2014

ConocoPhillips Alaska

CD5 Lakes Recharge Studies

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Michael Baker INTERNATIONAL

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Acronyms and Abbreviations

ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
Baker	Michael Baker Jr., Inc.
BPMSL	British Petroleum Mean Sea Level
CRD	Colville River Delta
CPAI	ConocoPhillips Alaska, Inc.
GPS	Global positioning system
NAD83	North American Datum of 1983
Mgal	Million gallons
TBM	Temporary benchmark
WSE	Water surface elevation

1.0 INTRODUCTION

ConocoPhillips Alaska Inc., (CPAI) builds and maintains ice roads and ice pads for access and transportation of people and equipment during the winter months. Each season, millions of gallons of fresh water and ice are withdrawn from lakes within the Colville River Delta (CRD) and the National Petroleum Reserve Alaska (NPRA) to meet winter construction and operation requirements. Additional fresh water is used for potable water supplies at temporary rig camps and make-up water for drilling operations. Water withdrawal for construction and operations may begin as early as December and continue into May.

To comply with stipulations of Alaska Department of Fish and Game (ADF&G) Fish Habitat Permits and Alaska Department of Natural Resources (ADNR) Temporary Water Use Permits, CPAI conducts studies at water withdrawal lakes to document seasonal recharge. Michael Baker Jr., Inc. (Baker) conducted spring lake recharge studies to monitor water levels and provide photo documentation for permit compliance. This report summarizes the hydrologic observations, measurements, and analyses undertaken for this project.

Baker was supported during field monitoring by CPAI Alpine Environmental Coordinators, Umiaq/LCMF, LLC, and Pathfinder Aviation. All Baker and support team crew members are recognized for their contribution to an incident-free field effort.

1.1 STUDY OVERVIEW

The objectives of the 2014 CD5 Lakes Recharge Studies include collection and analysis of spring breakup recharge data at six water withdrawal lakes. Lake studies included observations and photos at all lakes and gage water surface elevation (WSE) measurements at Lake L9341. The 2014 CD5 Lakes are listed in Table 1.1 and the locations are shown on Figure 1.1.

Table 1.1: 2014 CD5 Area Lakes

L9306	L9341
L9808	L9809A
L9809B	MB0301

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Date:	08/12/2014	Project:	141010
Drawn:	MEA	File:	Figure 1.1
Checked:	SME	Scale:	1 in = 0.5 miles

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2014 CD5 AREA LAKES RECHARGE STUDY

FIGURE: 1.1

(SHEET 1 of 1)

Lake recharge was determined using visual observations and photos focusing on key hydrologic features, including peak water levels, hydraulic connectivity with other bodies of water, and inflow/outflow locations. Existing staff gages were restored during spring breakup setup and data was collected when Baker field personnel were in the vicinity of these lakes.

1.2 Lake Recharge Background

Annual recharge of lakes in the NPRA occurs as a result of three primary mechanisms: spring breakup flooding, snow melt, and precipitation. Of these, spring breakup flooding and snow melt (considered overland flow) were investigated. Lake elevation, proximity to streams, and local topography typically dictate the recharge mechanism. Lakes located within annually inundated stream floodplains or hydraulically connected areas recharge primarily from spring breakup flood flows. Lakes not inundated because of distance or topographical limitations depend solely on snowmelt runoff and precipitation for recharge.

The magnitude of spring breakup flooding fluctuates from year to year in terms of stage and discharge. If flood stage is relatively low, bankfull recharge may not occur depending on topography and elevation. In addition, flow extents are affected by the unpredictable establishment and release of ice jams during breakup. Presence and location of ice jams can determine whether a lake becomes hydraulically connected to a stream recharge source regardless of flood magnitude.

