.
- West Arm – No obvious erosion problems.

Photograph 1. McClintock Beach, note eroding bluff

Photograph 2. Close-up of eroding bluff on McClintock Beach

Photograph 3. Army beach, note the high level of bank protection

Photograph 4. Army beach properties have varying levels of bank protection

Photograph 5. A portion of the Alaska Highway is in close proximity to Marsh Lake's shoreline

Photograph 6. Boat Launch at Marsh Lake subdivision, coarse sediment on beach

Photograph 7. California Beach on Tagish Lake exhibits erosion at Tagish River outlet

Photograph 8. California beach, characterized by stable Aeolian deposits alongside eroding lacustrine deposits.

Photograph 9. Typically, stable shoreline along Tagish Lake

Photograph 10. Whitepass Railway line is in close proximity to shoreline of Bennet Lake

Photograph 11. Eroding bluff on Bovee Island

Photograph 12. Typically eroding bluff on Yukon River

Soil Analysis - Sieve

Parameter	Unit	G / S	RDL	SS20 2113517	SS2 2113523	SS21 2113524	SS4 2113525	SS1 2113526	SS5 2113527	SS8 2113528	SS3 2113529	SS6 2113530	SS7 2113531
Sieve Analysis - 12.5mm	%		N/A	0	0	0.02	44	0	0	0	0	74.5	0.01
Sieve Analysis - 4.75 mm	%		N/A	0	1.93	0.4	5.36	1.61	0	0.02	0	1.64	0
Sieve Analysis - 2.00 mm	%		N/A	0.43	4.06	0.23	5.92	1.66	1.85	0.12	0.02	2.2	0
Sieve Analysis - 850 microns	%		N/A	0.37	4.42	0.23	7.54	5.38	4.14	11.3	0.02	2.51	0
Sieve Analysis - 425 microns	%		N/A	16.8	2.88	0.58	12.1	16.8	21.1	76.8	31.4	4.99	0.2
Sieve Analysis - 250 microns	%		N/A	65.2	3.47	3.47	16.6	35.6	59.6	11	67.5	5.98	64.2
Sieve Analysis - 125 microns	%		N/A	13.3	14.8	44.9	7.24	30.9	10.5	0.79	0.8	5.19	33.3
Sieve Analysis - 75 microns	% passing		0.01	2.36	36.7	36.8	0.9	5.46	1.45	0.15	0.18	2.05	2.23
Sieve Analysis - 45 microns	%		N/A	1.14	24.5	10.5	0.21	1.73	1.05	0.01	0.04	0.66	0.13
Sieve Analysis - 38 microns	%		N/A	0.16	3.65	1.56	0.01	0.41	0.24	0	0.03	0.17	0.01
Sieve Texture				Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2113517-2113533 Value reported is amount of sample retained on sieve after wash with water and represents proportion by weight particles larger than indicated sieve size.

Appendix B

Minutes of Meeting of two North M’Clintock residents

AECOM

Minutes of Meeting

Date of Meeting	October 5, 2010	Start Time	5pm	Project Number	60146345
Project Name	Marsh Lake Fall Storage				
Location	Fulmer and Miller Residences, North McClintock (Swan Haven Road)				
Regarding	Water Level and Erosion				
Attendees	Deborah Fulmer, North McClintock Resident (Swan Haven) Rebecca Miller, North McClintock Resident (Swan Haven) Chad Davey, AECOM Jay Chou, AECOM				
Minutes Prepared By	Jay Chou				

PLEASE NOTE: If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.

PURPOSE AND OBJECTIVES

In response to Marsh Lake residents' requests, the purpose of the meeting was to discuss erosion issues with property owners. The trip was also primary data collection opportunity for the socio-economic baseline report.

FULMER RESIDENCE

Erosion

- Property has experienced 1-2 metres of erosion in each of the last 5 years. Neighbours have lost 1 foot per year in the last 50 years. Residents in the neighbourhood are long-time residents. Neighbours include John and Marny Rider.
- Since the 2007 flood, erosion seems to have exacerbated every year following.
- The Fulmer's have actively employed live staking of Willow trees to slow the pace of erosion – each tree is staked about 1 metre deep.
- Metal pins with wood backing was also installed after the 2007 flood to help stabilize the bank and slow bank sloughing.
- The live staking does appear to have slowed erosion, as grass and other small shrubs have begun to grow at the toe of the erosion bank.
- The Fulmers indicated that the mean average water level on Marsh Lake is causing significant erosion along the base of the bank.
- The property has been built overtop of a silt/sand deposit. Bedrock does exist approximately 50 m south of theproperty.

