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Fish Habitat Management and Monitoring Related to Oil and Gas Exploration in the National Petroleum Reserve-Alaska: 2008–2009

Matthew S. Whitman, Shane Walker, and Richard T. Kemnitz

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Ice-road channel crossing at the Ublutuoch River in the National Petroleum Reserve-Alaska. BLM photo by Matthew Whitman. Unless otherwise noted, photos in this report are by the authors.

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Abstract

In 2008 a consulting firm under contract to the Bureau of Land Management (BLM) completed a fisheries monitoring plan for the National Petroleum Reserve-Alaska (NPR-A). The plan outlined a strategic approach to monitoring fish habitat where oil and gas activities are occurring. This report addresses how the BLM's Arctic Field Office implemented this plan to manage and monitor fish habitat during oil and gas exploration in the NPR-A during the winter of 2008–2009. Two operators, ConocoPhillips Alaska, Inc. and Anadarko Petroleum Corporation, conducted exploration operations during this time. The BLM's multifaceted strategy relied on Required Operating Procedures, lease stipulations, permit-specific stipulations, permitting by other regulatory agencies, compliance inspections, and additional effectiveness monitoring. Primary concerns about fish habitat included impacts on water source lakes, ice- and snow-road stream crossings, and water quality. Data and observations confirmed that the majority of management objectives were accomplished. However, one lake was overpumped and a potential barrier to fish movements was left at one ice-road crossing during spring breakup.

Acknowledgements

The successful fish habitat monitoring efforts described in this report would not have been possible without the contributions of the BLM Arctic Field Office's hydrology program and oil and gas compliance program. The expertise, cooperation, and regulatory decisions provided by the Alaska Department of Fish and Game Habitat Division (Jack Winters and Bill Morris) were essential to mitigating impacts to fish habitat on BLM-managed public lands. The cooperation of the University of Alaska Fairbanks Water and Environmental Research Center and Geo-Watersheds Scientific also provided many benefits to the fish habitat monitoring program.

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Introduction

In 2008, a consulting firm under contract to the Bureau of Land Management (BLM) completed a fisheries monitoring plan for the National Petroleum Reserve-Alaska (NPR-A) (Noel et al. 2008). The plan outlined a strategic approach to the inventory, assessment, and monitoring of fish and fish habitat in areas associated with oil and gas (O&G) activities. This plan analyzed both exploration and development activities with respect to potential impacts on fish resources, reviewed existing protective measures in BLM planning documents, and made recommendations on how to monitor, evaluate, and improve the effectiveness of these measures. The multiple and complex elements of the monitoring plan require that implementation be both incremental and adaptive. The information provided within this report addresses the current state of fish habitat management and monitoring by the BLM Arctic Field Office with regard to O&G exploration in the NPR-A, as guided by the fisheries monitoring plan and applied to activities conducted during the 2008–2009 winter.

The O&G industry conducts overland exploration activities in the Arctic during winter to minimize potential impacts to the ecosystem. Conducting operations during periods of sufficient snow cover and frozen soil significantly reduces impacts to the terrestrial landscape. Similarly, operating in the winter is advantageous for protecting aquatic systems because lake and stream surfaces are frozen. To accomplish its winter work the industry builds ice or snow roads to provide the stability necessary for moving vehicles and heavy equipment. Construction of these travel surfaces and associated infrastructure (such as drilling pads, construction camp pads, and airstrips) requires the use of liquid water and ice chips from lakes. The use of lakes as water sources, the crossing of stream channels by ice or snow roads, and the risk of contaminated overland runoff from industrial operations are primary concerns related to fish habitat.

Utilizing lakes as winter water sources poses several potential problems for fish. Pumping water from lakes reduces the volume of under-ice habitat and can affect spring and summer accessibility if recharge from snowmelt is not adequate to restore water levels. A reduction in winter dissolved oxygen (DO) concentrations is also a concern. Diminishing space and oxygen can intensify stress due to overcrowding and increase the concentration of metabolic byproducts to a point where some fish die (Schmidt et al. 1989). Additionally, water velocities generated at pump intake hoses can capture or impair the movement of small fish in the vicinity. These potential problems are particularly critical to address through management actions because winter is the most vulnerable period of the annual cycle for Arctic fish. By late winter, ice cover significantly reduces available North Slope freshwater habitat (Craig 1989). This habitat limitation may be the single most important factor affecting Arctic fish population size and cyclical fluctuations in abundance (Reynolds 1997). Many recent studies have significantly contributed to knowledge about winter lake water use and confirmed that current management practices are effective in certain hydrologic settings (Hinzman et al. 2006; Baker 2007; Chambers et al. 2008; Cott et al. 2008; Holland et al. 2009b; Clilverd et al. 2009). However, water use continues to generate concern in winter O&G exploration because it involves complex ecological processes.

Ice- or snow-road channel crossings (ice bridges) can also impact overwintering habitat, creating barriers to fish movements during spring breakup, and degrading stream bank or stream channel conditions. Ice bridges are preferably located where water will freeze to the bottom under normal winter conditions. However, if ice bridges are placed above overwintering habitat, the increased ice thickness associated with these crossings will result in a loss of habitat where conditions are already marginal. Once streams and rivers begin to thaw in the spring, the increased ice thickness and density at channel crossings can cause these bridges to remain intact longer than the surrounding ice. While the bridges are typically "prepared" for breakup by slotting in order to expedite dismantling and provide fish passage during high flows, the effectiveness of this practice has not been confirmed in a wide range of hydrologic settings. When ice-bridge remnants do persist in a channel, they may impede fish movements; several species of Arctic fish make migrations during or immediately after breakup to access more productive feeding habitat or to reach spawning grounds (Bond and Erickson 1985; Armstrong 1986; Chang-Kue and Jessop 1992; Blackman 2002; Morris 2003; Morris et al. 2006). Remnant ice bridges may also impact habitat by either deflecting flow into stream banks or causing streambed scour.

Water quality impairment due to contaminated overland runoff during the spring melting period is another fish habitat concern. Operations associated with winter O&G exploration activities involve extensive use of vehicles and heavy equipment, considerable storage volumes of fuels and mechanical fluids, and temporary ice pads that support drilling operations and industrial construction camps. Consequently, the mechanisms are in place for both point- and nonpoint-source contamination of surface waters. While regulatory practices have been enacted to mitigate water quality impacts, operations must be monitored for appropriate implementation.

During the 2008–2009 winter, O&G exploration activities in the NPR-A included drilling operations by ConocoPhillips Alaska, Inc. (CPAI) and Anadarko Petroleum Corporation (APC) (Figure 1). CPAI's exploration infrastructure consisted of about 27 miles of ice road, 2 drilling ice pads (Grandview #1 East and Pioneer #1 prospects), and 1 construction camp ice pad (Talkeetna Camp) (Figure 2). The company utilized water from 8 fish-bearing lakes to construct and maintain this infrastructure. Additionally, CPAI's ice road crossed 4 stream channels that support fish. APC's exploration infrastructure consisted of approximately 36 miles of snow road, 1 drilling ice pad (Wolf Creek prospect), 1 construction camp ice pad, and a few miles of ice road in the

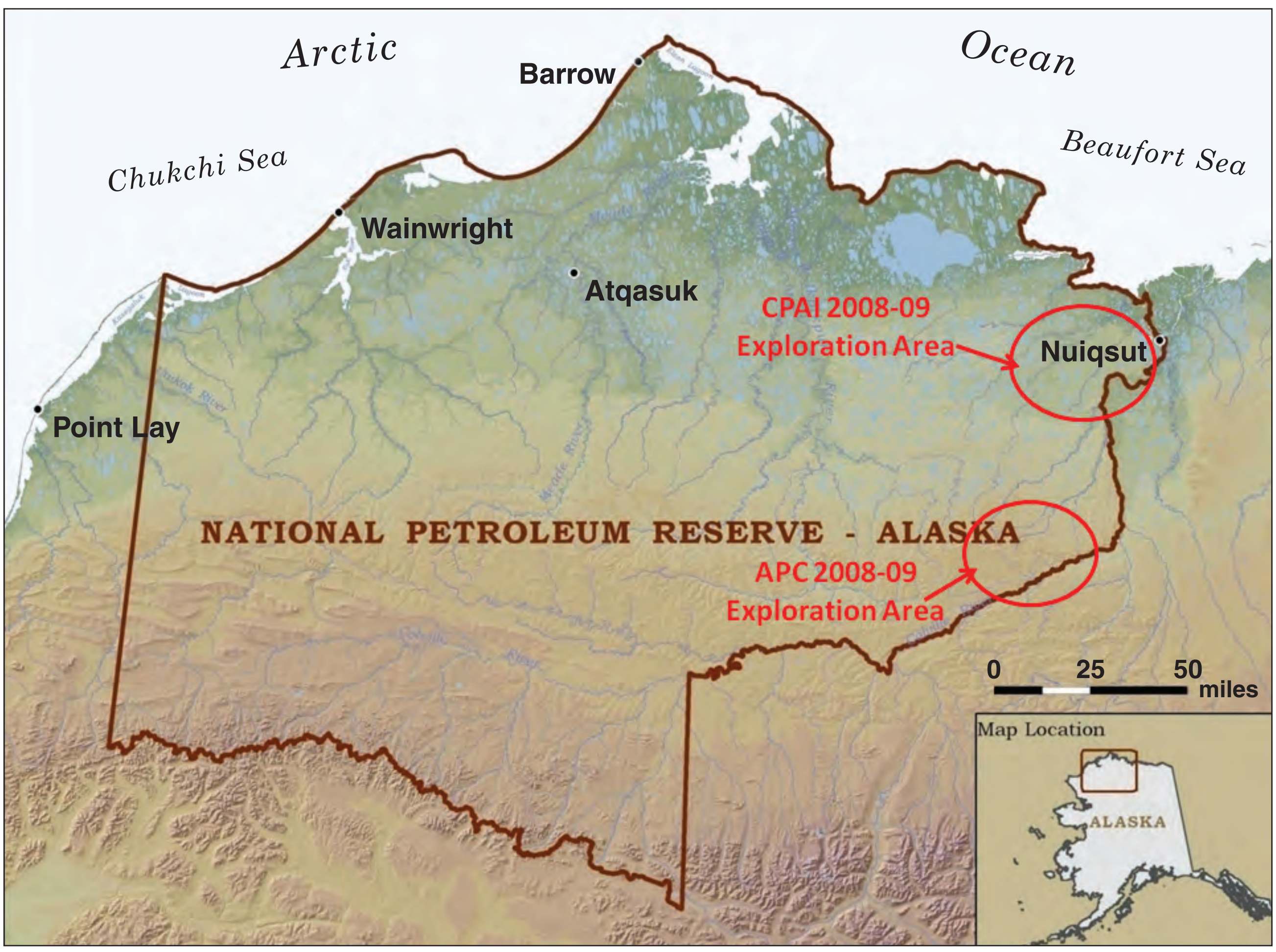

Figure 1. Overview of NPR-A showing location of CPAI and APC 2008–2009 exploration areas.

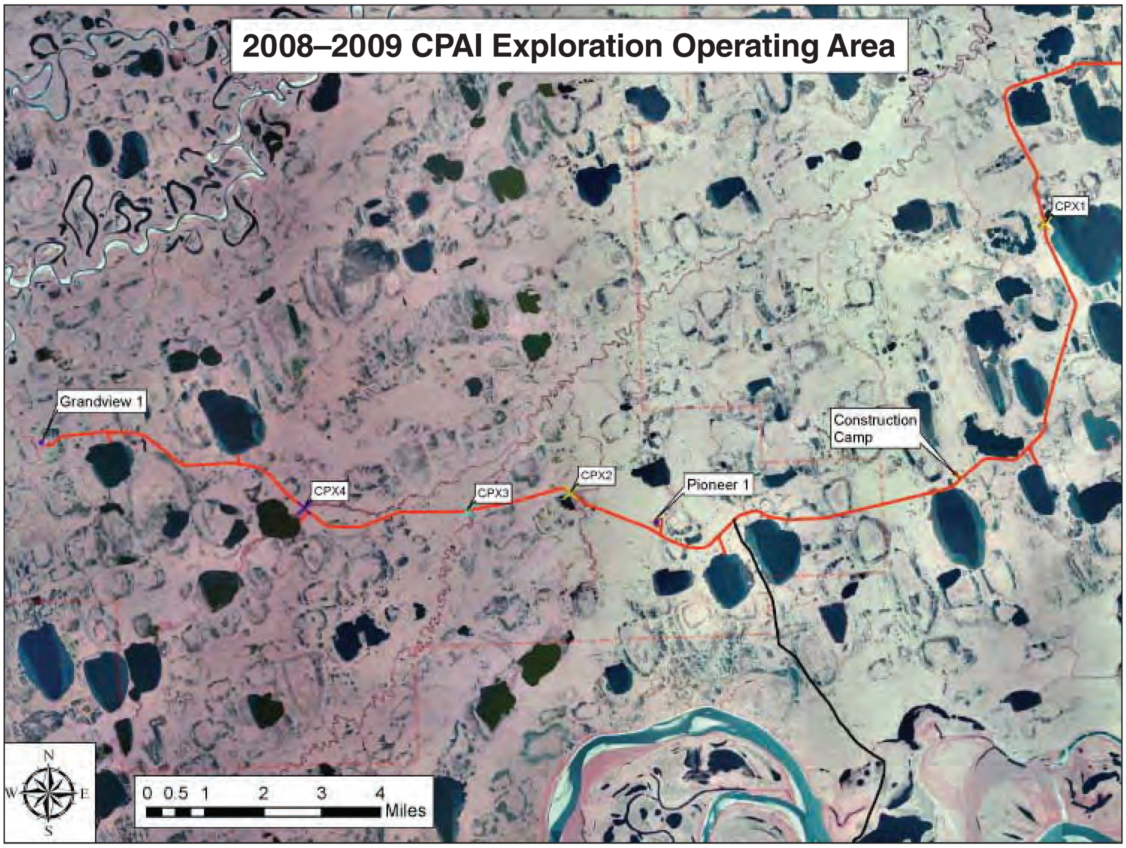

Figure 2. ConocoPhillips Alaska, Inc. (CPAI) operating area in the NPR-A for the 2008–2009 winter exploration period.