2.0 PERMITS AND WATER USE

CPAI requires water sources for building ice roads and ice pads, drilling, drinking water, and general operations. ADNR, ADF&G, or both agencies grant permits on the condition of CPAI compliance with temporary water use requirements to regulate water withdrawal and maintain conditions supportive of fish habitat. To maintain fish habitat, lakes must seasonally recharge water volumes borrowed during the winter season and lost naturally through evaporation. Fish Habitat and Temporary Water Use permits stipulate the water withdrawal quantities for each water year. Additionally, these permits specify the form of water that may be borrowed from each lake – liquid only, specific quantities of liquid and ice, or a total of both without designation of individual quantities. Ice aggregate removal is permitted over naturally grounded portions of the lake 4 feet deep or less. A water year is defined as one year beginning and ending with spring breakup (June through May). Actual withdrawal quantities are reported by CPAI per water year; these numbers are compared to the maximum water withdrawal allowed. If two permits are issued for one lake, the maximum water withdrawal by CPAI is less than or equal to the lesser allowable quantity.

All 2014 CD5 Recharge Lakes were permitted for specific borrow quantities of liquid and ice. Water and ice was withdrawn from all six study lakes during the 2013/2014 ice road construction season. During the 2013/2014 season, Lake L9306 was used as a water and ice source. No water was withdrawn from lakes L9808, L9809A, L9809B, and MB0301.

Table 2.1 summarizes the permits regulating water use, purpose, and permitted versus actual withdrawal volumes by form at the six water withdrawal lakes. The permitted and actual withdrawal volumes are based on fourth quarter 2013 and first and second quarter 2014 water use reports (CPAI 2013a, 2013b, 2014a, and 2014b).

Table 2.1: Summary of Permitted and Actual Withdrawal Volumes

2014 CD5 Lakes Recharge Study										
Lake	Permit		Permit Expiration	Water Use Purpose	Permitted Volume[1]			Withdrawal Volume[3]		
	ADF&G	ADNR			Liquid	Ice	Total Water[2]	Liquid	Ice	Total Water
					(Mgal)					
L9306	FH12-III-0319	TWUP A2012-53	12/17/2017	Ice Road/Pad	0.58	1.26	1.84	0.10	0.09	0.19
L9341	FH13-III-0070	TWUP A2013-162	12/6/2018	Ice Road/Pad	1.18	2.31	3.49	0.00	0.03	0.03
L9808	FH13-III-0321	TWUP A2013-162	12/6/2018	:::	0.18	0.39	0.57	0.00	0.00	0.00
L9809A	FH12-III-0323	TWUP A2012-54	12/17/2017	:::	0.03	1.38	1.41	0.00	0.00	0.00
L9809B	FH12-III-0322	TWUP A2012-54	12/17/2017	:::	0.15	0.96	1.11	0.00	0.00	0.00
MB0301	FH13-III-0314	TWUP A2013-162	12/6/2018	:::	0.92	13.26	14.18	0.00	0.00	0.00

Notes

1 Per water year. Some permits do not stipulate specific liquid/ice volumes.

2 Total permitted withdrawal may be either ice, water, or a combination

3 Total withdrawal volume between June 1, 2013 and May 31, 2014. Specific liquid/ice withdrawal volumes not available when not stipulated in permit.

::: n/a

3.0 STUDY METHODS

3.1 WATER SURFACE ELEVATIONS SURVEYS

Changes in WSE were measured at Lake L9341. Existing gages G32 and G33, rehabilitated for 2014, were used to monitor recharge at the lake.

A staff gage assembly consists of a metal gage faceplate mounted on a two-by-four timber. The timber is attached with U-bolts to a 1.5-inch wide angle iron driven approximately 2 feet into the ground. All gages installed are indirect-read staff gages; meaning, the values read on the gage faceplate do not directly correspond to a known elevation. Photo 3.1 shows a gage setup at Lake L9341. A tabulated list of gage and temporary benchmark (TBM) locations is included in Appendix A.

Standard differential leveling techniques were used to establish the staff gage elevation with a local TBM. Elevations of the staff gages at Lake L9341 were based on a preexisting TBM tied to British Petroleum Mean Sea Level (BPMSL) elevation.