- The Fulmers are concerned that with the heaviest windfall in September and October combined with higher than current water levels on Marsh Lake would would greatly exacerbate erosion.

Personal Property

- The tree along the bank is no longer stable and erosion is affecting the perimeters of the property.

Summer Use

- In the summer time the Fulmers use the lake for boating, skiing and fishing.

Winter Lake Use

- The area is used as a skating rink in the winter and also ski with tracks

Winter Ice

- Currently the lake drops in January causing the edges of the lake ice to break and slide downwards, resulting in the plucking of sediment from the bank.
- The Fulmers believe that ice plucking of sediment is a significant source of bank erosion.

Flooding

- The property experiences no flooding.

Mitigation Costs

- The Fulmers have spent $15,000 in the last three years to stabilize the bank from further erosion.
- Rock mitigation is an option and may not be aesthetically pleasing as it affect summer use.

MILLER RESIDENCE

Erosion

- Rebecca Miller has lived at this property for the last 7 years.
- Similar to Fulmers, willow staking has been done around the bank
- Rebecca's property has eroded and receded 6 feet from when see started living at this residence, ~ 7 years..
- Since the 2007 flood, the bank erosion has accelerated significantly . In addition, the ground on her property has gotten 'soggy' causing her house to subside to the point that her door frames in her house had to be replaced as doors were no closing properly. The ground sogginess and house subsidence suggests that thje 2007 flood initiated or accelerated melting of permafrost in this area.

Flooding

- The property experiences no flooding.

Photograph 1
View of Marsh Lake, mouth of McClintock on left (out of view).

Photograph 2
View along erosion bluff at North McClintock property.

Photograph 3
View along erosion bluff at North McClintock property with house in close proximity.

Photograph 4
View of property along North McClintock subdivision.

Appendix C

Resident of California Beach letter entitled "Potential Impact of Marsh Lake Fall Storage Concept on Tagish Beach Erosion"

June 25, 2010

Yukon Energy:

RE: Potential impact of Marsh Lake Fall Storage Concept on Tagish Beach Erosion

I own Lot 51, Tagish Beach Subdivision and am concerned about any changes to the southern lake levels because the lake erodes the crown reserve bank in front of my property. I reviewed Yukon Energy's open house power point presentation on the Marsh Lake Fall Storage Concept to get an idea of what is being proposed. I believe that raising the full supply level by 30 cm and retaining that level for several months in the fall will significantly increase the erosion of the bank in front of Lots 38 to 58, Tagish Beach Subdivision unless there is an adequate erosion control structure constructed.

Attached Sketch 1 shows the extent of the erosion in front of my property since the original survey in 1972. Up to 15 m of the crown reserve has eroded over the last 38 years. The concept being proposed by Yukon Energy will speed up that erosion such that some of the lake bed may be within the titled parcels along the beach within 20 to 30 years if there is no erosion control structure constructed.

Some owners including myself have attempted to build erosion control structures, some being more successful than others depending on the amount of resources being expended on the construction. Over the last five years I have laid down rocks by hand on geo-textile cloth as shown on sketch 1 and in the attached photos. This structure seems to work, but it needs to be slightly higher and further strengthened. More important, the same needs to be done on the neighbouring banks to stop the erosion eating at the sides.

I know through analysis of water survey data and land claim legal survey data that the Lewes River dam affects the water levels in Tagish Lake when the gates are closed. I suspect that some of the gates were closed in August of 2008 during a low water year because the high water in Tagish Lake occurred in October. During the summer months Tagish Lake is only 20 cm above that of Marsh Lake (not 2 m as shown in your presentation) and the lake levels are typically at the same level later in October. I will be submitting a detailed report through my work at the Surveyor General Branch, Natural Resources Canada, showing this analysis and how the water licence is related to the OHWM of the First Nation settlement land on the southern lakes.