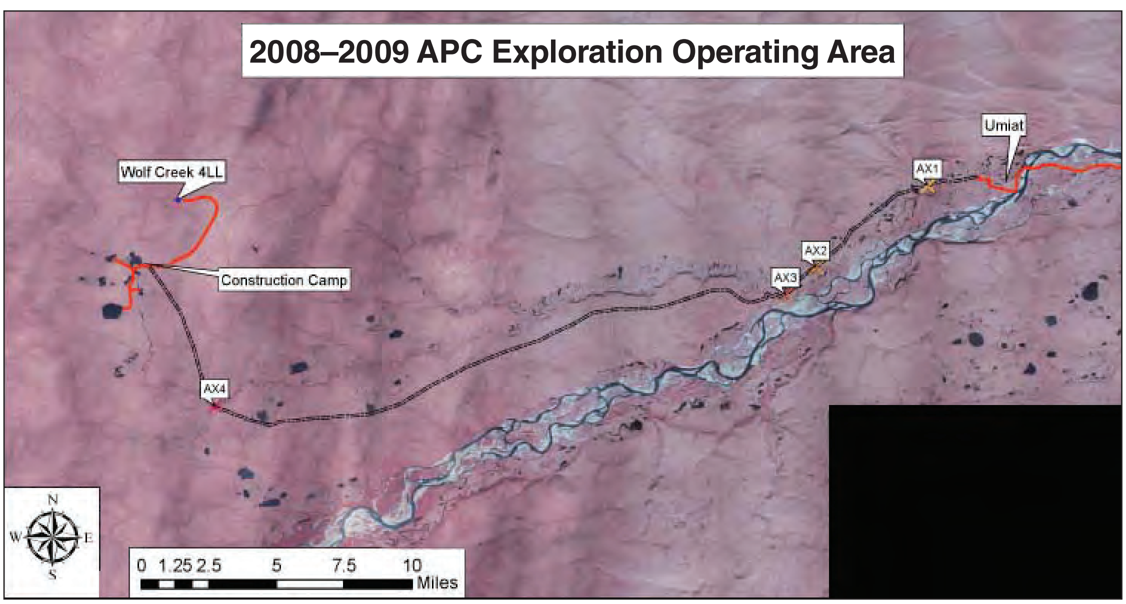

Figure 3. Anadarko Petroleum Corporation (APC) operating area in the NPR-A for the 2008–2009 winter exploration period.

vicinity of its drilling operation (Figure 3). APC utilized water from 3 fish-bearing lakes, and its snow road crossed 4 stream channels that support fish. To mitigate potential impacts to fish and fish habitat from these operations, the BLM utilized a wide range of tactics. These ranged from time-tested industry requirements to the implementation of new management guidelines and data-collection standards intended to help the agency track and better understand the status of fish resources.

Study Areas

Anadarko Petroleum Corporation

APC's exploration activities during the winter of 2008–2009 occurred in the Arctic Foothills Province (Warhaftig 1965) in the far eastern portion of the NPR-A. This area is comprised of rolling hills and generally steeper gradient streams than those in the Arctic Coastal Plain. Streams in the operating area drain to the east and southeast into the Colville River. Lakes are sparse in the uplands, but are fairly prevalent along stream and river corridors. Upland terrain is typically rolling hills of tussock tundra interspersed with riparian zones dominated by relatively dense, tall willows. APC accessed the area from a commercial camp at Umiat, a historic industrial outpost. Nuiqsut, located approximately 95 miles down the Colville River, is the closest village.

ConocoPhillips Alaska, Inc.

During the winter of 2008–2009, CPAI conducted O&G exploration in the Arctic Coastal Plain Province (Warhaftig 1965) in the far northeastern portion of the NPR-A. This area is comprised of extremely low-gradient streams and a high density of thermokarst lakes that drain northward into the Beaufort Sea. Upland terrain is characterized by polygonized tundra with narrow riparian zones primarily composed of sparse willows. The flat topography contributes to poorly defined drainage areas that often consist of complicated networks of interconnected lakes and small tundra streams. CPAI gained access to the area from the Alpine oilfield facility located in the Colville River Delta. The village of Nuiqsut is approximately 8 miles to the south of Alpine and is located immediately to the east of the exploration area.

Objectives

The objectives of fish habitat management and monitoring in the NPR-A for the 2008–2009 O&G exploration period included:

- Protecting fish resources among O&G exploration activities by mitigating potential impacts with proactive management requirements
- Evaluating the effectiveness of management requirements aimed at protecting fish resources
- Obtaining additional fish habitat data during winter and spring breakup to better understand the potential impacts of O&G exploration activities
- Using collected data to improve adaptive management practices

Methods

The existing strategy utilized by the BLM Arctic Field Office to minimize potential impacts to fish and fish habitat from O&G exploration is multifaceted. The impetus behind this strategy is derived from the NPR-A Fisheries Monitoring Implementation Plan (Noel et al. 2008). Required Operating Procedures (ROPs) and lease stipulations established for industry in Environmental Impact Statements (EISs) are based on established and accepted best management practices. Environmental Assessment (EA)-level, permit-specific stipulations formulate additional requirements that are based on the most recent information available and adapted to knowledge gained from past efforts. The BLM also relies on cooperation and communication with other regulatory agencies whose authority and environmental protection objectives overlap with those of the BLM. Compliance inspections and frequent in-season interactions with O&G companies are essential for in-season tracking of requirements. Finally, additional effectiveness monitoring and data collection by the BLM, whether through its own resources entirely, a cooperative effort, or contracted work, fills gaps in data and provides information to advance the understanding of aquatic ecosystem dynamics in the Arctic and the likely effects O&G exploration activities can have on these systems. It is only through this comprehensive and adaptive approach that BLM's ability to protect fish resources is optimized.

EIS ROPs and Lease Stipulations

CPAI and APC were subject to industry ROPs and lease stipulations from the Northeast NPR-A Supplemental Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) (USDOI 2008) for the 2008–2009 O&G exploration work. These ROPs and stipulations (Appendix A) contribute, either directly or indirectly, to the protection of fish resources. Appendix A abbreviates or summarizes the Objective or Requirement/Standard; complete descriptions can be found in the IAP/EIS.

EA-Level Permit-Specific Stipulations

Although O&G exploration activities are evaluated during the EIS process using a general scenario, National Environmental Policy Act (NEPA) requirements demand that specific O&G actions also be reviewed through an EA process before the BLM can grant an authorization to carry out those actions. Through this process specific lakes are evaluated and approved for varying levels of water use, planned ice-road stream crossings are closely examined, and any other relevant concerns for fish habitat are addressed. This provides an opportunity to apply the most recent knowledge regarding resource status and protection and to implement further protective measures if necessary. These measures may include prescriptive rules as well as data collection related to effectiveness monitoring.

The BLM imposed similar mitigation and monitoring requirements on APC and CPAI for their 2008–2009 exploration projects based on recommendations made in the NPR-A Fisheries Monitoring Implementation Plan (Noel et al. 2008). Measurements of ice thickness and water depth at stream channel crossings during snow- or ice-road construction provided quantitative documentation of overwintering fish habitat potential at those locations. Requiring as-built GPS data of roads and pads at the time of completed construction allowed the BLM to evaluate these structures in-season before its field site visits. Signs that clearly identified lakes helped reduce the possibility of overpumping an individual lake. (While posting lake identification signs at access points seems rudimentary, the lack of identifiable land features and the numerous subcontractors involved in pumping water made the misidentification of lakes an issue during past years.) The BLM was able to keep close track of activities in-season — rather than learning about them in post-season reports — due to required weekly submittals of daily water use records and notification within 24 hours of any lake overpumping or observation of dead fish at pumping holes. Finally, operators were required to photograph the slotting of ice- or snow-road channel crossings at the end of the winter, enabling the BLM to obtain necessary information without the expense of additional site visits.

Where the BLM allowed operators to exceed current standard practices for lake water use, the agency mandated additional monitoring requirements. These deviations from existing guidelines were supported by new knowledge that wasn't available during the initial development of standards listed in the EISs. The decisions in these cases were in concurrence with the State of Alaska's permitted water use levels for the specific lakes in question. By allowing this on a limited basis and requiring additional data collection, the BLM gained knowledge that will inform future evaluations.

Permit-specific stipulations designed to contribute to fish resource protection and imposed on APC and CPAI for 2008–2009 exploration activities are listed in Appendix B. These stipulations are summarized from the EAs that evaluated the companies' respective proposed actions.

Other Regulatory Agency Authorizations and Approvals

In addition to the BLM's review and approval of proposed O&G exploration activities, other federal and state agencies also have jurisdiction and regulatory roles regarding aspects of industrial operations in the NPR-A. The following list summarizes agency roles that contribute to the evaluation and protection of aquatic habitat:

- Alaska Department of Fish and Game (ADFG) Habitat Division: Fish Habitat Permits for Water Withdrawals
- ADFG Habitat Division: Fish Habitat Permits for Ice-Road Stream Crossings

- ADFG Habitat Division: Water Intake Fish Exclusion Screen Certifications
- Alaska Department of Natural Resources (ADNR): Temporary Water Use Permits
- U.S. Environmental Protection Agency (USEPA): National Pollutant Discharge Elimination System (NPDES) Wastewater Discharge Permit
- National Marine Fisheries Service (NMFS): Essential Fish Habitat Assessment (salmon only); completed by the BLM unless consultation is required

Compliance Inspections

BLM compliance inspections of O&G exploration activities are critical to the successful implementation of management practices, including measures intended to protect aquatic resources. On-site examination of operations helps to verify and document that operators are properly following rules and regulations. If problems are identified, or if clarification of requirements is required, then prompt, in-season corrective actions can often be taken to help avoid longer-term issues. For aquatic resources, key inspection items include the handling and storage of fuels and waste, water pumping and ice chip removal operations at lakes, water pump intake screens and their condition, and observations at ice- or snow-road stream crossings. These compliance inspections also function well as a means to maintain direct and frequent communication with industry personnel working in the field.

Additional Effectiveness Monitoring and Data Collection

As a supplement to monitoring data collected by industry during the winter of 2008–2009, the BLM collected other effectiveness monitoring information and field data through its own resources and cooperative relations. For example, a new Cooperative Ecosystems Study Unit agreement established with the University of Alaska Fairbanks Water and Environmental Research Center helped the BLM to create the Cooperative Arctic Lakes Data Collection Network (CALDCN). This network is intended to extend an ongoing cooperative effort among many entities to study Arctic lakes where pumping has occurred over the last several years. Through this mechanism, the BLM funded the collection of late winter dissolved oxygen (DO) data from selected lakes in the CPAI operating area. In addition to expanding the ongoing dataset to include new lakes, the project will generate data that can be used to test the accuracy of a recently developed tool for predicting winter DO depletion rates in Arctic lakes based on physical characteristics and pumping activities (White et al. 2008). This tool, once tested and refined to an acceptable degree of scientific confidence, has the potential to help regulators base water use management upon more site-specific characteristics than had previously been the norm. As part of the CALDCN agreement, researchers also worked on centralizing winter lake data collected in this region over the last several years for inclusion in a summary report.

The BLM evaluated the effectiveness of slotting ice bridges across stream channels by conducting site visits during the 2009 spring breakup. To be considered an effective practice, slotting a given ice bridge should not cause hydrologic alterations that hinder fish passage or degrade stream habitat. The current methods of evaluating these factors are by field observation, photographic documentation, and professional judgment. In 2009 the BLM supplemented observation from a helicopter with deployment of time-lapse cameras at select sites to determine this technology's potential for evaluating ice bridges at breakup.

Protective Measures Summary

Protections for the 3 primary fish habitat concerns (water sources, stream channel crossings, and water quality) were provided through the multiple avenues discussed above. Implemented collectively, these provide a thorough set of protective measures. Table 1 provides a summary of all elements that contributed to preserving the integrity of fish habitat during the 2008–2009 winter O&G exploration period.