Photo 3.1: Staff gage, G32-B on Lake L9341, pre-breakup; May 5, 2014

When water levels were not sufficiently high to be recorded on the staff gage face plate, standard differential leveling techniques were used to measure WSE. The horizontal position of each staff gage and TBM was recorded using a handheld global positioning system (GPS) in North American Datum of 1983 (NAD83).

In addition to visual WSE observation, In-Situ® Level TROLL® 500 pressure transducers were installed on gages at G32 and G33. Pressure transducers measure the absolute pressure of the atmosphere and water, allowing the depth of water above the sensor to be calculated. Resulting data yield a comprehensive record of the fluctuations in stage. Pressure transducers supplement gage measurements and are used to validate and adjust data. Each pressure transducer consists of an unvented pressure sensor designed to collect and store pressure and temperature data at discrete pre-set intervals. The pressure transducers were programmed to collect gage pressure and water temperature at 15-minute intervals from May 10 to July 10, 2014.

Activities at Lake L9341 included pre-breakup surveys, observations during breakup, and a post-breakup investigation. High water marks were not evident.

3.2 Lake Recharge Observations

Throughout breakup, aerial photographs were taken from a helicopter using a GPS camera. Photos were taken from various perspectives to capture the extent of snow melt, flow pattern, potential lake water recharge sources, and hydraulic connectivity with other water bodies. Written documentation of visual observations combined with time-stamped GPS photos support identification of the lake's recharge mechanism(s), extent, and timeline.

A hydrograph showing changes in WSE over time was used to determine estimated lake recharge at Lake L9341. Recession of floodwaters is evident in a negative slope after peak stage, indicating the lake has recharged over bankfull conditions and is discharging excess water by means of overbank flow.

4.0 STUDY RESULTS

The WSE and lake recharge observations are presented in this section. Photographs of each lake are included in Appendix B.

4.1 WATER SURFACE ELEVATION

Existing gages G32 and G33 were used to monitor recharge of Lake L9341 (Photo 4.1 and Photo 4.2). The WSE data and hydrograph for Lake L9341 are presented in Table 4.1.

