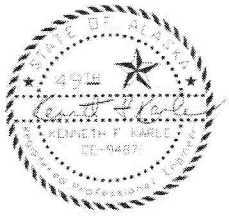
Prepared for:

Fairbanks North Star Borough
Doug Sims, CFM
PO Box 71267
Fairbanks, Alaska 99707-1267

Prepared by:

Kenneth F Karle, P.E.
Hydraulic Mapping and Modeling
1091 W Chena Hills Drive
Fairbanks, AK 99709



Section A: Hydrology

Reasons for Performing a New Hydrologic Analysis

Harding Lake and the developed area on its shoreline, located in Panels 02090C7275J and 02090C7300J, is shown as a Special Flood Hazard Area, Zone A-no base flood elevations determined. Harding Lake has a contiguous drainage basin consisting of the hillsides immediately around the lake and the Little Harding Lake basin, together encompassing about 5760 acres, including the 2,470 acre surface area of the lake. The contiguous basin provides water into the lake through hillside runoff, springs, permafrost seeps, and the inlet from Little Harding Lake.

A second watershed is located to the east with an area of about 10 square miles; water currently flows from this drainage north into the Salcha River. A recently constructed diversion structure can provide some flow diversion from this watershed into an abandoned channel (Rogge Creek) which eventually drains into Harding Lake.

Changing watershed conditions over the past 40 years have resulted in a well-documented lake level decline. Lake levels appear to have declined nearly 5 ft through the 1970's with some recovery in the 1980's followed by continued decline in the 1990's and into the 2000's (Fox, 2009; Ranft, 2005). This lake level decline translated into over 300 ft of shoreline retreat in places where broad, shallow littoral zones existed. This shoreline retreat has adversely affected pike habitat, recreational opportunities, and water access from on-shore cabins. The Rogge Creek diversion structure was constructed to

provide additional inflow into Harding Lake, and has resulted in some stabilization of the lake levels. The structure can be closed during flooding conditions.

Though a likely past outlet channel was tentatively identified by researchers, Harding Lake exhibits no active outflow channels exist (Ranft, 2005). It is believed the lake is losing water due to the combination of evaporation, groundwater seepage and very little precipitation recharge from the drainage area.

Due to the recent acquisition of high accuracy LiDAR data and the improvements in NOAA meteorlogical statistics for Alaska, improved estimates of flood hydrology and lake levels can now be made.

Harding Lake Lidar

Detailed topographic data is available at Harding Lake that was not used in either the previous FIRM or current effective FIRM. The new LiDAR data was acquired by the Natural Resource Conservation Service (NRCS) at 2 meter intervals.

Rainfall Analysis-Data Record

Updated precipitation frequency (PF) estimates are available through the National Oceanic and Atmospheric Administration (NOAA's) National Weather Service. Online information includes precipitation frequency estimates and Intensity-Duration-Frequency (IDF) Curves for various areas of the U.S., including Alaska, as Volumes of NOAA Atlas 14 (NOAA, 2014).

The PF estimates for Harding Lake are located in Volume 7 Version 2 of Atlas 14, and are found in this document in Appendix A. For this analysis, we utilized the 24-hour 100-year recurrence interval storm estimate (3.52 inches).

New Analysis, This Study

Peak lake levels for the base (100-year) flood were developed using WinTR-55, a single-event rainfall runoff, small watershed hydrologic model (USDA, 2009).

For the purposes of the new analysis, the Harding Lake watershed was divided into 5 smaller subareas. Based on land and climate characteristics, flood hydrographs were routed downstream and combined at the lake. The hydrographs for each subarea were integrated over the 24-hour storm period to provide estimates of total discharge into the lake. In addition, as the lake surface represents almost 50 percent of the watershed area, precipitation falling directly onto the lake surface was also added to the combined total discharge into the lake.

1. Updated storm data for the Harding Lake area of the FNSB were inserted into the model, including the 2-, 5-, 10, 25-, 50-, and 100-year 24-hr rainfall amounts. The 2-yr storm is used to calculate a time-of-concentration. Rainfall distribution is Type 1.