Table 1. Summary of elements contributing to the protection of fish habitat during winter oil and gas exploration.

Fish Habitat Concern	Protective Elements
Water Sources	Required Operating Procedures/Lease Stipulations • B-1, B-2 Permit-Specific Stipulations • Lake identification signs • Daily water-use records/weekly reporting • 24-hour notification for overpumping or dead fish • Lake basin snow surveys to correlate with recharge analyses • Lake outlet surveys and observations (breakup, freeze-up) Other Agency Authorizations and Approvals • ADFG water withdrawal permits (volumes permitted, additional monitoring) • ADFG water intake screen certifications • ADNR temporary water-use permits • NMFS Essential Fish Habitat Assessment (salmon only) Compliance Inspections • Water pumping and ice chip removal operations • Water pump intake screen use and condition BLM Monitoring and Data Collection • Winter DO measurements
Stream Channel Crossings	Required Operating Procedures/Lease Stipulations • C-2, C-3, C-4 Permit-Specific Stipulations • Ice thickness and water depth measurements • In-season as-built locations for roads and pads • Photographic documentation of slotting/breaching • Site-specific additional removal requirements Other Agency Authorizations and Approvals • ADFG channel crossing permits • NMFS Essential Fish Habitat Assessment (salmon only) Compliance Inspections • Ice bridge structure, location, and condition BLM Monitoring and Data Collection • Ice bridge evaluations at breakup
Water Quality	Required Operating Procedures/Lease Stipulations • A-2, A-3, A-4, A-5, A-6, D-1 Other Agency Authorizations and Approvals • USEPA NPDES Wastewater Discharge Permit • NMFS Essential Fish Habitat Assessment (salmon only) Compliance Inspections • Handling and storage of fuels and waste

Results

Water Sources

For APC's exploration operations in the NPR-A, 21 lakes were evaluated as potential water sources (Table 2). Ten of these were fish-bearing lakes, 8 of which had sensitive species present. Per ROP B-2, the BLM approved the use of ice chips in addition to the maximum allowable liquid water amount for the 10 fish-bearing lakes. This posed no additional risk to overwintering fish and was based on the successful use of this practice in the coastal region, where adequate spring recharge has been documented in many cases. However, because these lakes are located in the foothills region where relatively little data regarding lake water use exists, the BLM required additional monitoring to evaluate recharge rates (snow and lake outlet surveys) and late summer water levels (lake outlet surveys). ADFG Fish Habitat permits also stipulated that future use of ice chips in addition to the standard liquid water volume at these lakes depended upon demonstrating the recharge capability. At 2 of these lakes (M0825 and M0830), ADFG permitted greater than the standard 15% of liquid water under 7 feet of ice, with the stipulation that water quality monitoring (including DO concentrations) be conducted before and during pumping activities. The BLM concurred with the ADFG decision, which was based on a site-specific evaluation that took into account the relatively large size of the lakes. Table 2 provides information on the water volumes actually used by APC; the daily water use record is in Appendix C, Table C-1.

In December 2008, APC withdrew 34,000 gallons of water from Lake M0829, which was only permitted for 6,000 gallons. APC verbally notified the BLM and ADFG of this infraction, and within a few days APC followed up with a full report of the incident and self-imposed corrective actions. Also in December 2008, APC began pumping water from Lake M0830 prior to collecting water quality data as required by ADFG. Attempts to collect acceptable water quality data failed for approximately 2 weeks while APC continued using water from the lake. As a result of the incidents at lakes M0829 and M0830, the State of Alaska issued a Notice of Non-Compliance to APC.

As required by permit-specific stipulations, APC conducted additional environmental work around water source lakes. Late winter snow surveys conducted in several basins provided quantitative data to estimate recharge capacity (Baker 2009). Lake water level surveys and photographic documentation of outlet conditions were conducted post-breakup, in June, and at the end of August (Hilton and Lilly 2009a, 2009b; Holland et al. 2009a). Based on snow-depth surveys and associated snow water equivalent measurements, it was estimated that ample water would be available in the spring to recharge the lakes that were used as water sources. Observations during the breakup period confirmed that lake volumes recharged back to baseline levels for all lakes evaluated.

For CPAI's exploration operations in the NPR-A, 38 lakes were evaluated as potential water sources (Table 3). Thirty of these were fish-bearing lakes, 8 of which had sensitive species present. Per ROP B-2, the BLM approved the use of ice chips and/or liquid water in excess of standard guidelines at some lakes. The agency adapted this management decision based on prior-year knowledge gained about recharge in the coastal plain, where lakes are highly concentrated. Previous investigations of lakes used exclusively for O&G exploration have documented spring recharge rates and volumes (URS 2001; Baker 2002; Hinzman et al. 2006; Baker 2007; Holland et al. 2008). Despite this evidence to support the decision, the BLM required additional monitoring (snow and lake outlet surveys) at some specific lakes if and when standard water use levels were exceeded.

The State of Alaska required that approval for the future use of additional ice chips at lakes would depend upon a demonstration of recharge capabilities. Because CPAI did not actually utilize more water than is typically permitted, the company was not subject to BLM's additional monitoring requirements. Table 3 provides information on the water source lakes that were evaluated and the actual total water volumes used by CPAI. Appendix C, Table C-2, contains the daily

Table 2. Lakes in the NPR-A evaluated for APC's 2008–2009 winter exploration and actual water volumes utilized.

Lake ID[a]	Latitude (N) (WGS84)	Longitude (W) (WGS84)	Max Depth (feet)	Surface Area (acres)	Fish Species Present[b]		Approved Liquid Water Volume (gallons)	Liquid Water Volume Utilized (gallons)	Approved Ice Chips?	Ice Chips Volume Utilized (gallons)
					Sensitive	Resistant				
M0681	69.37959	152.11275	5.1	16	none	none	20% of total lake = 3,300,000	945,600	Y	0
M0811	69.37285	152.19635	<4.0	10	--	--	0%: too shallow	0	Y	0
M0812	69.36496	152.24990	7.2	20	none	none	20% of total lake = 4,744,000	162,500	Y	0
M0813*	69.35913	152.26641	6.9	18	BW/AG	none	15% under 7 ft of ice = 0	0	Y	0
M0814	69.35016	152.29122	13.8	26	none	none	20% of total lake = 5,250,000	0	Y	0
M0815	69.33174	152.39418	4.1	61	none	none	0%: too shallow	0	Y	0
M0816	69.32300	152.41085	6.4	7	none	none	20% of total lake = 1,529,000	76,000	Y	0
M0817	69.31465	152.43027	6.2	18	none	none	20% of total lake = 3,034,000	0	Y	0
M0818	69.31437	152.44660	7.2	19	none	none	20% of total lake = 3,457,000	0	Y	0
M0819	69.26697	153.02817	5.5	18	none	none	20% of total lake = 2,012,000	0	Y	0
M0820	69.25321	153.06902	8.5	54	none	none	20% of total lake = 18,510,000	4,000	Y	0
M0821*	69.27613	153.17333	10.5	137	none	NS	30% under 5 ft of ice = 5,400,000	0	Y	0
M0822	69.25609	153.20339	8.6	20	none	none	20% of total lake = 6,170,000	0	Y	0
M0823*	69.24982	153.23138	7.2	89	none	NS	30% under 5 ft of ice = 1,459,000	0	Y	0
M0824*	69.30779	153.45055	9.5	232	AG	--	15% under 7 ft of ice = 420,000	0	Y	0
M0825*	69.31807	153.40815	15.9	36	AG	--	20% under 7 ft of ice = 1,570,000*	0	Y	0
M0826*	69.32376	153.42552	10.4	39	AG	--	15% under 7 ft of ice = 104,000	72,000	Y	0
M0827*	69.32385	153.46420	9.7	60	AG	--	15% under 7 ft of ice = 544,000	0	Y	0
M0828*	69.32834	153.41460	9.2	23	AG	--	15% under 7 ft of ice = 330,000	0	Y	0
M0829*	69.33493	153.41479	8.4	129	AG	NS	15% under 7 ft of ice = 6,000	34,000	Y	915,153
M0830*	69.33646	153.45258	14.9	46	AG	NS	25% under 7 ft of ice = 5,610,000*	2,298,000	Y	0

[a] Sources for data: MJM Research (2008a)
[b] BW = broad whitefish; RW = round whitefish; AG = Arctic grayling; NP = northern pike; NS = ninespine stickleback
* = additional monitoring required due to approval to exceed currently established guidelines
-- = not estimated or not applicable

Table 3. Lakes in the NPR-A evaluated for CPAI's 2008–2009 winter exploration and actual water volumes utilized.

Lake ID[a]	Latitude (N) (WGS84)	Longitude (W) (WGS84)	Max Depth (feet)	Surface Area (acres)	Fish Species Present[b]		Approved Liquid Water Volume (gallons)	Liquid Water Volume Utilized (gallons)	Approved Ice Chips?	Ice Chips Volume Utilized (gallons)
					Sensitive	Resistant				
L9308/77097	70.29379	151.16922	5.1	855	none	NS	30% under 5 ft of ice = 0	0	Y	0
L9806	70.24957	151.09729	6.8	362	none	NS	30% under 5 ft of ice = 14,630,000	226,800	Y	0
L9803*	70.25830	151.18946	6.7	171	none	NS	30% under 5 ft of ice = 440,000	0	Y*	0
L9804	70.24378	151.21208	5.2	253	none	NS	30% under 5 ft of ice = 0	0	Y	0
L9805*	70.23854	151.15850	5.7	439	none	NS	30% under 5 ft of ice = 10,000	0	Y*	0
L9811*	70.20870	151.16803	8.0	1034	BW/AG	NS	15% under 7 ft of ice = 940,000	0	Y*	859,358
L9813*	70.18531	151.16089	6.3	391	AG	NS	15% under 7 ft of ice = 0	0	Y*	0
L9816	70.21676	151.29542	7.6	198	none	none	20% of total lake = 31,690,000	0	Y	0
L9817	70.23330	151.34066	9.3	62	none	NS	30% under 5 ft of ice = 5,490,000	0	Y	0
M0016	70.16151	151.87878	6.2	306	none	NS	30% under 5 ft of ice = 4,790,000	0	Y	0
M0420*	70.20991	151.22279	6.0	126	BW/AG	NS	15% under 7 ft of ice = 0	0	Y*	0
M0702	70.19700	151.22756	6.7	119	none	NS	30% under 5 ft of ice = 3,930,000	0	Y	0
M0703	70.18773	151.20613	6.2	58	none	NS	30% under 5 ft of ice = 211,000	0	Y	0
M0704	70.17240	151.21803	6.0	276	none	NS	30% under 5 ft of ice = 564,000	0	Y	419,051
M0705	70.15990	151.16922	<4.0	167	--	--	0%: too shallow	0	Y	0
M0706	70.14780	151.21684	6.2	236	none	NS	30% under 5 ft of ice = 3,790,000	0	Y	0
M0707	70.14296	151.17517	6.4	328	none	NS	30% under 5 ft of ice = 5,730,000	0	Y	0
M0708*	70.11957	151.14898	28.9	323	BW/RW/AG/NP	NS	15% under 7 ft of ice = 69,980,000	0	Y*	0
M0709	70.11513	151.23351	<4.0	46	--	--	0%: too shallow	0	Y	0
M0710	70.13611	151.27399	6.5	604	none	NS	30% under 5 ft of ice = 6,060,000	3,950,065	Y	3,309,894
M0711	70.11554	151.36328	<4.0	125	--	--	0%: too shallow	0	Y	0
M0712*	70.08731	151.31685	14.4	109	BW/NP	NS	15% under 7 ft of ice = 13,810,000	0	Y*	0
M0802	70.15950	151.24899	7.2	244	none	NS	30% under 5 ft of ice = 11,969,000	8,414,154	Y	0
M0803	70.17522	151.41209	8.5	55	none	NS	30% under 5 ft of ice = 6,910,000	0	Y	0
M0804*	70.15385	151.48829	11.3	143	AG	NS	15% under 7 ft of ice = 4,884,000	0	Y*	0
M0805	70.15103	151.40257	8.5	79	none	NS	30% under 5 ft of ice = 7,480,000	0	Y	0
M0806	70.13490	151.40376	7.1	481	none	NS	30% under 5 ft of ice = 32,180,000	16,032,777	Y	0
M0807	70.12562	151.43828	<5.0	371	--	--	0%: too shallow	0	Y	2,999,653
M0808	70.12723	151.48948	6.1	172	none	NS	30% under 5 ft of ice = 1,940,000	0	Y	0
M0809	70.14870	151.55138	<5.0	22	--	--	0%: too shallow	0	Y	0
M0810	70.14901	151.79664	8.3	27	none	NS	30% under 5 ft of ice = 3,350,000	0	Y	0
R0059	70.14982	151.88116	7.6	35	none	none	20% of total lake = 11,620,000	0	Y	0
R0060	70.14619	151.83354	8.2	115	none	NS	30% under 5 ft of ice = 9,230,000	0	Y	0
R0061/L9911*	70.17119	151.78711	8.0	540	none	NS	30% under 5 ft of ice = 59,080,000	0	Y*	2,709,357
R0062	70.17724	151.61686	<4.0	49	--	--	0%: too shallow	0	Y	0
R0066/M0151	70.14619	151.76211	9.6	248	AG	--	15% under 7 ft of ice = 5,030,000	4,530,540	Y	244,650
R0067	70.14296	151.79068	7.5	81	none	NS	30% under 5 ft of ice = 4,820,000	0	Y	0
R0068/M9917	70.18732	151.80140	9.8	63	AG	--	15% under 7 ft of ice = 7,900,000	0	Y	0

[a] Sources for data: MJM Research (2000, 2003, 2005, 2007, 2008b)
[b] BW = broad whitefish; RW = round whitefish; AG = Arctic grayling; NP = northern pike; NS = ninespine stickleback* = additional monitoring required due to approval to exceed currently established guidelines
-- = not estimated or not applicable

Figure 4. Lake identification sign at water source lake access road.

water use record for CPAI.