Photo 4.1: Gage G32 during breakup; May 21, 2014

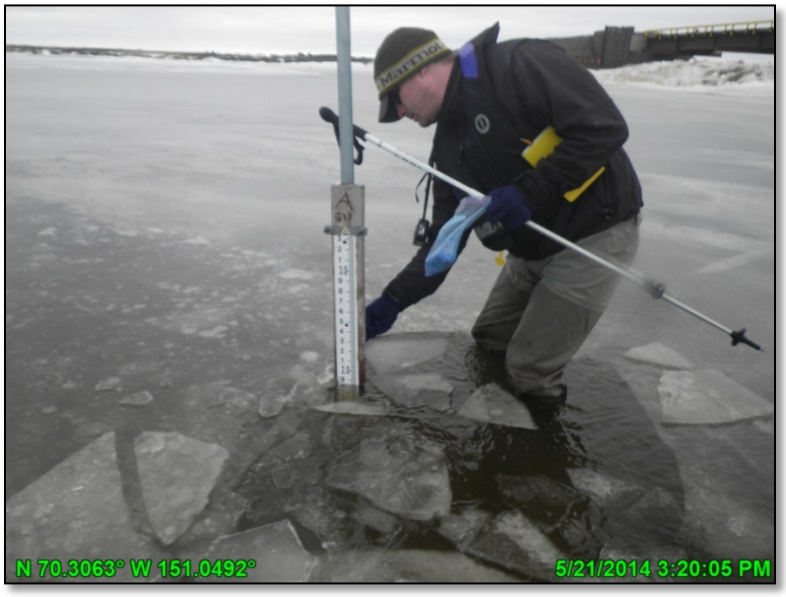


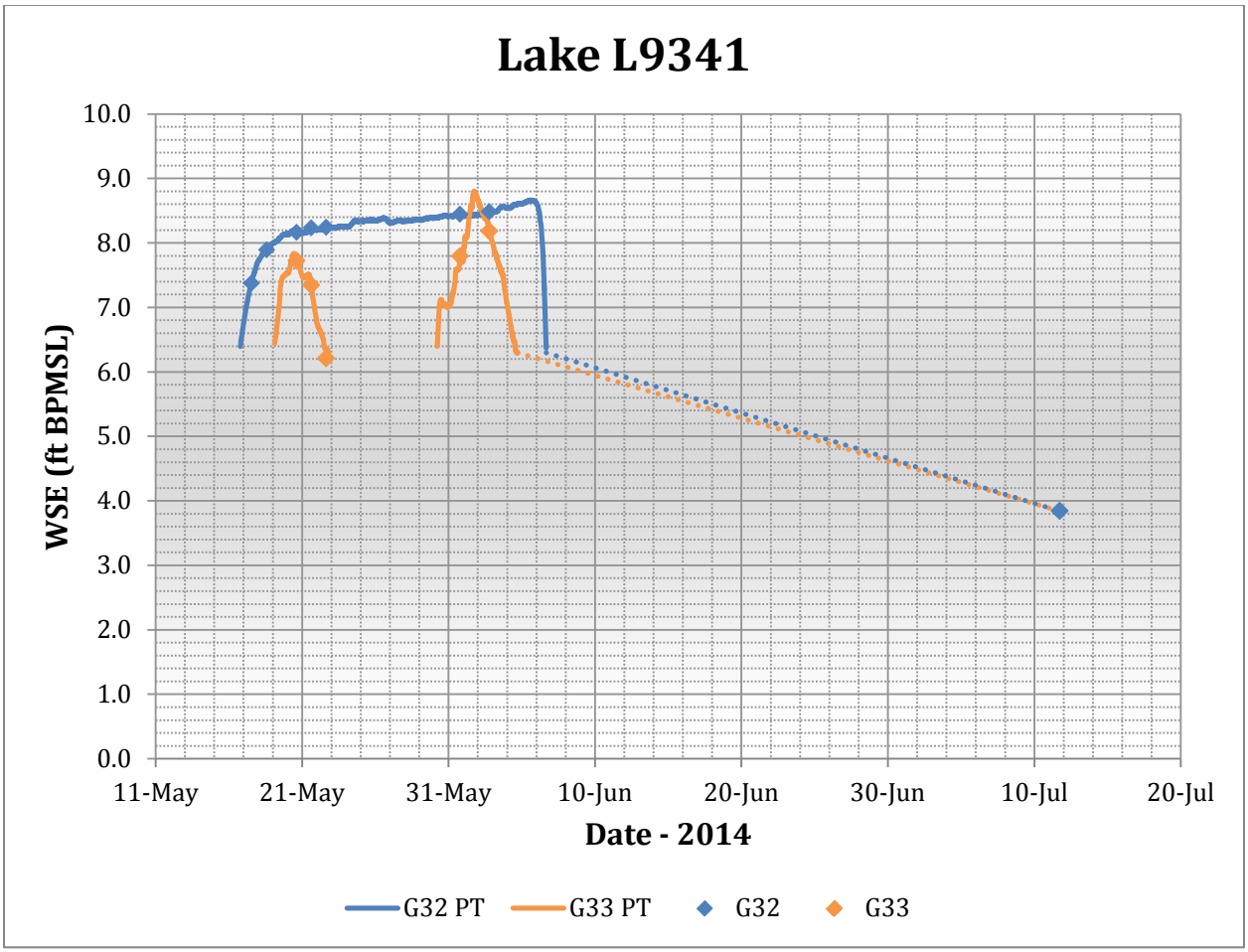
Photo 4.2: Gage G33 during breakup; May 21, 2014