Marsh Lake current FSL = 656.23
Tagish Lake water level at current Marsh Lake FSL = 656.43
Estimated Tagish Lake water level at proposed FSL = 656.73

The erosion along the bank does not occur at the current full supply level. The erosion occurs in years when the natural levels exceed the current full supply level by about 20 cm. The water survey records indicate that this has occurred in one of every 2½ years since 1966. This occurred in 2009 when the water levels were about 40 cm above that of the current full supply level, similar to that being proposed by the concept. A small portion of the unprotected bank to the north of my property in front of Lot 50 eroded by about 1 m in 2009, when the water was only a few weeks at 40 cm over the full supply level. Holding the water back for several months during the fall storms will significantly increase the erosion. Longer terms of wind and wave action cause the erosion.

The 2007 flood did the most erosion damage, leaving behind a slightly higher beach elevation at the toe of the bank. For this reason, there was limited erosion in 2009 to the south of me in front of Lot 52 because the toe of the bank is slightly higher than that to the north. Over time, however, I expect that the wind and wave action will eat away the beach at the toe making the bank more susceptible to erosion.

Thank you for considering the effect of your concept on the erosion along Tagish Beach. I look forward to further discussions with you if the concept goes forward to see what can be done to mitigate the erosion. In the interim please let me know of any new developments with the concept. Call me or email me at any time if you wish to further discuss this.

Sincerely:

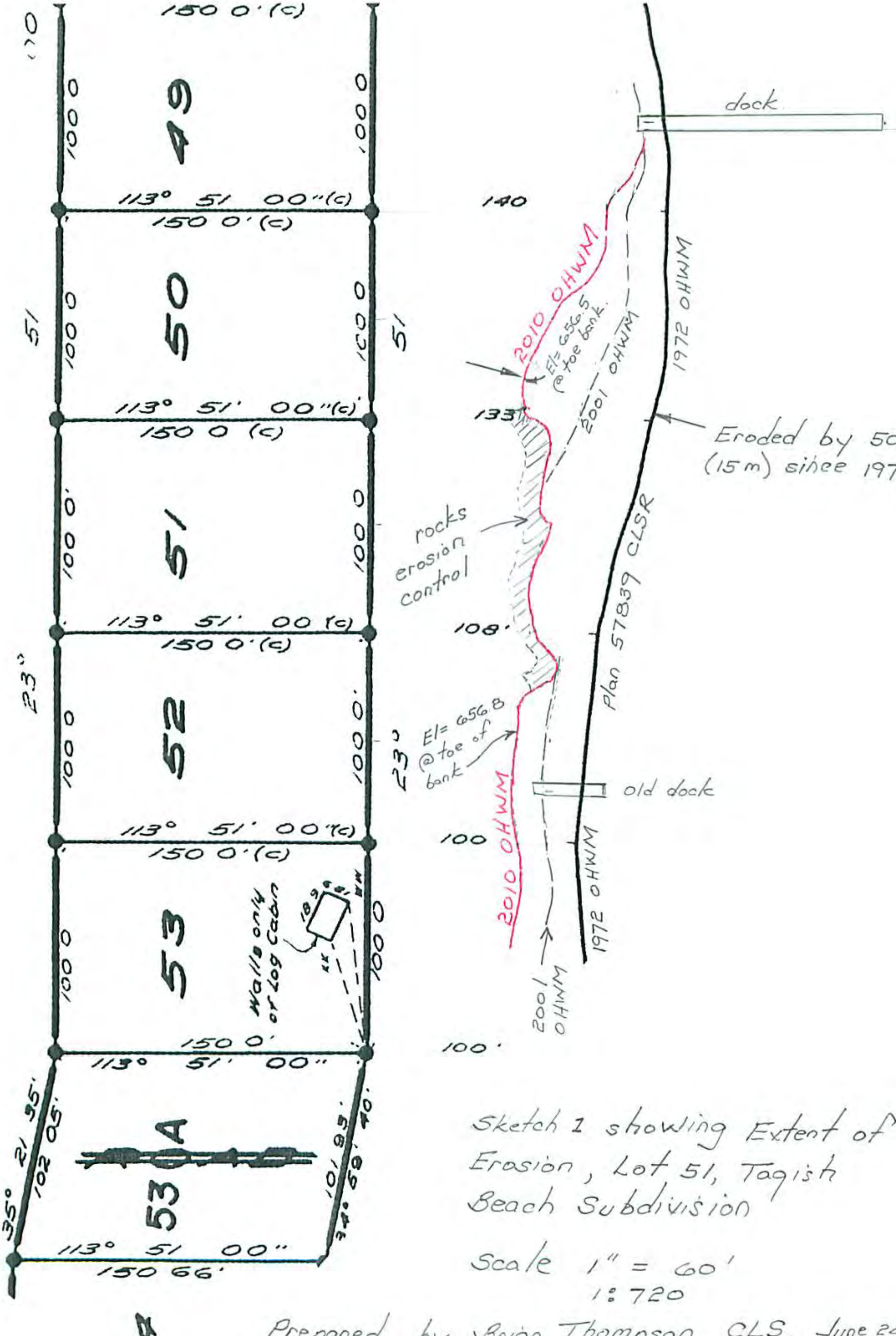
Brian Thompson
Lot 51, Tagish Beach Subdivision