2. Six subareas and three reaches were delineated based on drainage characteristics. See Figure 1.

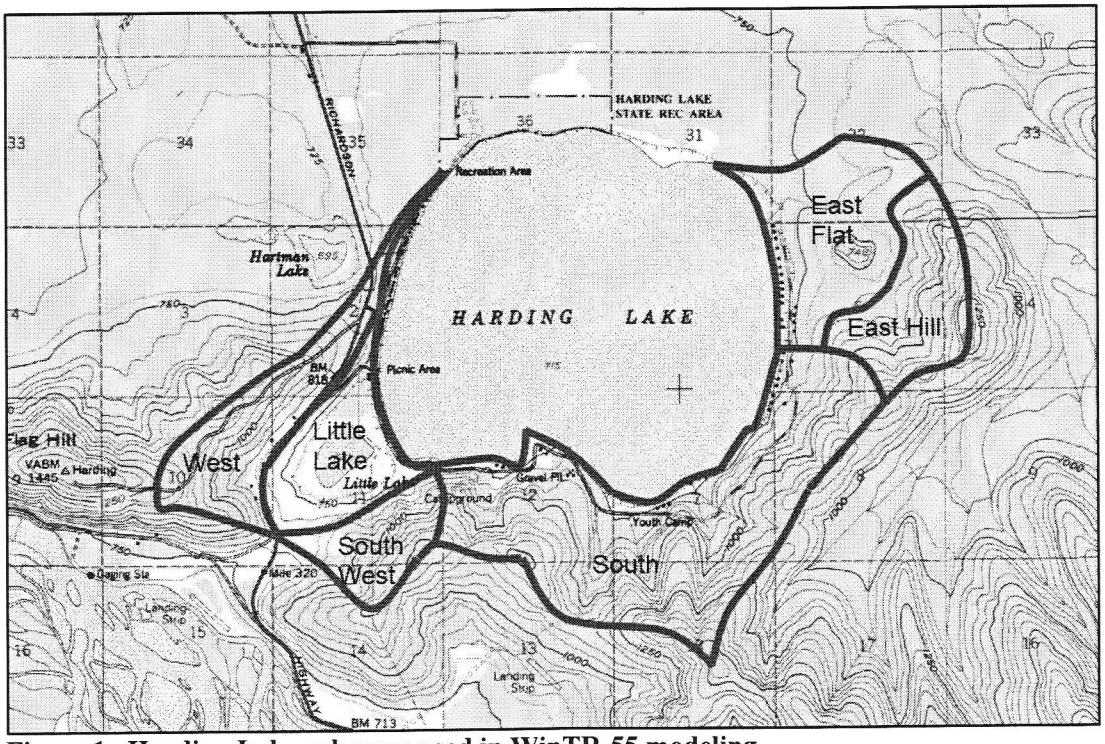


Figure 1. Harding Lake subareas used in WinTR-55 modeling.

3. Hydrologic soil group selections: weighted CN numbers for four of the subareas are high (CN 96) and represent local conditions that result in high runoff potential when thoroughly wet, including the presence of permafrost in non-south facing slopes, steep slopes, silt loam and silty clay loam. Selected CN values are conservative.

4. Results from the WinTR-52 Harding Lake Runoff Model for the 100-year storm are found in Appendix B.

5. Total runoff and predicted rise in water level from 100-year 24-hr storm:

- Total runoff into Harding Lake is 2.544 inches from the 3290 acre drainage area.
- 2.544 in = 0.212 feet. Total runoff is 0.212 ft x 3290 acre = 697.48 acre-feet.
- Harding Lake is 2470 acres, so the rise in Harding Lake from watershed runoff is 697.48 acre-feet/2470 acre = 0.282 feet = 3.39 inches.
- Rise in Harding Lake from direct precipitation on lake = 3.52 inches.

- Total rise in Harding Lake from the 100-year 24-hr storm = 3.39 + 3.52 = 6.91 inches.

Though researchers have identified a potential surface outflow once water levels rise above 713.4 feet, the conservative approach for this analysis assumes no runoff from Harding Lake during the 100-year 24-hr storm.

Section B: Hydraulics

The State of Alaska determined through surveys that the OHW elevation of Harding Lake is 717.0 feet (USDA, 2005). To determine the new BFE of Harding Lake, we added the estimated total rise in Harding Lake from the 100-year 24-hr storm to the OHW level. So 717.0 + 6.91 inches (0.58 ft) = 717.58 ft = 718.0 ft.

Proposed new BFE = 718.0 feet.

The file generated by the WinTR-55 hydrologic analysis program is found in the library of electronic files for this project. File name is:

Harding Lake LOMR-Fairbanks North Star Borough.w55

References

Fox, J.D. 2009. Water level changes in a subarctic lake near Fairbanks, Alaska. AWRA 2009 Spring Specialty Conference, Anchorage, AK, May 4-6, 2009.