Table 4.1: WSE Data for Lake L9341

Date and Time	WSE (feet BPMSL)		Observations
	G32	G33	
5/17/14 12:49 PM	7.37	-	Pressure transducer and gages are dry at G33
5/18/14 2:19 PM	7.89	-	Water begins to pond south of ice bridge crossing near G32
5/20/14 2:52 PM	8.16	7.72	Backwater effects observed from the Nigliq Channel
5/21/14 3:15 PM	8.23	7.34	
5/22/14 3:38 PM	8.24	6.21	Pressure transducer dry at G33
5/31/14 7:08 PM	8.44	7.79	
6/1/14 6:00 PM	**-**	**8.80**	**Peak stage – based on pressure transducer data**
6/2/14 7:04 PM	8.48	8.18	
6/5/14 3:30 PM	**8.67**	**-**	**Peak stage – based on pressure transducer data**
7/11/14 5:30 PM	3.84	3.84	Not hydraulically connected to the Nigliq Channel

Notes:

1. Elevations are assumed based on Monument MON27 at 13.91 feet elevation BPMSL, surveyed by LCMF in 2014
2. Dashed line indicates a greater time interval between observations and that the change in WSE is not likely direct



4.2 Lake Recharge

Recharge of lakes L9306, L9808, L9809A, L9809B, and MB0301 were determined by visual observation and aerial photographs. All lakes were observed to fully recharge over bankfull during the 2014 monitoring season. Bankfull recharge was determined through visual observations of inflow and outflow.

Lake L9809B recharged primarily from local flow from the Nigliagvik. Lakes L9306, L9808, L9809A, and MB0301 recharged from channelized flow from neighboring lakes.

During open water season, lakes L9809A and L9809B were hydraulically connected to the Nigliagvik; Lake L9306 was likely connected to Lake L9815 to the south. Other observed hydraulic connections with lakes L9341, L9808, and MB0301 are likely seasonal and limited to an increase in stage conditions during spring breakup. These lakes should be considered hydraulically isolated during the remainder of the year.

4.3 Summary

A compilation of 2014 hydrologic observations, including whether the lake recharged to bankfull, the primary recharge mechanism, additional hydraulic connections, and estimated bankfull WSE is provided provided in Table 4.2. At the time of the study, all lakes appeared to recharge to or above bankfull elevations via channelized flow of spring breakup flood waters.

Table 4.2: Summary of 2014 Hydrologic Recharge Observations

Study Lake	Recharge to Bankfull	Primary Recharge Mechanism	Additional Hydraulic Connection[1]		Estimated Bankfull WSE[2] (feet BPMSL)
			Flow In	Flow Out	
L9306	√	Channelized flow from Lake L9815 (south)	Channelized flow from Lake L9815 (south)	Channelized flow into Lake L9815 (south)	--
L9341	√	Nigliq Channel overbank flow (north)	Nigliq Channel overbank flow (north)	Channelized flow into the Nigliq Channel (north)	3.8
L9808	√	Beaded stream connecting to Lake L9807 (southwest)	Beaded stream connecting to Lake L9807 (southwest)	Channelized flow into Lake L9809B (northeast)	--
L9809A	√	Channelized flow from Lake L9809B (south)	Channelized flow from Lake L9809B (south)	Channelized flow into Lake L9809B (south)	--
L9809B	√	Channelized flow from Nigliagvik (east)	Channelized flow from Nigliagvik (east) and Lake L9808 (southwest)	Channelized flow to Lake L9809A (north) and Nigliagvik (east)	--
MB0301	√	Channelized flow from Lake L9308 (Oil Lake) from the south	Channelized flow from Lake L9308 (Oil Lake) from the south	Interconnected wetland network (east and west)	--

Notes:
1. Observations between May 1 and July 12, 2014. Unless specified, hydraulic connections are likely seasonal only.
2. WSE estimated based on gage readings for all years available

-- Visual observation only; WSE not available

5.0 REFERENCES

ConocoPhillips AK, Inc. (CPAI). 2013a. Alaska Department of Natural Resources Alpine 3rd Quarter 2013 Water Use Report.

——2013b. Alaska Department of Natural Resources Alpine 4th Quarter 2013 Water Use Report.

—— 2014a. Alaska Department of Natural Resources Alpine 1st Quarter 2014 Water Use Report.

—— 2014b. Alaska Department of Natural Resources Alpine 2nd Quarter 2014 Water Use Report.