867-633-3871 (h), 867-667-3954 (w)
email: thompson@klondiker.com

Photo 1 taken on beach in front of Lot 51, looking north, showing rock erosion control structure along bank in front of Lot 51 and eroding bank in front of Lots 40 and 49. Sand bags were placed during 2007 flood to control high water

Photo 2 taken on beach in front of Lot 51, looking south, showing rock erosion control structure along bank in front of Lot 51 and eroding bank in front of Lots 52 and 53. Sand bags were placed during 2007 flood to control high water

Photo 3 near toe of bank (OHWM) in front of Lot 50, looking south, showing rock erosion control structure along bank in front of Lot 51 and eroding bank in front of Lot 50.



Sketch 1 showing Extent of Erosion, Lot 51, Tagish Beach Subdivision

Scale 1" = 60'
1:720

Prepared by Brian Thompson, CLS, June 24/10

Appendix D

STWAVE Model Set-up and Results

Water

Prepared for:
Yukon Energy Corporation

Prepared by:
AECOM

60190477
May 8, 2011

Technical Report

Wave Study
Marsh Lake, Yukon

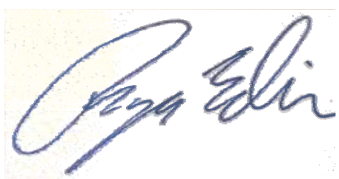
Water

Prepared for:
Yukon Energy Corporation

Prepared by:
AECOM

60190477
May 8, 2011

Technical Report
Wave Study
Marsh Lake, Yukon
Final



Prepared By: Ryan Edison, PE

Reviewed By: Jena F. Gilman, PE, PEng

CONTENTS

1.0 General Overview

1.1 Background and Purpose

This Technical Report details the numerical wave modeling performed on Marsh Lake for a variety of wind conditions and lake levels. The results of this analysis will be used to make operational decisions and assess how operational changes may, or may not, impact the wave climate at various locations around the lake.

1.2 Project Datum

All topographic and bathymetric data were corrected to have a common vertical datum of meters Above Sea Level (mASL).

2.0 Technical Approach

The study was performed using a 2D near shore wind-wave growth and propagation model called STWAVE, which stands for the Steady-State Spectral Wave Model. Version 4.0 was used as developed and documented by the USACE (February 2001). STWAVE is a widely used and robust model used for the simulation of near shore wind-wave growth and propagation. It is a steady-state finite-difference model based on the wave action balance equation. STWAVE simulates depth-induced wave refraction and shoaling, current-induced refraction and shoaling, depth- and steepness-induced wave breaking, diffraction, wind-wave growth, and wave-wave interaction and white-capping that redistributes and dissipates energy in a growing wave field.

2.1 Conditions Evaluated

Forty-eight (48) individual runs of the model were conducted. Because the whole lake is modeled in a single run, it is possible to generate as many individual locations for wave climate output as needed. The 48 individual runs of the model came from looking at the impacts of seasonal variations (October and November) in both lake levels (historical and projected, Table 1) and wind speed. The 2-, 5-, 10- and 50-year wind speeds were evaluated (Table 2). Finally, three wind directions were investigated (120-150 deg., 150-180 deg., and 300-330 deg.).

Table 1 - Marsh Lake Levels

Historical Average	
Month	**Monthly Averages (based on 1984 to 2010 lake level readings)**
October	656.14
November	656.04

Model Projected Lake Level	
Month	**Lake Level**
October	656.53
November	656.51

Note:

1. All measurements are in meters.

2.2 Extent of Modeling

The extent of the 2D numerical wave modeling includeincludes all of Marsh Lake – as far north as Swan Haven and as far south as Tagish River.

