

**STATE OF ALASKA**  
**ALASKA OIL AND GAS CONSERVATION COMMISSION**  
333 West 7<sup>th</sup> Avenue, Suite 100  
Anchorage, Alaska 99501

Re: THE APPLICATION OF ) Area Injection Order No. 35  
CONOCOPHILLIPS ALASKA, ) Docket No. AIO 08-24  
INC. for an order authorizing )  
underground injection of fluids for ) Colville River Field  
enhanced oil recovery in the Qannik ) Colville River Unit  
Oil Pool, Colville River Unit, Arctic ) Qannik Oil Pool  
Slope, Alaska )  
July 7, 2008

**IT APPEARING THAT:**

1. By letter and application dated April 3, 2008, and received by the Alaska Oil and Gas Conservation Commission (Commission) that same day, ConocoPhillips Alaska, Inc. (CPAI), in its capacity as unit operator and on behalf of the working interest owners of the Colville River Unit (CRU), requests an order from the Commission authorizing the injection of fluids for enhanced oil recovery in the Qannik Oil Pool.
2. A notice of a public hearing was published in the ANCHORAGE DAILY NEWS, on the State of Alaska Online Public Notice Web site, and on the Commission's Web site on April 9, 2008.
3. The Commission received no comments or requests for a public hearing.
4. The Commission held a public hearing on May 15, 2008, and left the record open so that CPAI could provide additional information requested at the hearing.
5. On May 27 and May 28, 2008, as requested by the Commission at the public hearing, CPAI provided revised information concerning existing wells penetrating the Qannik reservoir.

**FINDINGS:**

1. Operator: CPAI is the operator of the leases in the area proposed for development.
2. Project Area Pool and Formations Authorized for Enhanced Recovery: Enhanced oil recovery injection is proposed within the Qannik Oil Pool, which is defined in Conservation Order No. 605. The target injection zone is the Qannik Oil Pool, which is correlative to the interval between the measured depths of 6,086' and 6,249' on the Electromagnetic Wave Resistivity (EWR) well log recorded in well CRU CD2-11 (see Figure 1, below).
3. Proposed Injection Area: CPAI requests authorization to inject fluids for the purpose of enhanced recovery operations on lands in or near the CRU within portions of Township (T) 10N, Range (R) 4E; T10N, R5E; T11N, R4E; T11N, R5E; T12N, R4E; and T12N, R5E, Umiat Meridian (see Figure 2, below).