Appendix A Gage and TBM Locations

Monitoring Location	Site Name	Type	Latitude[1]	Longitude[1]
L9306	Lake L9306	Aerial Photos	70.2956°	-151.1042°
L9341	G32-A	Gage	70.3054°	-151.0507°
	G33-A	Gage	70.3062°	-151.0491°
	Monument 27	TBM	70.3060°	-151.0533°
L9808	Lake L9808	Aerial Photos	70.2736°	-151.0936°
L9809A	Lake L9809A	Aerial Photos	70.2814°	-151.0864°
L9809B	Lake L9809B	Aerial Photos	70.2770°	-151.0821°
MB0301	Lake MB0301	Aerial Photos	70.3088°	-151.2006°
Note 1: Locations are referenced NAD 83 datum in decimal degrees				

Appendix B Photos

B.1 Lake L9306

Photo B.1: Lake L9306 pre-breakup, looking southeast; May 22, 2014

Photo B.2: Lake L9306 post breakup, looking northwest; July 11, 2014

B.2 Lake L9341

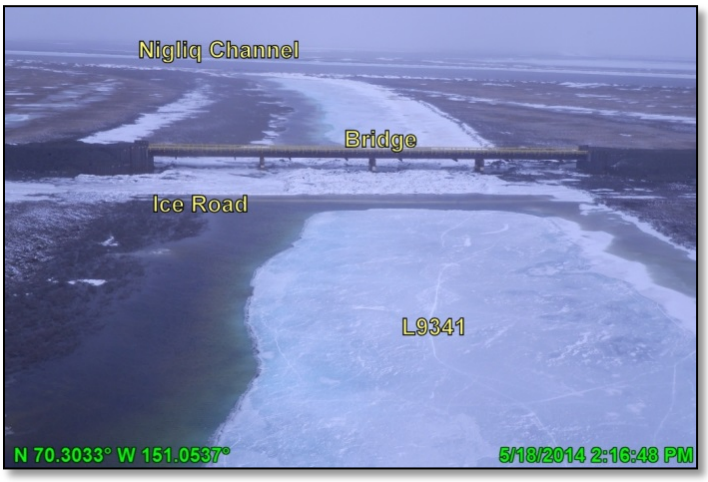


Photo B.3: Lake L9341 during breakup, looking northeast; May 18, 2014

Photo B.4: Lake L9341 post-breakup, looking northeast; July 11, 2014

B.3 Lake L9808

Photo B.5: Lake L9808 post-breakup, looking northeast; July 11, 2014

B.4 Lake L9809A

Photo B.6: Lake L9809A post-breakup, looking south; July 11, 2014

B.5 Lake L9809B

Photo B.7: Lake L9809B post-breakup, looking north; July 11, 2014

B.6 Lake MB0301

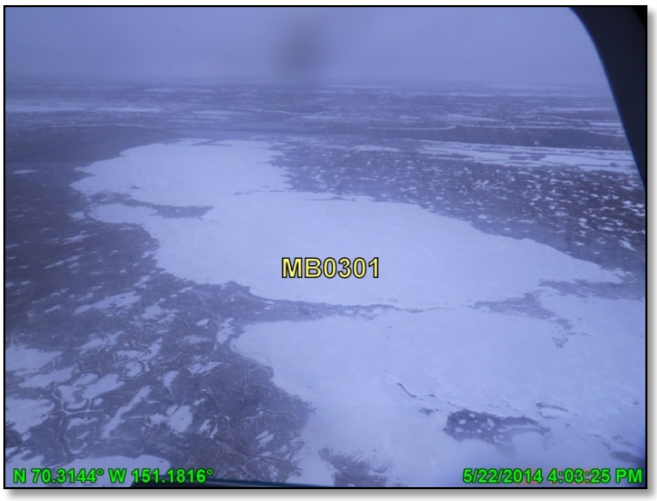


Photo B.8: Lake MB0301 pre-breakup, looking southwest; May 22, 2014

Photo B.9: Lake MB0301 post-breakup, looking north; July 11, 2014

2014 CD5 Lakes Recharge Studies