2.3 Wind Analysis

The wind analysis was performed by AECOM and is detailed in the main body of the report. Table 2 below provides a summary of the winds speeds used as input to the 2D numerical wave model.

Table 2 - Summary of Wind Speeds

Month	Wind Direction	Return Period (Yr)	Wind Speed (m/s)
October	120-150	2	13.25
		5	16.79
		10	19.14
		50	24.3
	150-180	2	15.55
		5	18.62
		10	20.64
		50	25.11
	300-330	2	8.55
		5	12.13
		10	14.49
		50	19.7
November	120-150	2	13.34
		5	17.32
		10	19.95
		50	25.75
	150-180	2	16.71
		5	19.68
		10	21.64
		50	25.95
	300-330	2	9.42
		5	13.93
		10	16.91
		50	23.47

2.4 Bathymetric Grid Generation

The STWAVE model utilizes bathymetric data in a 2D grid format. This depth grid was developed from a variety of data sources and included data collected by a boat mounted depth finder to provide more detail information at some of the locations where wave climate was to be generated. The data was compiled AECOM Canada and provided in ArcGIS grid format prior to modeling. The ArcGIS grid was a 30m grid and includes both the bathymetric data from Marsh Lake and also surrounding shoreline topographic data. Because of this both Figures 1 and 2 shown in this report have data reported beyond just the limits of the shoreline – making the Lake appear to be larger than it is. This was done to make sure the increased lake levels were captured with the STWAVE depth grids generated in ArcGIS.

Because STWAVE is a half-plane model, two orientations of depth grids were developed: one for the 300-330 deg. wind direction and another for the 120-150 and 150-180 deg. wind directions. This was facilitated in ArcGIS, which was used to generate the required input files for the STWAVE model.