BLM compliance monitoring trips included spot checks of lake identification signs at water source lakes (Figure 4) and also inspection of water pump intake screens to document that these were in place and in functional condition (Figure 5). ADFG fish habitat permits also specified that intake screens must be inspected by industry personnel prior to being utilized. Neither company reported dead or injured fish in or around pumping holes.

Further efforts to advance knowledge regarding winter lake water use and DO levels were carried out under the CALDCN agreement between the BLM and UAF's Water and Environmental Research Center. Through a cooperative effort partially funded by the BLM, researchers from the Water and Environmental Research Center and Geo-Watersheds Scientific measured DO concentrations during March along vertical profiles in several lakes within CPAI's exploration area and adjacent development area. Holland et al. (2009b) completed a report on these findings. Hilton et al. (2009) summarized conditions in water source lakes over the last several years.

Figure 5. Intake screen being checked for proper use and condition.

Stream Channel Crossings

Ice- and snow-road channel crossings were assigned arbitrary names according to the company respon-

Table 4. Extent of water present at channel crossings for the 2008–2009 APC snow road and CPAI ice road.

Channel Crossing ID	Stream Name	ADF&G Anadromous Fish Distribution Database Code	Latitude (N) (WGS84)	Longitude (W) (WGS84)	Ice Depth During Construction[a] (inches)	Liquid Water Depth During Construction[a] (inches)
Anadarko Snow Road						
AX1	Seabee Creek	none	69.36763	152.23348	4	0
AX2	Rainy Creek	none	69.32502	152.40278	4	0
AX3	Prince Creek	none	69.30993	152.45579	2	0
AX4	Prince Creek	none	69.25564	153.29909	2	0
ConocoPhillips Snow Road						
CPX1	unnamed	330-00-10840-2017-3163	70.21089	151.20396	0	0
CPX2	unnamed	330-00-10840-2017-3483	70.15018	151.54847	0	0
CPX3	Ublutuoch River	330-00-10840-2017	70.14695	151.62401	24	0
CPX4	unnamed	330-00-10840-2017-3508	70.14867	151.74046	0	0

[a] Information provided by CPAI and APC, respectively.

Figure 6. Slotting at crossing AX1 (Seabee Creek). (Photo provided by APC)

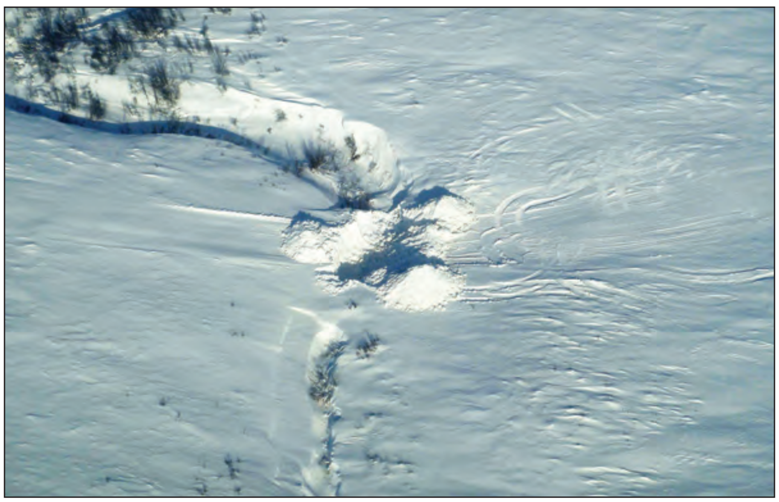

Figure 7. Slotting at crossing AX2 (Rainy Creek). (Photo provided by APC)

Figure 8. Slotting at crossing AX4 (Prince Creek). (Photo provided by APC)

sible and the location along the route (Figures 2 and 3). Industry personnel measured the extent of ice and water at crossings during the construction phase to document the presence or absence of potential overwintering fish habitat (Table 4). Compliance inspections included observation of general conditions at stream crossings during the construction and operation phases. This included evaluating any issues with site selection, access ramps, stream bank willow damage, and extent of in-channel activities, if any. At the termination of exploration activities, the operators slotted the ice bridges and provided the BLM with photographic documentation.

APC submitted photos of slotting at 3 crossings in March (Figures 6–8). Crossing AX3 in lower Prince Creek was not slotted because no fill or other alteration was made at that location. CPAI submitted photos of ice-bridge slotting, which also ocurred in March, for 3 of its 4 crossings (Figures 9–11). The crossing at CPX1 was mistakenly not slotted, but the BLM did not identify this oversight until breakup. At the BLM's request, CPAI investigated the issue and confirmed that their contractor did not slot that crossing. Regarding CPX3, Figure 10 clearly shows the extensive removal of ice-bridge materials from the Ublutuoch River channel as compared to removal from other channels. This level of work was done in response to a permit-specific stipulation based upon past experiences with the ineffectiveness of a single slot in ice bridges across that particular river.

The BLM conducted further observations at ice-bridge locations during breakup to evaluate the effectiveness of slotting techniques in avoiding hydrologic alterations that might potentially affect fish or fish habitat. Timing site visits for spring breakup evaluations at ice bridges is difficult because helicopter arrangements must be made far in advance. As it turned out, the scheduled site visits in 2009 occurred too late to observe peak-flow events, although conditions were observed and documented as soon as possible. In the foothills region, where river and stream breakup occurs earlier than on the coastal plain, only minor remnants of APC ice bridges were still visible on 19 and 25 May (Figures 12–14). Because of the late timing of the visits, no additional knowledge was gained regarding ROP effectiveness (Table 5).

In the coastal plain region, although peak flows were missed, observations still proved valuable at some sites because small coastal tundra streams are often the last channel types to open due to melting (Table 5; Figures 15–17). It was during these site evaluations that the BLM documented that crossing CPX1 was not slotted. This crossing may have presented a barrier to fish if it remained in place when lake moating occurred at Lake L9811 (Figure 17). The ice road in the vicinity of CPX2 veered around the actual planned stream crossing and was routed along the edge of Lake R0066 such that no slotting was actually necessary (Figure 18). Water was flowing freely through crossings CPX3 and CPX4, revealing no potential issues. To address continuing problems associated with the timing of these evaluations, time-lapse cameras were deployed experimentally at 2 ice-bridge sites. Although deployed too late to provide useful evaluation information, the cameras show promise as a potential alternative to intermittent site visits.

Figure 9. Slotting at crossing CPX2 (unnamed creek). (Photo provided by CPAI)

Figure 10. Slotting at crossing CPX3 (Ublutuoch River). (Photo provided by CPAI)

Figure 11. Slotting at crossing CPX4 (unnamed creek). (Photo provided by CPAI)

Table 5. Observations made at ice- and snow-road stream crossings regarding hydrologic alterations potentially affecting fish.

Observation Guideline	Stream Crossing						
	AX1	AX2	AX4	CPX1	CPX2	CPX3	CPX4
Crossing persists longer than other ice in channel?	Undetermined	Undetermined	Undetermined	Yes	NA	Undetermined	No
Ice damming?	Undetermined	Undetermined	Undetermined	No	NA	Undetermined	No
Flow channelized?	Undetermined	Undetermined	Undetermined	No	NA	Undetermined	No
Cascade created?	Undetermined	Undetermined	Undetermined	No	NA	Undetermined	No
Potential fish barrier?	Undetermined	Undetermined	Undetermined	Yes	NA	Undetermined	No
Breaching technique influences hydrology?	Undetermined	Undetermined	Undetermined	NA	NA	Undetermined	No

Figure 12. Crossing AX1 (Seabee Creek) on 25 May 2009.

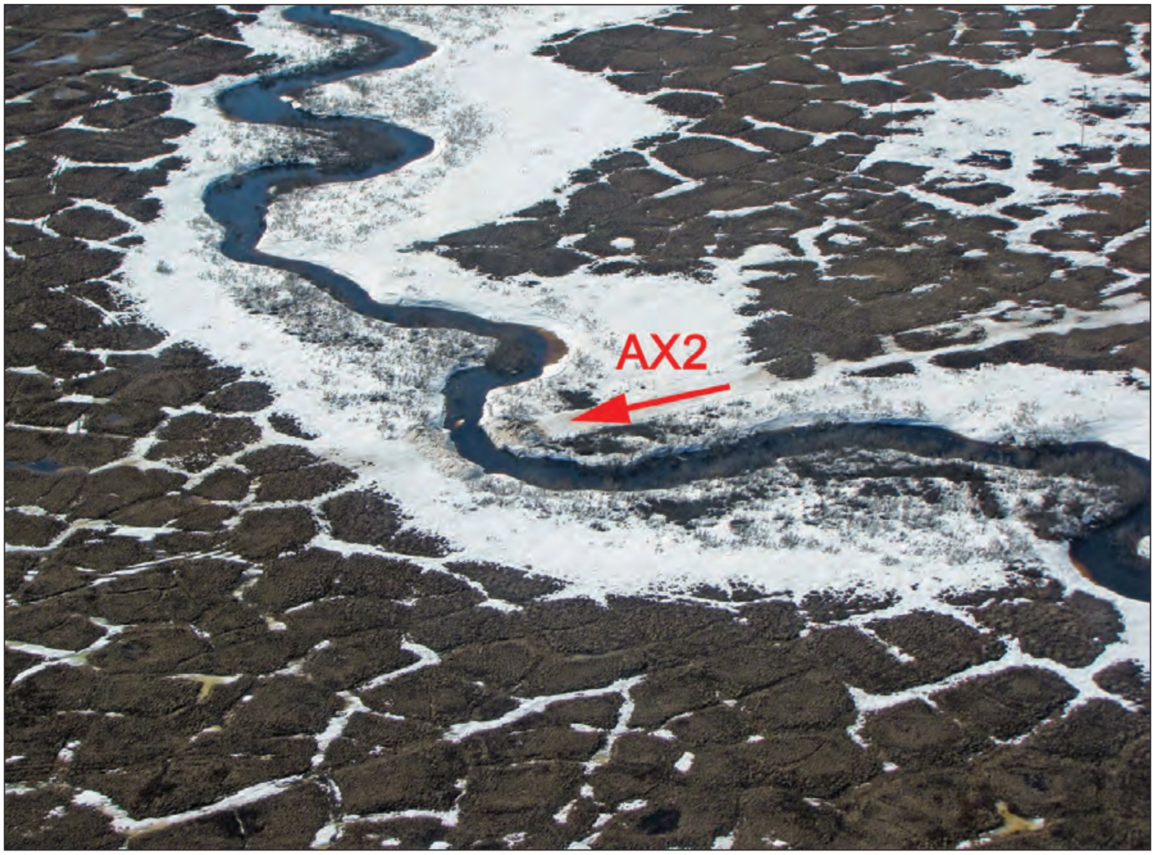

Figure 13. Crossing AX2 (Rainy Creek) on 19 May 2009.