Ranft, R.D. 2005. Does Harding Lake have a surface outflow? Senior thesis, University of Alaska Fairbanks, Natural Resources Management. December 2005.

NOAA, 2014. NOAA Atlas 14 Point Precipitation Frequency Estimates: AK. Found at: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_ak.html.

United States Department of Agriculture (USDA), 2005. Harding Lake Aquatic Habitat Enhancement Project, Environmental Assessment. December 13, 2005. In partnership with Salcha-Delta Soil and Water Conservation District and the Alaska Department of Fish and Game.

United States Department of Agriculture (USDA), 2009. Small Watershed Hydrology WinTR-55 User Guide. USDA NRCS Conservation Engineering Division, January 2009.

Appendix A- Precipitation Frequency estimates for Harding Lake, from NOAA Volume 7 Version 2 of Atlas 14.

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.118** (0.100-0.149)	**0.148** (0.124-0.189)	**0.201** (0.165-0.262)	**0.245** (0.197-0.325)	**0.306** (0.241-0.416)	**0.353** (0.273-0.488)	**0.400** (0.305-0.562)	**0.474** (0.355-0.677)	**0.572** (0.419-0.835)	**0.646** (0.466-0.958)
10-min	**0.158** (0.134-0.200)	**0.198** (0.166-0.253)	**0.270** (0.221-0.353)	**0.329** (0.265-0.437)	**0.411** (0.324-0.558)	**0.474** (0.367-0.655)	**0.537** (0.409-0.754)	**0.637** (0.477-0.910)	**0.768** (0.563-1.12)	**0.868** (0.626-1.29)
15-min	**0.185** (0.157-0.234)	**0.232** (0.194-0.297)	**0.316** (0.259-0.413)	**0.386** (0.311-0.512)	**0.481** (0.379-0.653)	**0.555** (0.430-0.767)	**0.629** (0.479-0.884)	**0.745** (0.558-1.06)	**0.899** (0.659-1.31)	**1.01** (0.732-1.51)
30-min	**0.245** (0.208-0.309)	**0.308** (0.258-0.394)	**0.420** (0.344-0.548)	**0.512** (0.413-0.680)	**0.639** (0.503-0.868)	**0.737** (0.571-1.02)	**0.834** (0.635-1.17)	**0.989** (0.741-1.41)	**1.19** (0.875-1.74)	**1.35** (0.973-2.00)
60-min	**0.336** (0.285-0.424)	**0.422** (0.353-0.540)	**0.575** (0.471-0.751)	**0.701** (0.565-0.931)	**0.875** (0.689-1.19)	**1.01** (0.781-1.39)	**1.14** (0.870-1.61)	**1.35** (1.01-1.94)	**1.63** (1.20-2.38)	**1.85** (1.33-2.74)
2-hr	**0.393** (0.334-0.496)	**0.495** (0.414-0.633)	**0.674** (0.553-0.880)	**0.823** (0.663-1.09)	**1.03** (0.809-1.40)	**1.18** (0.916-1.63)	**1.34** (1.02-1.88)	**1.59** (1.19-2.27)	**1.91** (1.40-2.79)	**2.16** (1.56-3.21)
3-hr	**0.449** (0.381-0.567)	**0.566** (0.474-0.724)	**0.772** (0.633-1.01)	**0.943** (0.760-1.25)	**1.18** (0.926-1.60)	**1.35** (1.05-1.87)	**1.53** (1.17-2.15)	**1.81** (1.36-2.59)	**2.19** (1.60-3.19)	**2.47** (1.78-3.67)
6-hr	**0.591** (0.502-0.746)	**0.744** (0.623-0.952)	**1.01** (0.831-1.32)	**1.24** (0.995-1.64)	**1.54** (1.22-2.09)	**1.78** (1.38-2.46)	**2.01** (1.53-2.83)	**2.39** (1.79-3.41)	**2.88** (2.11-4.20)	**3.25** (2.35-4.82)