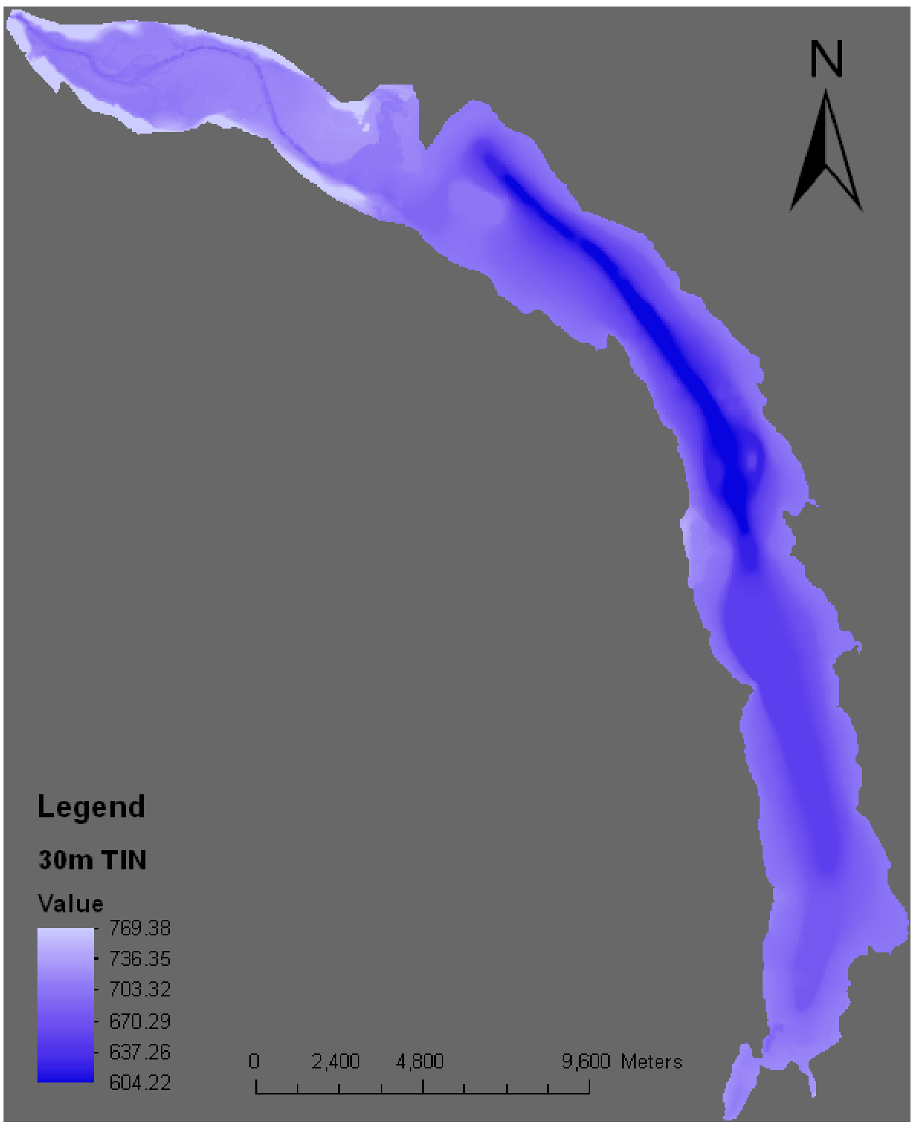


Figure 1 – Topographic Plot of Marsh Lake and Surrounding Shoreline

3.0 Results

STWAVE generates a number of wave parameters at each grid throughout the 2D domain. In order to define the wave climate at various locations, the following wave parameters were recorded at the seven locations shown on Figure 2:

- Significant Wave Height in meters, and
- Peak Wave Period in seconds.

These two selected wave parameters are summarized in Table 4 for each of the 48 STWAVE runs. The exact XY locations of each point are shown in Table 3 below.

Table 3 - XY Point Locations for Wave Climate Output

Location	Coordinates	
	x	y
Swan Haven	390453.5	673096.4
Army Beach	392849.3	674116.6
Highway 1	*393954.1*	674353.6
Boat Ramp	400468.5	667957.7
Marsh Lake Marina	402309.8	663652.9
Judas Creek	402462.2	663652.9
Tagish River	402491.5	648220.5