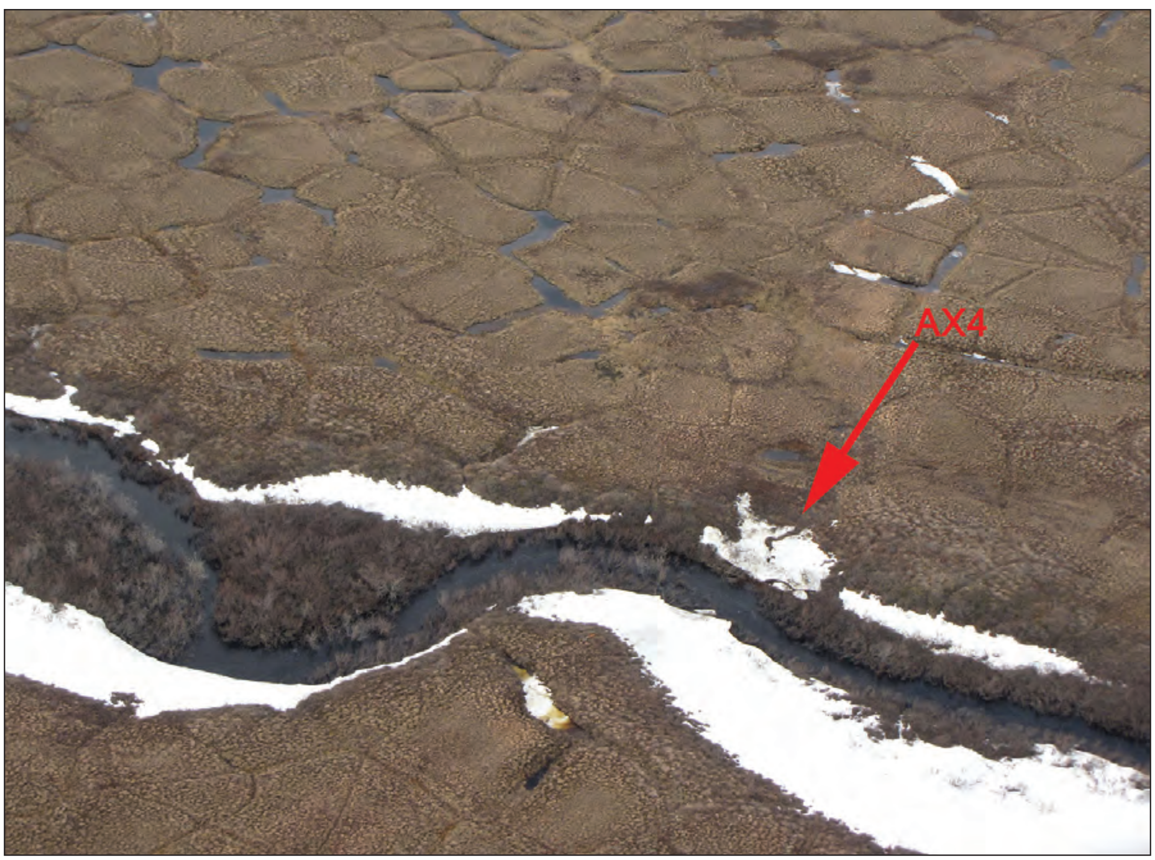

Figure 14. Crossing AX4 (Upper Prince Creek) on 19 May 2009.

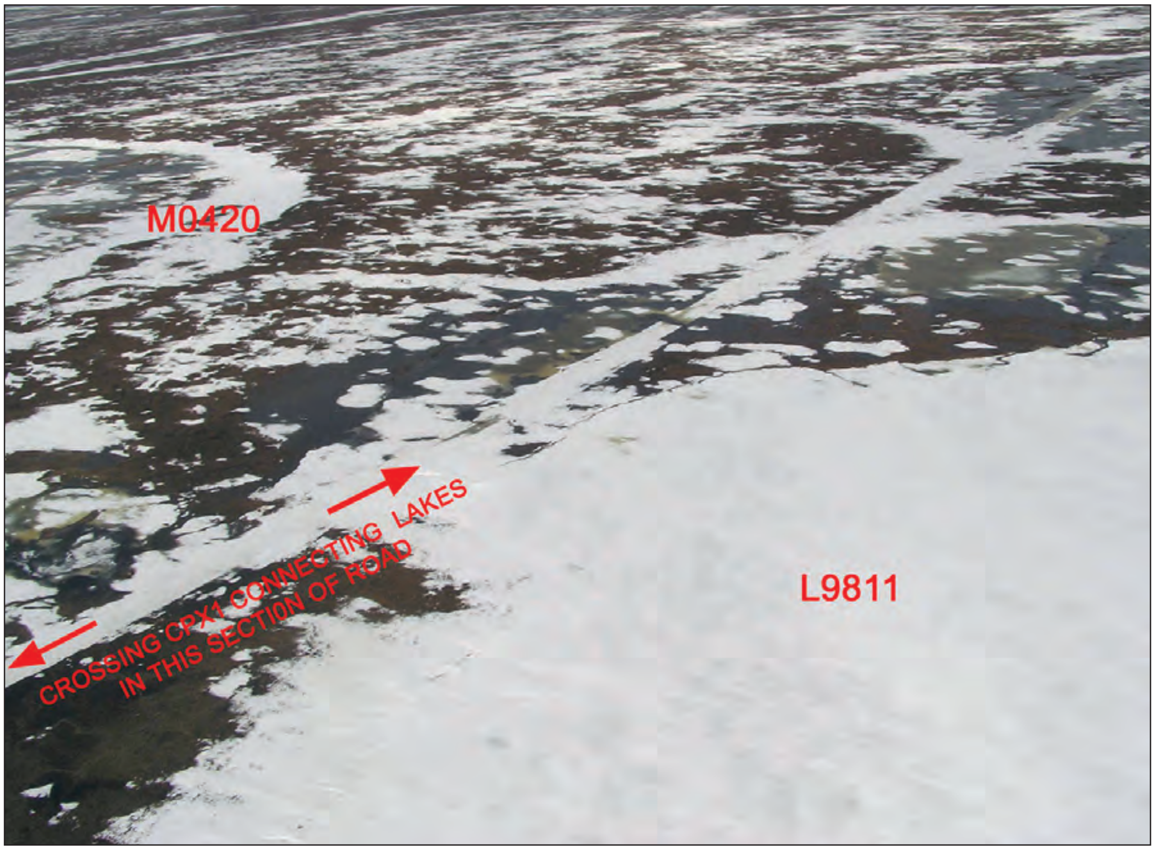

Figure 15. Crossing CPX1 (unnamed creek) on 29 May 2009.

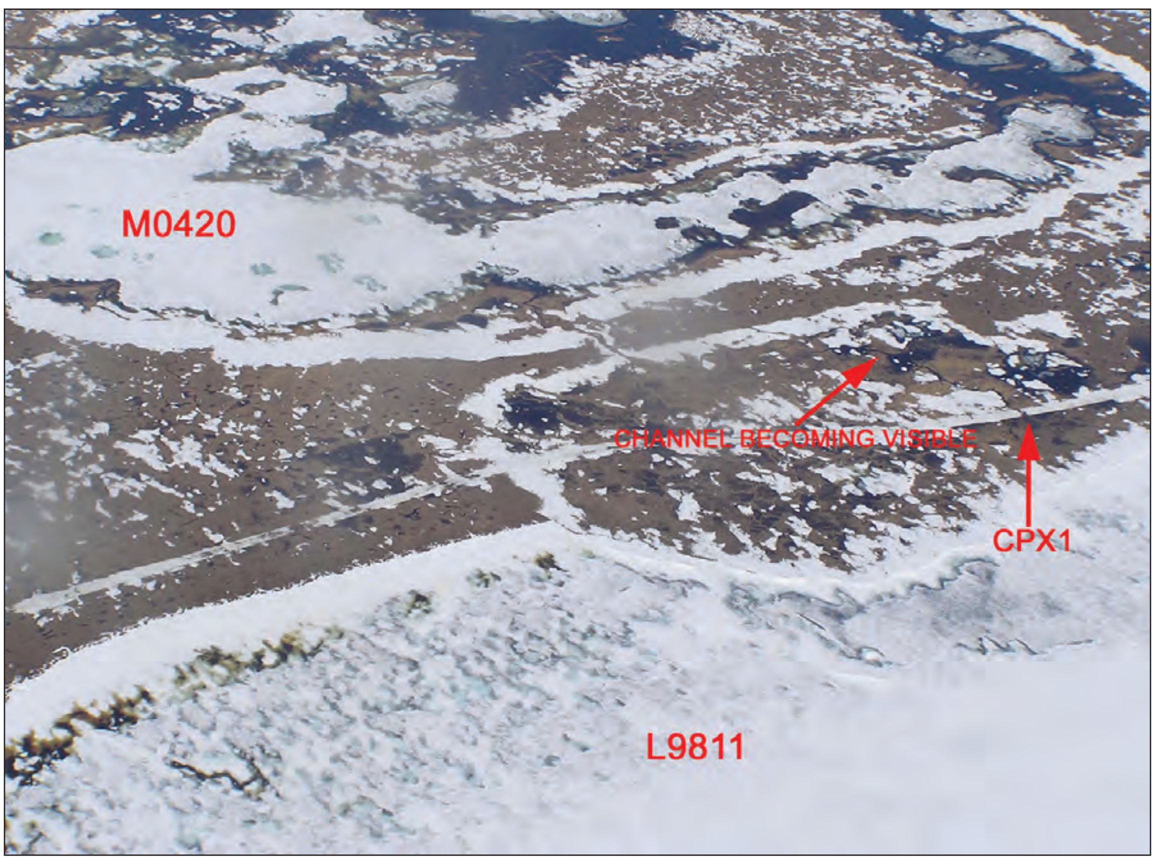

Figure 16. Crossing CPX1 (unnamed creek) on 1 June 2009.

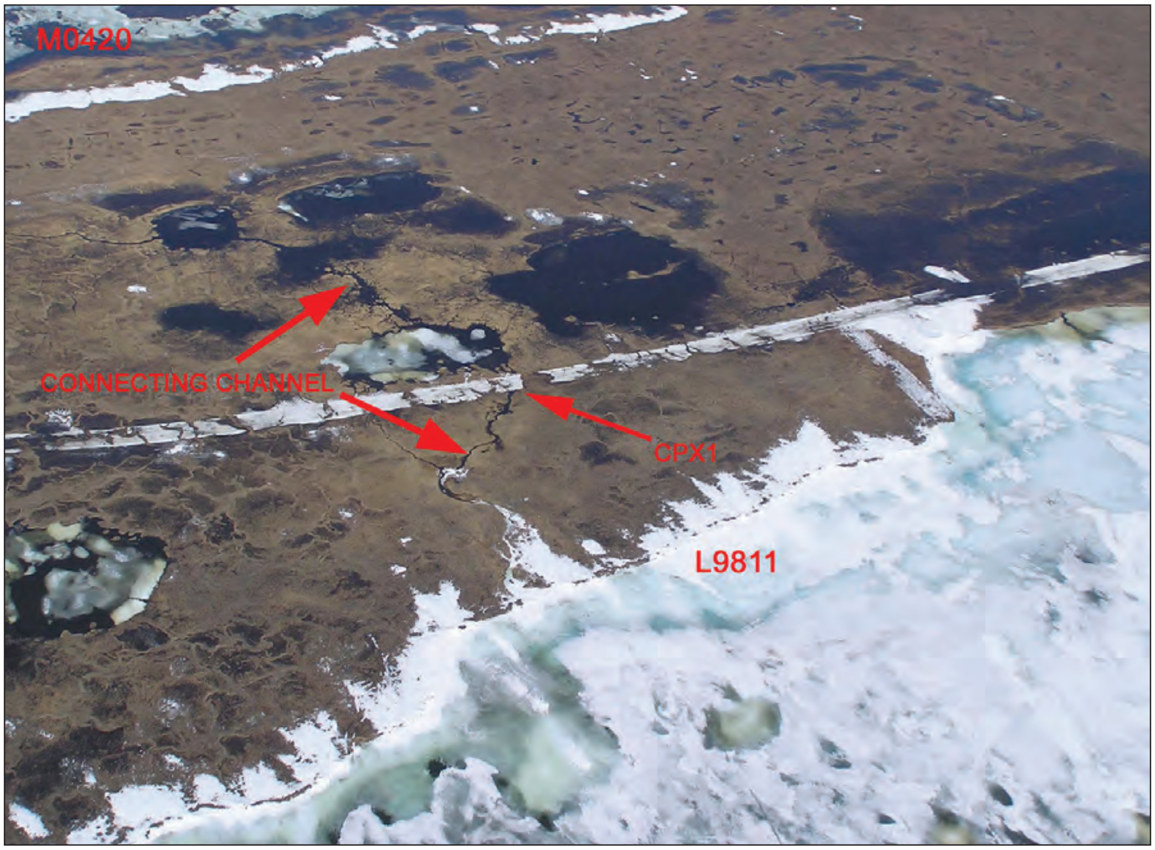

Figure 17. Crossing CPX1 (unnamed creek) appeared to be a potential barrier to fish movements on 4 June 2009.