12-hr	**0.783** (0.665-0.989)	**0.985** (0.825-1.26)	**1.32** (1.08-1.72)	**1.59** (1.28-2.12)	**2.00** (1.57-2.71)	**2.32** (1.80-3.21)	**2.67** (2.03-3.75)	**3.16** (2.37-4.52)	**3.82** (2.80-5.57)	**4.31** (3.11-6.19)
24-hr	**1.03** (0.909-1.19)	**1.30** (1.13-1.51)	**1.70** (1.45-2.02)	**2.05** (1.71-2.47)	**2.57** (2.10-3.17)	**3.02** (2.43-3.79)	**3.52** (2.78-4.49)	**4.17** (3.24-5.41)	**5.03** (3.83-6.67)	**5.68** (4.26-7.66)
2-day	**1.29** (1.14-1.48)	**1.64** (1.42-1.90)	**2.14** (1.82-2.54)	**2.58** (2.16-3.11)	**3.22** (2.64-3.98)	**3.78** (3.04-4.74)	**4.39** (3.48-5.61)	**5.17** (4.02-6.71)	**6.20** (4.72-8.22)	**6.97** (5.22-9.40)
3-day	**1.46** (1.29-1.68)	**1.86** (1.62-2.16)	**2.45** (2.08-2.90)	**2.94** (2.46-3.55)	**3.67** (3.01-4.53)	**4.29** (3.46-5.39)	**4.97** (3.94-6.35)	**5.83** (4.53-7.57)	**6.95** (5.29-9.22)	**7.80** (5.84-10.5)
4-day	**1.59** (1.40-1.83)	**2.02** (1.76-2.35)	**2.66** (2.26-3.16)	**3.19** (2.67-3.85)	**3.98** (3.26-4.92)	**4.65** (3.74-5.84)	**5.38** (4.26-6.87)	**6.30** (4.90-8.18)	**7.51** (5.72-9.96)	**8.42** (6.31-11.4)
7-day	**1.90** (1.67-2.18)	**2.37** (2.06-2.75)	**3.07** (2.61-3.64)	**3.67** (3.07-4.43)	**4.58** (3.75-5.65)	**5.36** (4.31-6.73)	**6.22** (4.92-7.95)	**7.35** (5.72-9.55)	**8.85** (6.74-11.7)	**9.98** (7.47-13.5)
10-day	**2.13** (1.87-2.44)	**2.62** (2.28-3.05)	**3.37** (2.87-4.00)	**4.02** (3.36-4.85)	**5.00** (4.09-6.17)	**5.85** (4.71-7.34)	**6.80** (5.38-8.68)	**8.05** (6.27-10.5)	**9.71** (7.40-12.9)	**11.0** (8.22-14.8)
20-day	**2.92** (2.57-3.35)	**3.53** (3.07-4.11)	**4.46** (3.80-5.29)	**5.25** (4.40-6.34)	**6.44** (5.27-7.95)	**7.47** (6.01-9.38)	**8.60** (6.80-11.0)	**9.96** (7.75-12.9)	**11.8** (8.95-15.6)	**13.1** (9.83-17.7)
30-day	**3.67** (3.23-4.21)	**4.41** (3.83-5.13)	**5.51** (4.69-6.54)	**6.43** (5.39-7.76)	**7.81** (6.39-9.64)	**8.98** (7.22-11.3)	**10.3** (8.12-13.1)	**11.7** (9.07-15.1)	**13.5** (10.3-17.9)	**14.9** (11.2-20.1)
45-day	**4.68** (4.12-5.38)	**5.63** (4.90-6.55)	**6.98** (5.94-8.28)	**8.06** (6.75-9.73)	**9.62** (7.88-11.9)	**10.9** (8.77-13.7)	**12.3** (9.71-15.7)	**13.6** (10.6-17.7)	**15.4** (11.7-20.5)	**16.8** (12.6-22.6)
60-day	**5.53** (4.87-6.35)	**6.71** (5.83-7.80)	**8.28** (7.05-9.82)	**9.46** (7.92-11.4)	**11.0** (9.03-13.6)	**12.2** (9.84-15.3)	**13.4** (10.6-17.1)	**14.6** (11.4-19.0)	**16.2** (12.4-21.5)	**17.4** (13.1-23.5)

Appendix B-Results from WinTR-55 for Harding Lake Watershed

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
Harding Lake
100-year flood elevation for LOMR

SUB-AREA:

East Hill Reach B	0.70313	96.	.242
West Reach A	0.54688	96.	.329
South Outlet	2.01875	96.	.432
Little Lak Outlet	0.83281	77.	.75
East Flat Outlet	0.82031	77.	.711
South West Reach C	0.21875	96.	.26