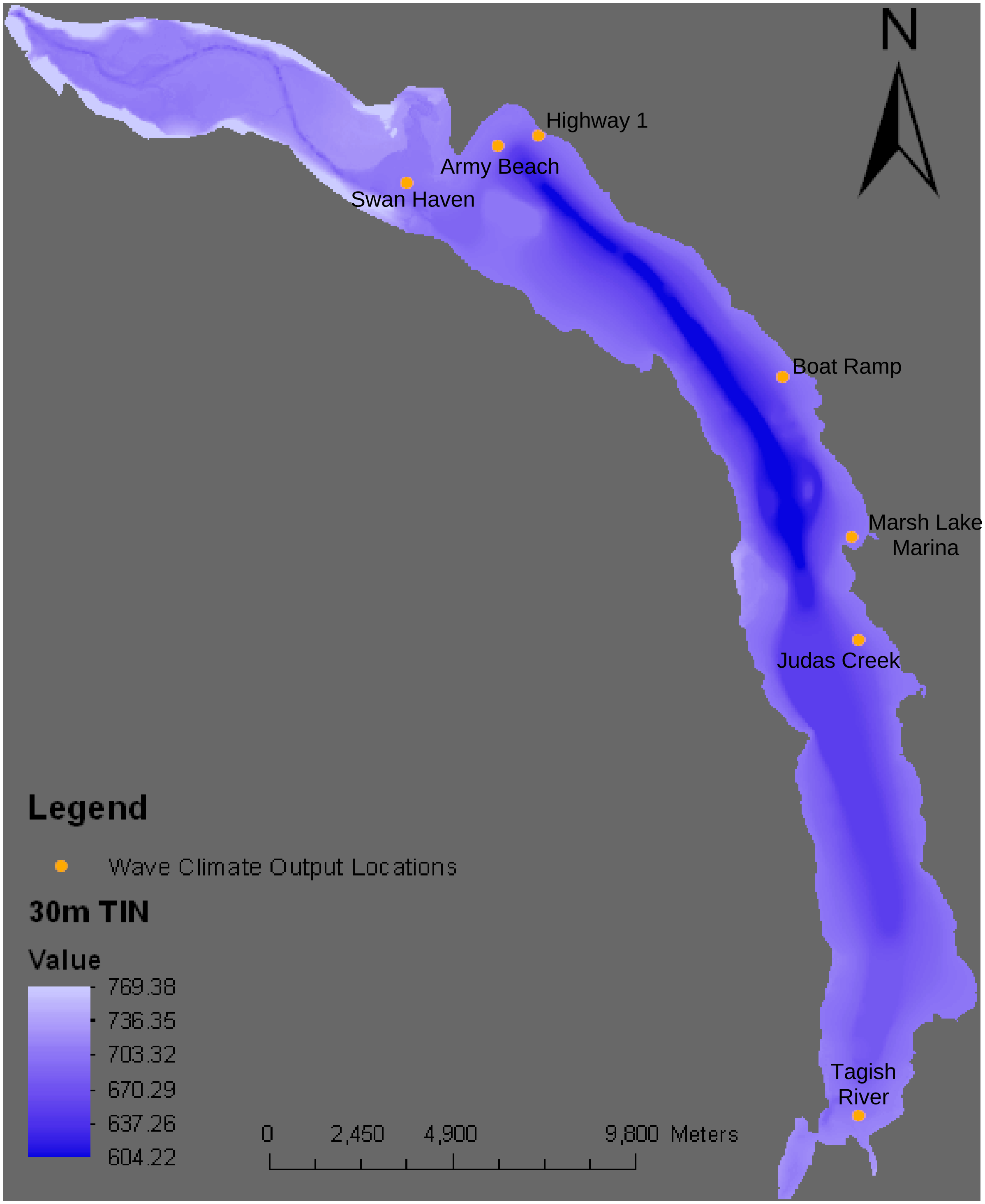


Figure 2 - Wave Climate Output Locations

Table 4 – Significant Wave Height (m) / Period (s) Output Summary

Month	Historical or Projected Lake Level	Location / Wind Direction (deg.)																				
		Tagish River			Judas Creek			Marsh Lake Marina			Boat Ramp			Swan Haven			Highway 1			Army Beach		
		120-150	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*	*120-150*	*150-180*	*300-330*
Nov	*historical*	0.00/1.2	0.00/1.2	0.05/1.4	0.24/4.2	0.78/3.6	0.37/2.3	0.08/1.2	0.19/3.6	0.38/2.3	0.28/3.6	0.79/3.6	0.33/2.5	0.37/1.9	0.31/1.7	0.11/1.7	0.45/2.5	0.71/2.8	0.13/1.7	0.57/2.8	0.64/2.8	0.08/1.3
	projected	0.00/1.2	0.00/1.2	0.10/1.4	0.25/4.2	0.79/3.6	0.38/2.3	0.08/1.2	0.18/3.6	0.39/2.3	0.29/3.6	0.80/3.6	0.34/2.5	0.40/1.9	0.32/1.7	0.11/1.7	0.46/2.8	0.73/2.8	0.13/1.7	0.58/2.8	0.66/2.8	0.08/1.3
Oct	*historical*	0.00/1.2	0.00/1.2	0.05/1.2	0.24/4.2	0.73/3.6	0.34/2.1	0.07/1.2	0.15/1.2	0.35/2.1	0.28/3.6	0.74/3.6	0.30/2.5	0.38/1.9	0.29/1.7	0.09/1.7	0.45/2.5	0.66/2.8	0.12/1.6	0.57/2.8	0.60/2.5	0.07/1.2
	projected	0.00/1.2	0.00/1.2	0.09/1.3	0.24/4.2	0.73/3.6	0.36/2.1	0.07/1.2	0.15/1.2	0.36/2.1	0.29/3.6	0.75/3.6	0.30/2.5	0.40/1.9	0.29/1.7	0.09/1.7	0.46/2.5	0.67/2.8	0.12/1.6	0.58/2.8	0.61/2.5	0.07/1.2
Nov	*historical*	0.00/1.2	0.01/1.2	0.09/1.8	0.35/4.2	0.93/4.2	0.55/2.5	0.13/1.3	0.24/3.6	0.55/2.5	0.35/4.2	0.92/3.6	0.51/2.5	0.41/2.1	0.38/1.8	0.19/2.1	0.58/2.8	0.84/3.1	0.23/2.1	0.76/3.1	0.75/2.8	0.16/1.6
	projected	0.00/1.2	0.01/1.2	0.18/1.8	0.36/4.2	0.94/4.2	0.56/2.5	0.13/1.3	0.23/3.6	0.56/2.5	0.36/4.2	0.94/3.6	0.52/2.5	0.48/2.3	0.39/1.9	0.19/2.1	0.59/2.8	0.86/3.1	0.23/2.1	0.77/3.1	0.77/2.8	0.16/1.6
Oct	*historical*	0.00/1.2	0.00/1.2	0.09/1.6	0.34/4.2	0.88/4.2	0.48/2.5	0.12/1.3	0.22/3.6	0.49/2.5	0.33/4.2	0.87/3.6	0.44/2.8	0.39/2.1	0.36/1.8	0.15/1.9	0.57/3.1	0.80/3.1	0.19/1.9	0.73/3.1	0.72/2.8	0.12/1.5