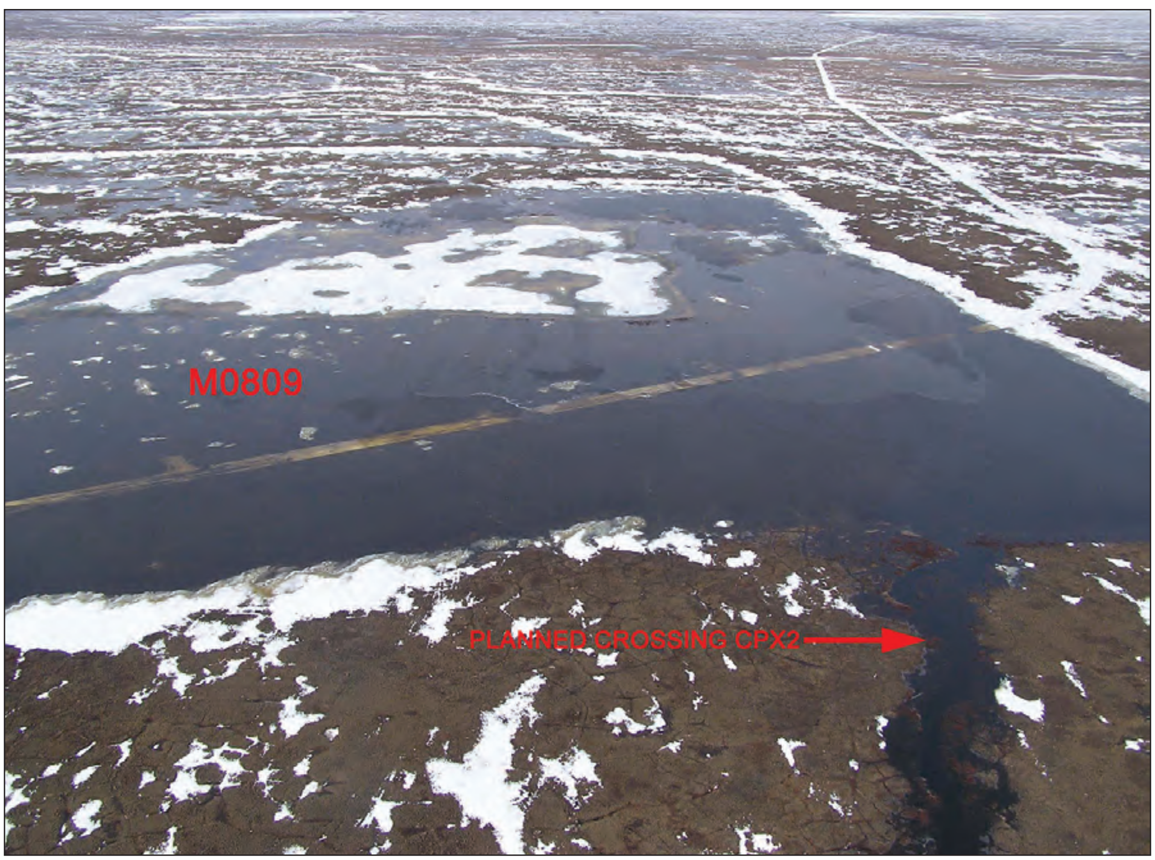

Figure 18. Crossing CPX2 (unnamed creek) on 29 May 2009.

Figure 19. Crossing CPX3 (Ublutuoch River) on 29 May 2009.

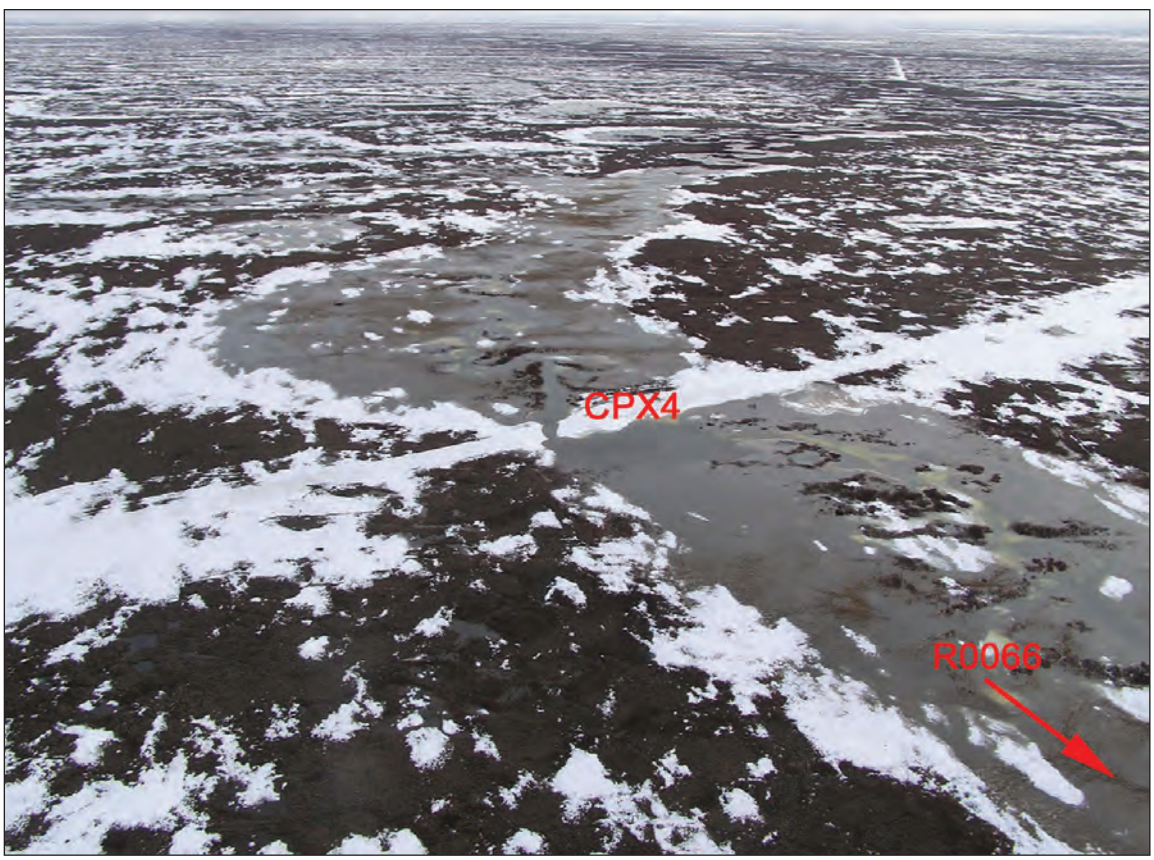

Figure 20. Crossing CPX4 (unnamed creek) on 29 May 2009.

Water Quality

Mitigating potential water quality impacts from fluid or waste spills is currently reliant on 1) assuming that ROPs and permit guidelines are effective, and 2) confirming through compliance inspections that the respective practices and necessary equipment are properly implemented in the field. Compliance trips to APC and CPAI operation areas checked for the consistent use of containment for bulk storage and external drip pans ("duck ponds") for individual vehicles and equipment. Inspectors also looked for visible spills and examined wastewater discharge systems (Figures 21–23). BLM personnel generally found all required practices in place, and they identified no significant spills.

Figure 21. Portable drip pan for water trucks that fill up on a water source lake.

Figure 22. Containment around a bulk fuel tank at a remote O&G support camp.

Figure 23. Water discharge from an O&G support camp under the EPA's NPDES permit.

Discussion

Water Sources

As occurs most years, industry used much less water than it had permitted. APC used only 6% of the liquid water it was permitted to use on BLM-managed public lands within its exploration region. Similarly, CPAI used 11% of its permitted liquid water on BLM-managed lands. This is due to several factors. ADFG Fish Habitat permits for removing lake water last for 5 years. Therefore, in any given year, companies will likely use only a percentage of the total volume allowable. In addition, companies give themselves operational flexibility by requesting more water than they expect to need.

Slight differences existed between permit-specific stipulations imposed on APC and CPAI. The BLM required APC to collect additional data because very little lake data and few observations existed for its project area in the Arctic Foothills region of the NPR-A; regulatory agencies needed documentation that current water use guidelines (developed primarily for the Arctic Coastal Plain) would also be effective in the foothills. CPAI's proposed work, on the other hand, exceeded standard water use amounts, so the BLM required the company to conduct additional monitoring. Although multiple years of data and observations in the coastal plain region have confirmed that current permitted levels are very effective in protecting fish habitat, the BLM required additional data-gathering to assess the impacts of exceeding these levels.

Given the large number of lakes that are utilized each winter, overpumping is relatively rare, although isolated incidents do occur, as demonstrated in 2009. Generally, the safeguards and systems undertaken by industry and agencies are effective. However, continuing to re-evaluate and pursue improvements, such as better daily records management, should further reduce the frequency of incidents.

Although spring recharge in water source lakes has been documented in numerous instances (URS 2001; Baker 2002; Hinzman et al. 2006; Baker 2007; Holland et al. 2008), local variation in snow distribution and basin-scale topography nonetheless requires that recharge rates be evaluated to some degree each year. Also, because water use in the northeast NPR-A will potentially span decades, long-term trends in annual lake conditions need to be documented. While the outflow of water from a lake in the spring defines "recharge" at one moment, water inputs are dynamic over time. Thus, the implications of winter water use on lake outflow regimes during the entire open-water period —and the attendant impacts on fish access and movements—is the next critical aspect needing investigation.

The large natural variability in winter DO depletion rates among Arctic lakes complicates the evaluation of the relationship between water removal and a potential decrease in DO concentration. However, much progress has recently been made in studying this relationship. At current pumping levels there has been little to no impact observed on DO concentration (Hinzman et al. 2006; Cott et al. 2008; Chambers et al. 2008; Clilverd et al. 2009). This research knowledge has been placed in a practical context through the development of a tool in which water removal rate parameters can be used to model winter DO depletion rates (White et al. 2008). Testing this DO model with field data from a variety of Arctic lakes is the fundamental next step to evaluate its potential for contributing to site-specific management decisions regarding use of lake water. Lake DO data collected by the CALDCN on the coastal plain and by APC in the foothills region as required by the State of Alaska will be utilized for this purpose.

Stream Channel Crossings

According to measurements made at stream channel crossings during the construction of ice and snow roads, bridge location caused no issues with overwintering fish habitat. Photographic documentation of ice-bridge breaching at the end of the winter proved valuable because it provided a record of compliance with a BLM ROP, documented the extent of ice removal at each site, and eliminated the need for a site visit.

As previously described, various species of fish can be impacted by remnant ice bridges if routine spring migrations are inhibited. Most mature Arctic grayling make an upstream spring migration to spawning grounds before occupying feeding habitat, and the timing of this migration is strongly associated with ice breakup (Tripp and McCart 1974; Armstrong 1986; Blackman 2002; Morris 2003). Grayling behaviors observed during the migration include swimming under the ice and congregating in areas well before ice conditions allow free passage (Tack 1980; Beauchamp 1990). Delayed access to spawning habitat or increased energetic demand could affect spawning success of grayling. Fleming and Reynolds (1991) found that many grayling, particularly females, continued to mature during a spawning-run delay. The results of the study indicated that the delay led to premature spawning during the run, with individuals failing to make it to upstream spawning areas. If downstream areas were of lesser quality, such effects could be compounded annually because Arctic grayling spawn in their natal areas (Hop and Gharrett 1989). Spawning delays may also affect egg viability. While no data are available for Arctic grayling, reduced egg viability has been reported for rainbow trout when spawning was postponed (Sakai et al. 1975; Bry 1981).

Instream barriers can also affect other Arctic fish attempting to migrate from overwintering areas to feeding habitat during the early part of the open-water season. Many broad whitefish move upstream during breakup to access productive feeding habitat (Bond and Erickson 1985; Chang-Kue and Jessop 1992; Morris 2003; Morris et al. 2006). In some cases this includes taking advantage of the opportunity to reach locations only accessible during spring flooding (Lugas'kov and Stepanov 1988). Humpback whitefish and least cisco have been documented making similar upstream migrations early in the open-water period (Alt 1979; Bond and Erickson 1985). Given the common life-history strategy of Arctic fish to utilize multiple habitats throughout the year to optimize feeding and growth (Craig 1984, 1989; Morris 2003; Moulton et al. 2007), other species may also be at risk if ice bridges create barriers to movements. Energy reserves are already typically low for most fish, and additional stress or delayed access to feeding habitat could have a detrimental impact. A barrier to movement could alter migration patterns to lower quality feeding habitat, and increased energetic demands could ultimately compromise survival.

Due to the late timing of ice-bridge site inspections relative to peak breakup, little was learned in 2009 regarding the potential for ice bridges to impact fish or fish habitat in the spring. However, an issue was identified at crossing CPX1, which was not slotted at the end of the winter exploration season. As a result, a portion of the ice bridge remained intact much later than other ice in the respective channel, as was most apparent during the 4 June observation (Figure 17). While Lake L9811 was still locked up in ice on that date, fish may have attempted to move out of the lake as soon as a moat formed around the lakeshore early in the ice melting process. Lakes L9811 and M0420 and the connecting channel crossed by the ice road are all listed waterbodies in the State of Alaska's Anadromous Waters Catalog. Broad whitefish and Arctic grayling, among other species, are known to utilize this stream/lake system.

While site visits will still be implemented, future evaluations of ice-road channel crossings during spring breakup will be augmented by the use of time-lapse cameras. These cameras can be mounted in late winter; if placed properly, they will be able to document ice-bridge conditions at all stages of breakup. This will alleviate the problem of scheduling helicopter use and will also provide more information by taking hourly photos. (Even when breakup timing is correctly predicted, observations from a helicopter typically occur only once a day.) Future evaluations should also incorporate post-breakup visits to observe stream bank conditions at the crossings.

Water Quality

Regulatory agencies will need to continue addressing water quality concerns through prescriptive measures to avoid spills (e.g., containment), prompt and effective cleanup of spills that occur, and other proven methods to minimize impacts (e.g., EPA NPDES). Smaller, unnoticed equipment or vehicle leaks and industrial emissions may also be contributing to non-point source pollution of surface waters. However, a study to investigate this would currently be cost-prohibitive due to the high number of streams and lakes in operation areas and the degree of technology that would be required.