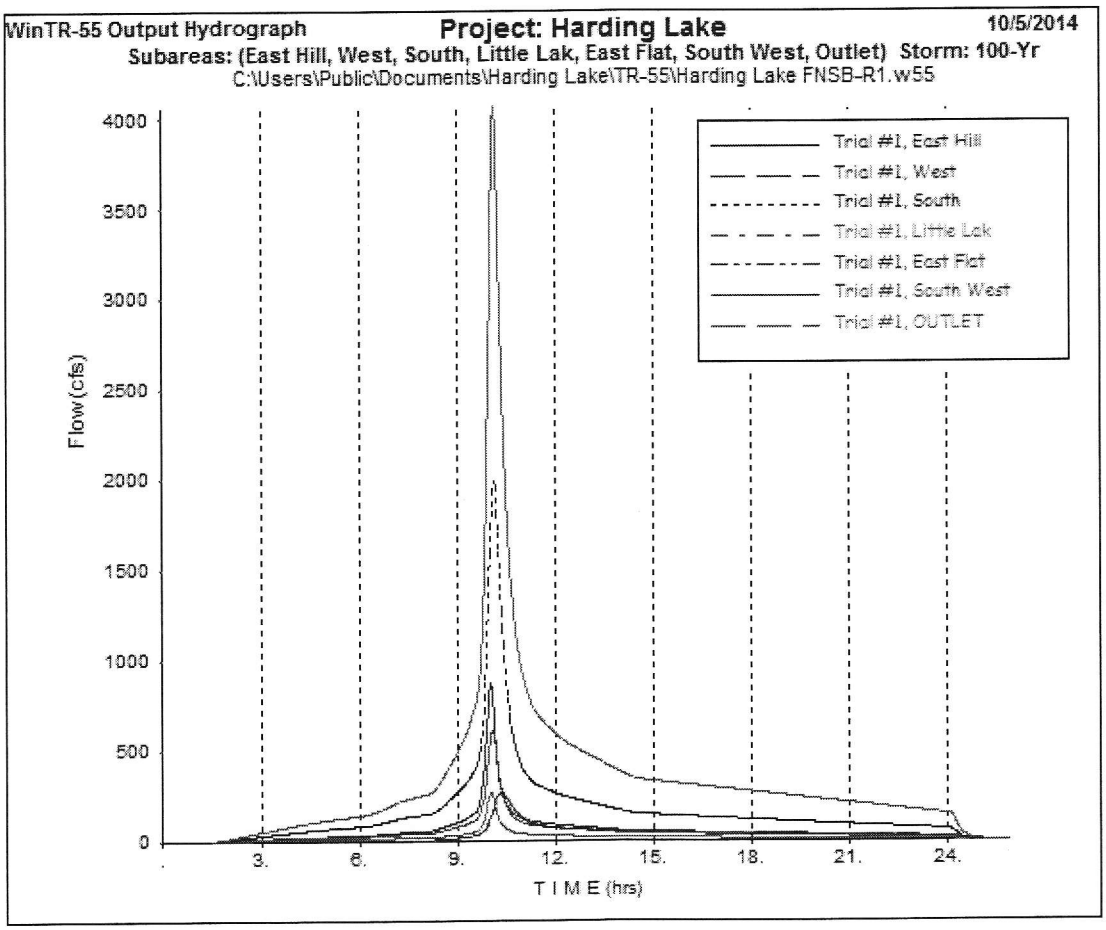
STREAM REACH:

Reach B Outlet	Xsec 1	4637.
Reach A Outlet	Xsec 2	4100.
Reach C Outlet	Xsec 3	2600.

STORM ANALYSIS:
100-Yr 3.52 Type I 2

STORM 100-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage Amount (in)	Runoff Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
East Hill	0.703	3.065	10.02	866.74	1232.70
South	2.019	3.065	10.14	1985.58	983.57
Little Lake	0.833	1.445	10.35	259.53	311.63
East Flat	0.820	1.445	10.33	263.84	321.64
West	0.547	3.065	10.08	605.41	1107.02
South West	0.219	3.065	10.04	263.51	1204.62
OUTLET	5.141	2.544	10.13	4067.31	791.21


WinTR-55 Output Hydrograph
Project: Harding Lake
10/5/2014
Subareas: (East Hill, West, South, Little Lak, East Flat, South West, Outlet) Storm: 100-Yr
C:\Users\Public\Documents\Harding Lake\TR-55\Harding Lake FNSB-R1.w55
Trial #1, East Hill
Trial #1, West
Trial #1, South
Trial #1, Little Lak
Trial #1, East Flat
Trial #1, South West
Trial #1, OUTLET
Flow (cfs)
4000
3500
3000
2500
2000
1500
1000
500
0
3.
6.
9.
12.
15.
18.
21.
24.
T I M E (hrs)