	projected	0.00/1.2	0.00/1.2	0.15/1.6	0.35/4.2	0.89/4.2	0.49/2.5	0.12/1.3	0.22/3.6	0.50/2.5	0.34/4.2	0.88/3.6	0.44/2.8	0.47/2.1	0.36/1.8	0.15/1.9	0.59/3.1	0.81/3.1	0.19/1.9	0.74/3.1	0.74/2.8	0.12/1.5
Nov	*historical*	0.01/1.2	0.01/1.2	0.12/1.8	0.35/5.0	1.02/4.2	0.66/2.8	0.16/1.4	0.27/3.6	0.67/2.8	0.42/4.2	1.03/4.2	0.64/2.8	0.40/2.3	0.43/1.9	0.26/2.3	0.67/3.1	0.92/3.1	0.29/2.3	0.84/3.1	0.83/3.1	0.22/1.8
	projected	0.01/1.2	0.01/1.2	0.22/1.9	0.36/5.0	1.03/4.2	0.68/2.8	0.16/1.4	0.26/3.6	0.68/2.8	0.43/4.2	1.05/4.2	0.65/2.8	0.44/2.3	0.44/1.9	0.26/2.3	0.69/3.1	0.94/3.1	0.29/2.3	0.85/3.1	0.86/3.1	0.21/1.8
Oct	*historical*	0.00/1.2	0.01/1.2	0.11/1.8	0.34/5.0	0.98/4.2	0.57/2.8	0.15/1.4	0.25/3.6	0.58/2.8	0.41/4.2	0.98/3.6	0.53/2.5	0.42/2.3	0.41/1.9	0.21/2.1	0.65/3.1	0.88/3.1	0.24/2.1	0.84/3.1	0.79/2.8	0.17/1.7
	projected	0.00/1.2	0.01/1.2	0.19/1.8	0.34/5.0	0.99/4.2	0.58/2.8	0.15/1.4	0.24/3.6	0.59/2.8	0.42/4.2	1.00/3.6	0.53/2.5	0.38/2.3	0.41/1.9	0.21/2.1	0.67/3.1	0.90/3.1	0.24/2.1	0.85/3.1	0.82/2.8	0.17/1.7
Nov	*historical*	0.03/1.2	0.03/1.2	0.17/2.1	0.52/5.0	1.24/5.0	0.90/3.1	0.24/1.7	0.37/4.2	0.93/3.1	0.52/3.6	1.19/4.2	0.87/3.1	0.52/2.3	0.48/2.1	0.39/2.8	0.86/3.6	1.11/3.6	0.42/2.8	1.14/3.6	0.98/3.1	0.34/2.1
	projected	0.03/1.2	0.03/1.2	0.30/2.3	0.53/5.0	1.26/5.0	0.93/3.1	0.24/1.7	0.38/4.2	0.95/3.1	0.54/5.0	1.22/4.2	0.89/3.1	0.54/2.3	0.45/2.1	0.39/2.8	0.88/3.6	1.13/3.6	0.43/2.8	1.15/3.6	1.02/3.1	0.34/2.1
Oct	*historical*	0.02/1.2	0.02/1.2	0.16/1.9	0.49/5.0	1.20/4.2	0.77/3.1	0.22/1.6	0.36/4.2	0.79/3.1	0.45/5.0	1.17/4.2	0.73/2.8	0.49/2.1	0.47/2.1	0.31/2.5	0.81/3.6	1.08/3.6	0.34/2.5	1.08/3.6	0.95/3.1	0.27/1.9
	projected	0.02/1.2	0.02/1.2	0.26/2.1	0.50/5.0	1.21/4.2	0.79/3.1	0.22/1.6	0.36/4.2	0.80/3.1	0.47/5.0	1.19/4.2	0.74/2.8	0.51/2.5	0.47/2.1	0.32/2.5	0.83/3.6	1.10/3.6	0.35/2.5	1.10/3.6	0.99/3.1	0.27/1.9