Conclusions and Management Implications

Water use management guidelines again proved effective during the 2008–2009 O&G exploration season. All physical and chemical data and observations of outlet conditions support water use at current levels to avoid impacts. Carefully observing deviations to these levels in a few select locations while requiring additional monitoring data served to advance the knowledge base of lake water use limits, which are still theoretically and practically unknown. Although present levels of permitted water use appear to be ecologically sustainable, close monitoring of these activities should still be a priority because of the variable climatological and hydrological factors involved, as well as the number of organisms that rely on water resources.

Regarding ice- and snow-road channel crossings, obtaining in-season information about as-built ice-bridge locations and water presence provided an increased level of resource tracking. Similarly, requiring photographic documentation of ice-bridge slotting provided a prudent, cost-effective method of confirming compliance and recording conditions prior to spring breakup. Thoroughly reviewing submitted information promptly, working proactively with industry, and encouraging better communication between industry and its contractors conducting field work will all help ensure that every stream crossings is slotted at the end of the season. Improvements in effectiveness monitoring can also be made; time-lapse cameras offer a hopeful solution.

In general, fish habitat management and monitoring related to O&G exploration activities in the NPR-A were improved greatly this past year by following many of the recommendations made in the NPR-A Fisheries Monitoring Implementation Plan (Noel et al. 2008). Permit-specific stipulations, in particular, provided an opportunity to implement site-specific evaluations and adaptive management based on the most current knowledge available. This should continue to be a primary mechanism to help protect and monitor fish resources.

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Appendix A. Selected Required Operating Procedures (ROPs) and Lease Stipulations from the NE NPR-A Supplemental Integrated Activity Plan/Environmental Impact Statement

A-2 Required Operating Procedure
Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation.
Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development.

A-3 Required Operating Procedure
Objective: Minimize pollution through effective hazardous-materials contingency planning.
Requirement/Standard: For O&G-related activities, a Hazardous Materials Emergency Contingency Plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.

A-4 Required Operating Procedure
Objective: Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes, and marine waters, as a result of fuel, crude oil, or other liquid chemical spills.
Requirement/Standard: Before initiating any O&G or related activity or operation, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan.

A-5 Required Operating Procedure
Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.
Requirement/Standard: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited.

A-6 Required Operating Procedure
Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process.
Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited.

B-1 Required Operating Procedure
Objective: Maintain populations of, and adequate habitat for, fish and invertebrates.
Requirement/Standard: Water withdrawal from rivers and streams during winter is prohibited.

B-2 Required Operating Procedure
Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl.
Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on water volume, depth, and fish population and species diversification.

a. Lakes that are ≥7 feet with sensitive fish (any fish except ninespine stickleback or Alaska blackfish): water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; lakes that are between 5 and 7 feet with sensitive fish: water available would be calculated on a case-by-case basis.
b. Lakes that are ≥5 feet with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet.
c. Any lake with no fish present, regardless of depth: water available for withdrawal is up to 35% as specified within the permit.
d. A water-monitoring plan may be required to assess drawdown and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern.
e. The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site-specific basis depending upon its size, water volume, and depth, and fish population and species diversification.

f. Removed ice aggregate shall be included in the 15% or 30% withdrawal limits —whichever is the appropriate case— unless otherwise approved.
g. Any water intake structure in fish-bearing or non-fish-bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury.
h. Compaction of snow cover or snow removal from fish-bearing water bodies shall be prohibited except at approved ice-road crossings, water pumping stations on lakes, or areas of grounded ice.

C-2 Required Operating Procedure
Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.
Requirement/Standard:
a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra.

C-3 Required Operating Procedure
Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.
Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris. Except at approved crossings, operators are encouraged to travel a minimum of 100 feet from known overwintering fish streams and lakes.

C-4 Required Operating Procedure
Objective: Avoid additional freeze-down of deep-water pools harboring overwintering fish and invertebrates used by fish.
Requirement/Standard: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to overwintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.

D-1 Lease Stipulation
Objective: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.
Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

Appendix B. Permit-Specific Stipulations Developed from Environmental Assessments

APC Additional Mitigation and Monitoring: EA DOI-BLM-LLAK01000-2009-0001

The following permit stipulations implement practices that will help reduce the likelihood of impacts to fish habitat and water resources (Noel et al., 2008). Anadarko shall:

- At time of ice-road construction, take the following measurements at stream or river channel crossings and provide the data to the BLM AO within 1 week of collection. Measure the ice thickness and water depth under ice (if not grounded) at a minimum of 3 mid-channel locations (at approximately road centerline and road edges).
- Provide the BLM with an as-built of the snow and ice roads, and as-built corner locations for the airstrips and ice pads. Data should be in the format of global positioning system (GPS) points or tracks at the time structures are ready for utilization.
- Post a sign on the access road to each lake being utilized as a water source, clearly identifying the lake by its number.
- For each lake utilized as a water source, maintain a daily record of water removed in liquid form and in the form of ice chips. Provide the BLM with this daily tracking record on a weekly basis. The BLM will provide Anadarko with a formatted spreadsheet to be used for the required reporting. The completed weekly spreadsheet should be submitted to the BLM within 5 days.
- Notify the BLM AO within 24 hours if water/ice removal exceeds the volume approved at any lake in the NPR-A.
- Notify the BLM AO within 24 hours of any observation of dead fish on intake screens, or in the hole being used for pumping. Temporarily cease pumping from that hole until discussions with the BLM or ADF&G Division of Habitat result in application of additional preventative measures to avoid additional fish mortality.
- Provide the BLM with photographs documenting breaching/slotting of ice-road channel crossings at the end of the winter season.

The following additional mitigation measures are required for the removal of ice chips and liquid water in 2008–2009 in excess of current standard practice. Based on results of the first year's program, the BLM may add, delete, or modify mitigation measures for water use in future years of exploration covered by this EA.

- Submit to the BLM the water quality monitoring data required by ADF&G under State Fish Habitat Permits FH08-III-0273 and FH08-III-0278 for Lakes M0825 and M0830 within 1 week of collecting in situ field measurements and within 1 week of receiving lab analytical data. Water quality data collected at these lakes under other programs must also be provided to the BLM within 1 week of obtaining the data.
- At the end of winter operations, conduct snow surveys in the following 2 drainage basins: the vicinity of the 7 lakes utilized in the Wolf Creek area (M0824, M0825, M0826, M0827, M0828, M0829, and M0830); and the vicinity of Lakes M0813 and M0821. Consult with the BLM in developing the methodology, timing, and selection of appropriate locations for these surveys. Provide snow survey data to the BLM within 1 week of collection.
- Survey water levels at Lakes M0825 and M0830 in the Wolf Creek area and at Lakes M0813 and M0821 in the NE NPR-A. Document conditions at the outflow with photographs and flow measurements taken: immediately after spring breakup, at the end of June, and at the end of August. At lakes M0823, M0824, M0826, M0827, M0828, M0829, and M0831, document conditions at the outflow with photo-

graphs taken: immediately after spring breakup, at the end of June, and at the end of August. Provide data to BLM within 1 week of collection. These requirements apply when the listed lakes are used for water supply.

Appendix B. (continued)

CPAI Additional Mitigation and Monitoring: EA DOI-BLM-LLAK01000-2009-0004

The following permit stipulations implement practices that will help reduce the likelihood of impacts to fish habitat and water resources (Noel et al. 2008). CPAI shall:

- At the time of ice-road construction, take the following measurements at stream or river channel crossings prior to the addition of any snow or ice and provide data to the BLM within 1 week of collection. Measure the ice thickness and water depth under ice (if not grounded) at a minimum of 3 mid-channel locations (at approximately road centerline and road edges).
- Provide the BLM with an as-built of all snow/ice roads and Rolligon trails, and as-built corner locations of ice pads at the time structures or routes are ready for utilization. The as-builts shall be submitted in digital format on a CD or from an accessible internet location (such as an ftp site) as follows:
    a. digital GPS file(s) referencing WGS Datum of 1984 (WGS84) with a defined projection; and
    b. digital ESRI shapefile(s) or geodatabase(s) feature referencing the North American Datum of 1983 (NAD83) with a defined projection and supplementary metadata.
- Post a sign on the access road to each lake being utilized as a water source, clearly identifying the lake by its number.
- Maintain a daily record of water removed in liquid form and in the form of ice chips for each lake utilized as a water source. Provide the BLM with the daily tracking record on a weekly basis. The completed weekly spreadsheet should be submitted to the BLM within 5 days of the week's end. The BLM will provide Conoco with a formatted spreadsheet that must be used for the reporting.
- Notify the BLM within 24 hours if water/ice removal exceeds the volume approved at any lake in the NPR-A.
- Notify the BLM within 24 hours of any observation of dead or injured fish on intake screens or in the hole being used for pumping. Temporarily cease pumping from that hole until discussions with the BLM or ADF&G Division of Habitat result in the application of additional preventative measures to avoid further impacts to fish.
- Provide the BLM with photographs documenting breaching/slotting/removal of ice-road channel crossings at the end of the winter season.

The following monitoring activities are required for the removal of ice chips and liquid water during the winter of 2008–2009 in excess of guidelines in BLM's ROP B-2. Based on results of this year's program, the BLM may add, delete, or modify mitigation measures for water use in future years of exploration covered by this EA. Before conducting work in future years CPAI must have written concurrence from BLM regarding water use.

- At the end of winter operations, conduct snow surveys adjacent to each of the following lakes and provide data to the BLM within 1 week of collection:
    a. L9811, M0708, M0712, and M0804 if the combination of liquid water and ice chips utilized exceeds the calculated volume of 15% of water under 7 feet of ice.
    b. L9813 and M0420 if the amount of ice chips utilized exceeds the calculated volume of 30% of water under 5 feet of ice.
    c. L9803, L9805, and R0061 if the amount of liquid water utilized exceeds the calculated volume of 30% of water under 5 feet of ice.
- At each of the following lakes, survey water levels and document conditions at the outlet of each of the following lakes with photographs immediately after spring breakup, at the end of June, and at the

end of August.

a. L9811, M0708, M0712, and M0804 if the combination of liquid water and ice chips utilized exceeds the calculated volume of 15% of water under 7 feet of ice.
b. L9813 and M0420 if the amount of ice chips utilized exceeds the calculated volume of 30% of water under 5 feet of ice.
c. L9803, L9805, and R0061 if the amount of liquid water utilized exceeds the calculated volume of 30% of water under 5 feet of ice.

- Submit to the BLM any water quality data that is collected at water source lakes in the NPR-A as a requirement by ADFG State Fish Habitat Permits or is collected at water source lakes under any other program. In-situ field measurements must be submitted within 1 week of collection, and water sample analytical data must be submitted within 1 week of receiving results from a lab.

The following mitigation measure is required for building an ice-road channel crossing (ice bridge) on the Ublutuoch River. CPAI shall:

- Remove as much of the ice bridge as is reasonable without damaging stream banks or the streambed.

Appendix C. Daily Water Use Data

Table C-1. Daily water use by Anadarko Petroleum Corporation from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
MO681	11/18/08	57,600	0
MO681	11/19/08	86,400	0
MO681	11/20/08	61,200	0
MO681	11/21/08	61,200	0
MO681	11/22/08	82,800	0
MO681	11/23/08	82,800	0
MO681	11/24/08	75,600	0
MO681	11/25/08	111,600	0
MO681	11/26/08	39,600	0
MO681	11/27/08	32,400	0
MO681	11/28/08	21,600	0
MO681	11/29/08	18,000	0
MO681	11/30/08	39,600	0
MO681	12/01/08	61,200	0
MO681	12/02/08	72,000	0
MO681	12/03/08	42,000	0
MO812	12/03/08	27,000	0
MO812	12/04/08	26,000	0
MO812	12/05/08	33,500	0
MO812	12/06/08	16,000	0
MO812	12/07/08	20,000	0
MO812	12/08/08	26,000	0
MO812	12/11/08	14,000	0
MO816	12/09/08	46,000	0
MO816	12/10/08	30,000	0
MO820	12/11/08	4,000	0
MO825	01/23/09	2,000	0
MO825	01/24/09	2,000	0
MO825	01/25/09	2,000	0
MO825	01/26/09	6,000	0
MO825	01/27/09	8,000	0
MO825	01/28/09	4,000	0
MO825	01/29/09	8,000	0
MO825	01/30/09	8,000	0
MO825	01/31/09	16,000	0
MO825	02/01/09	6,000	0
MO825	02/02/09	14,000	0
MO825	02/03/09	4,000	0

(cont.)

Table C-1 (continued). Daily water use by Anadarko Petroleum Corporation from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
MO825	02/04/09	6,000	0
MO825	02/05/09	6,000	0
MO825	02/06/09	12,000	0
MO825	02/07/09	4,000	0
MO825	02/08/09	2,000	0
MO825	02/09/09	14,000	0
MO825	02/10/09	8,000	0
MO825	02/11/09	4,000	0
MO825	02/12/09	14,000	0
MO825	02/13/09	4,000	0
MO825	02/14/09	12,000	0
MO825	02/15/09	14,000	0
MO825	02/16/09	12,000	0
MO825	02/17/09	8,000	0
MO825	02/18/09	4,000	0
MO825	02/19/09	8,000	0
MO825	02/20/09	4,000	0
MO825	02/21/09	16,000	0
MO825	02/22/09	2,000	0
MO825	02/23/09	14,000	0
MO825	02/24/09	6,000	0
MO825	02/25/09	10,000	0
MO825	02/26/09	6,000	0
MO825	02/27/09	10,000	0
MO825	03/02/09	2,000	0
MO825	03/03/09	6,000	0
MO825	03/04/09	8,000	0
MO825	03/06/09	6,000	0
MO825	03/09/09	2,000	0
MO825	03/10/09	2,000	0
MO825	03/11/09	4,000	0
MO825	03/13/09	4,000	0
MO826	12/14/08	68,000	0
MO826	12/16/08	4,000	0
MO829	12/12/08	20,000	0
MO829	12/13/08	14,000	0
MO829	12/29/08	0	23,316
MO829	12/30/08	0	116,580

(cont.)

Table C-1 (continued). Daily water use by Anadarko Petroleum Corporation from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
MO829	12/31/08	0	108,808
MO829	01/01/09	0	110,751
MO829	01/02/09	0	73,834
MO829	01/03/09	0	54,404
MO829	01/05/09	0	25,259
MO829	01/06/09	0	52,461
MO829	01/07/09	0	58,290
MO829	01/08/09	0	58,290
MO829	01/09/09	0	9,715
MO829	01/11/09	0	62,176
MO829	01/12/09	0	114,637
MO829	01/13/09	0	46,632
MO830	12/14/08	18,000	0
MO830	12/16/08	10,000	0
MO830	12/18/08	70,000	0
MO830	12/22/08	20,000	0
MO830	12/23/08	50,000	0
MO830	12/24/08	56,000	0
MO830	12/25/08	42,000	0
MO830	12/26/08	62,000	0
MO830	12/27/08	50,000	0
MO830	12/28/08	46,000	0
MO830	12/29/08	58,000	0
MO830	12/30/08	62,000	0
MO830	12/31/08	108,000	0
MO830	01/01/09	86,000	0
MO830	01/02/09	92,000	0
MO830	01/03/09	88,000	0
MO830	01/04/09	86,000	0
MO830	01/05/09	104,000	0
MO830	01/06/09	56,000	0
MO830	01/07/09	62,000	0
MO830	01/08/09	62,000	0
MO830	01/09/09	56,000	0
MO830	01/10/09	44,000	0
MO830	01/11/09	46,000	0
MO830	01/12/09	66,000	0
MO830	01/13/09	70,000	0

(cont.)

Table C-1 (continued). Daily water use by Anadarko Petroleum Corporation from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
MO830	01/14/09	82,000	0
MO830	01/15/09	26,000	0
MO830	01/16/09	36,000	0
MO830	01/17/09	36,000	0
MO830	01/18/09	44,000	0
MO830	01/19/09	40,000	0
MO830	01/20/09	30,000	0
MO830	01/21/09	42,000	0
MO830	01/22/09	48,000	0
MO830	01/23/09	50,000	0
MO830	01/24/09	44,000	0
MO830	01/25/09	32,000	0
MO830	01/26/09	16,000	0
MO830	01/27/09	24,000	0
MO830	01/28/09	18,000	0
MO830	01/29/09	10,000	0
MO830	01/30/09	4,000	0
MO830	02/03/09	4,000	0
MO830	02/07/09	8,000	0
MO830	02/08/09	24,000	0
MO830	02/09/09	18,000	0
MO830	02/10/09	8,000	0
MO830	02/11/09	18,000	0
MO830	02/13/09	12,000	0
MO830	02/15/09	8,000	0
MO830	02/17/09	8,000	0
MO830	02/20/09	14,000	0
MO830	02/21/09	10,000	0
MO830	02/22/09	14,000	0

Table C-2. Daily water use by ConocoPhillips Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
L9806	12/29/08	108,864	0
L9806	12/30/08	117,936	0
L9811	02/03/09	0	281,898
L9811	02/04/09	0	382,612
L9811	02/05/09	0	170,556
L9811	02/07/09	0	0
M0704	01/30/09	0	24,293
M0704	01/31/09	0	254,062
M0704	02/01/09	0	86,543
M0704	02/06/09	0	78,446
M0704	02/07/09	0	0
M0710	12/29/08	3,780	0
M0710	12/30/08	11,340	0
M0710	12/31/08	14,700	0
M0710	01/01/09	25,200	0
M0710	01/02/09	9,450	0
M0710	01/03/09	9,450	0
M0710	01/04/09	29,400	0
M0710	01/05/09	47,040	0
M0710	01/06/09	82,320	0
M0710	01/07/09	82,320	0
M0710	01/08/09	64,680	0
M0710	01/09/09	58,800	0
M0710	01/10/09	82,320	0
M0710	01/11/09	47,040	0
M0710	01/12/09	47,040	0
M0710	01/13/09	35,280	0
M0710	01/14/09	11,760	0
M0710	01/15/09	119,070	0
M0710	01/16/09	105,840	0
M0710	01/17/09	285,600	212,562
M0710	01/18/09	532,140	327,953
M0710	01/19/09	639,240	282,404
M0710	01/20/09	790,230	343,136
M0710	01/21/09	487,200	270,257
M0710	01/22/09	89,460	218,635
M0710	01/24/09	4,200	0
M0710	01/25/09	3,150	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
M0710	01/26/09	2,940	0
M0710	01/27/09	3,150	0
M0710	01/29/09	4,200	0
M0710	01/30/09	4,200	0
M0710	02/01/09	4,200	0
M0710	02/03/09	4,200	0
M0710	02/04/09	4,200	0
M0710	02/05/09	4,200	0
M0710	02/06/09	4,200	0
M0710	02/07/09	3,150	0
M0710	02/08/09	4,200	0
M0710	02/09/09	4,200	0
M0710	02/11/09	4,200	0
M0710	02/12/09	4,200	0
M0710	02/13/09	4,200	0
M0710	02/14/09	3,150	0
M0710	02/15/09	4,200	0
M0710	02/16/09	4,200	0
M0710	02/17/09	4,200	0
M0710	02/18/09	4,200	0
M0710	02/19/09	3,150	0
M0710	02/20/09	3,150	0
M0710	02/21/09	3,150	0
M0710	02/22/09	4,200	0
M0710	02/23/09	4,200	0
M0710	02/24/09	4,200	0
M0710	02/26/09	7,350	0
M0710	02/28/09	175	0
M0710	03/02/09	4,200	0
M0710	03/03/09	7,350	0
M0710	03/04/09	7,350	0
M0710	03/06/09	7,350	0
M0710	03/07/09	7,350	0
M0710	03/08/09	7,350	0
M0710	03/10/09	7,350	0
M0710	03/11/09	7,350	0
M0710	03/13/09	4,200	0
M0710	03/14/09	4,200	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
M0710	03/15/09	4,200	0
M0710	03/16/09	4,200	0
M0710	03/17/09	4,200	0
M0710	03/19/09	2,100	0
M0710	03/20/09	2,100	0
M0710	03/21/09	2,100	0
M0710	03/22/09	2,100	0
M0710	03/23/09	2,100	0
M0710	03/24/09	2,100	0
M0710	03/25/09	2,100	0
M0710	03/26/09	2,100	0
M0710	03/27/09	2,100	0
M0710	03/28/09	2,100	0
M0710	03/29/09	2,100	0
M0710	03/30/09	2,100	0
M0710	03/31/09	2,100	0
M0710	04/01/09	2,100	0
M0710	04/02/09	2,100	0
M0710	04/03/09	2,100	0
M0710	04/04/09	2,100	0
M0710	04/07/09	2,100	0
M0710	04/08/09	2,100	0
M0710	04/09/09	2,100	0
M0710	04/11/09	2,100	0
M0710	04/12/09	2,100	0
M0802	01/23/09	153,300	0
M0802	01/23/09	153,300	0
M0802	01/24/09	85,260	0
M0802	01/24/09	85,260	0
M0802	01/25/09	402,780	0
M0802	01/25/09	402,780	0
M0802	01/26/09	326,970	0
M0802	01/27/09	371,700	0
M0802	01/28/09	579,684	0
M0802	01/29/09	460,110	0
M0802	01/30/09	393,960	0
M0802	01/31/09	330,750	0
M0802	02/01/09	270,480	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips, Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
M0802	02/02/09	270,480	0
M0802	02/03/09	335,160	0
M0802	02/04/09	401,100	0
M0802	02/05/09	392,910	0
M0802	02/06/09	315,210	0
M0802	02/07/09	63,000	0
M0802	02/12/09	128,310	0
M0802	02/13/09	0	0
M0802	02/21/09	80,850	0
M0802	02/25/09	148,050	0
M0802	02/26/09	14,700	0
M0802	02/27/09	122,850	0
M0802	03/04/09	226,800	0
M0802	03/05/09	98,700	0
M0802	03/06/09	26,250	0
M0802	03/07/09	194,250	0
M0802	03/08/09	211,050	0
M0802	03/13/09	225,750	0
M0802	03/14/09	151,200	0
M0802	03/15/09	235,200	0
M0802	03/21/09	156,450	0
M0802	03/22/09	283,500	0
M0802	03/23/09	87,150	0
M0802	03/24/09	160,650	0
M0802	04/03/09	68,250	0
M0806	01/22/09	417,270	0
M0806	01/22/09	417,270	0
M0806	01/23/09	520,170	0
M0806	01/23/09	520,170	0
M0806	01/24/09	653,940	0
M0806	01/24/09	653,940	0
M0806	01/25/09	426,090	0
M0806	01/25/09	426,090	0
M0806	01/26/09	351,960	0
M0806	01/27/09	345,240	0
M0806	01/28/09	432,600	0
M0806	01/29/09	398,370	0
M0806	01/30/09	468,930	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips, Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
M0806	01/31/09	494,130	0
M0806	02/01/09	414,330	0
M0806	02/02/09	374,850	0
M0806	02/03/09	134,400	0
M0806	02/10/09	339,570	0
M0806	02/11/09	738,360	0
M0806	02/12/09	703,290	0
M0806	02/13/09	233,100	0
M0806	02/14/09	414,750	0
M0806	02/15/09	231,000	0
M0806	02/16/09	228,900	0
M0806	02/17/09	127,890	0
M0806	02/18/09	99,330	0
M0806	02/19/09	178,500	0
M0806	02/20/09	278,250	0
M0806	02/21/09	201,600	0
M0806	02/22/09	244,440	0
M0806	02/23/09	216,300	0
M0806	02/24/09	334,950	0
M0806	02/25/09	119,700	0
M0806	03/02/09	278,250	0
M0806	03/03/09	476,700	0
M0806	03/04/09	515,550	0
M0806	03/06/09	128,100	0
M0806	03/07/09	107,100	0
M0806	03/09/09	16,380	0
M0806	03/11/09	24,360	0
M0806	03/12/09	6,552	0
M0806	03/13/09	187,017	0
M0806	03/14/09	195,300	0
M0806	03/15/09	60,690	0
M0806	03/16/09	6,300	0
M0806	03/17/09	24,150	0
M0806	03/18/09	27,300	0
M0806	03/19/09	16,044	0
M0806	03/20/09	2,730	0
M0806	03/21/09	24,654	0
M0806	03/22/09	16,170	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
M0806	03/24/09	136,500	0
M0806	03/25/09	342,300	0
M0806	03/26/09	291,900	0
M0806	03/27/09	86,100	0
M0806	03/28/09	102,900	0
M0806	04/02/09	313,950	0
M0806	04/04/09	82,950	0
M0806	04/05/09	51,450	0
M0806	04/08/09	166,950	0
M0806	04/09/09	22,050	0
M0806	04/12/09	49,350	0
M0806	04/13/09	129,150	0
M0806	04/16/09	2,100	0
M0806	04/18/09	2,100	0
M0807	01/27/09	0	158,915
M0807	01/28/09	0	112,354
M0807	01/29/09	0	244,446
M0807	01/30/09	0	267,221
M0807	01/31/09	0	190,800
M0807	02/01/09	0	273,800
M0807	02/02/09	0	259,629
M0807	02/04/09	0	85,025
M0807	02/10/09	0	329,471
M0807	02/11/09	0	547,600
M0807	02/12/09	0	341,111
M0807	02/13/09	0	87,555
M0807	02/15/09	0	101,726
R0061	02/05/09	0	385,648
R0061	02/06/09	0	460,551
R0061	02/07/09	0	528,368
R0061	02/08/09	0	596,692
R0061	02/09/09	0	387,673
R0061	02/10/09	0	105,775
R0066	02/03/09	0	244,650
R0066	02/04/09	425,670	0
R0066	02/05/09	500,640	0
R0066	02/06/09	633,990	0
R0066	02/07/09	755,790	0

(cont.)

Table C-2 (continued). Daily water use by ConocoPhillips Alaska, Inc. from lakes in the NPR-A during the 2008–2009 exploration period.

Lake Name	Date	Liquid Water Volume Removed (gallons)	Ice Chips Volume Removed (gallons)
R0066	02/08/09	922,740	0
R0066	02/09/09	802,410	0
R0066	02/10/09	489,300	0