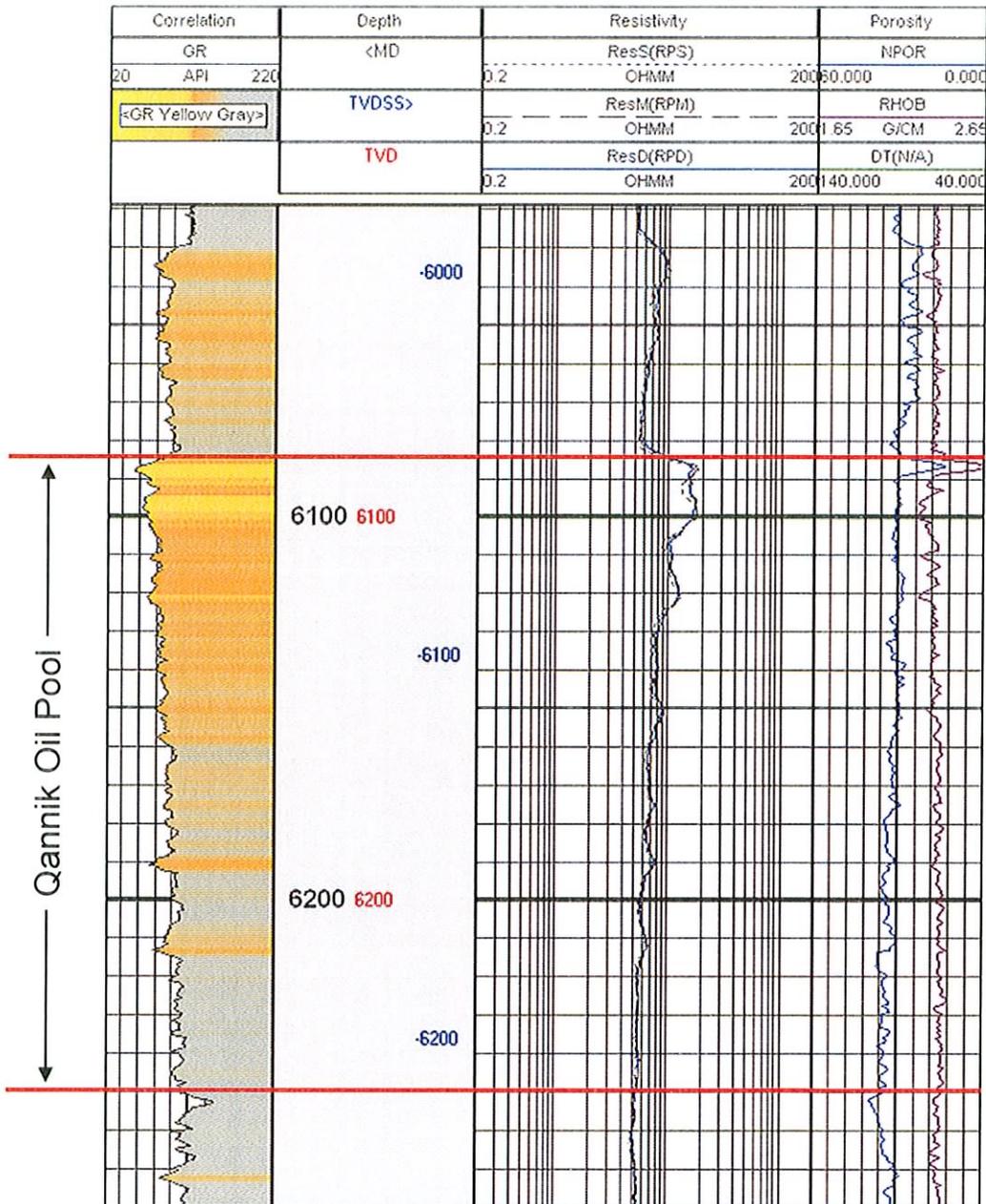
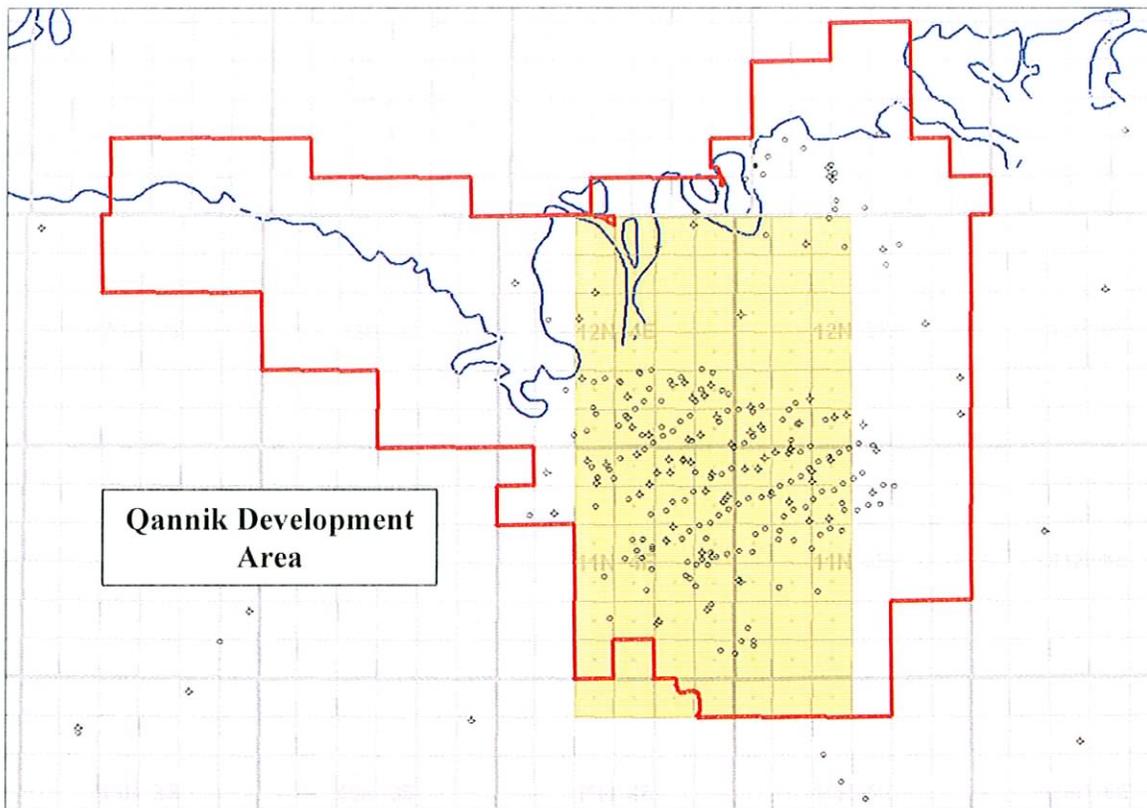


Figure 1. CRU CD2-11 – Type Well Log for Qannik Oil Pool<sup>1</sup>

4. Operators/Surface Owners Notification: All lands within the proposed development area are leased and lie in or near the CRU. The only affected surface owners are the State of Alaska, Department of Natural Resources and Kuukpik Corporation. The affected operator is CPAI, which operates the CRU. CPAI provided the application for injection to all operators and surface owners within a one-quarter-mile radius of the proposed injection operations.

<sup>1</sup> Figure 1 is for illustration purposes only. Refer to the EWR well log measurements recorded in well CRU CD2-11 for the precise representation of the Qannik Oil Pool.



**Figure 2. Proposed Injection Area for Qannik Oil Pool<sup>2</sup>  
(highlighted with yellow)**

- Description of Operations: The Qannik Oil Pool will be developed initially with nine horizontal wells: the CD2-404 well and eight new wells. The producer-to-injector ratio will be about 2:1. The production and injection wells will range in length from 6,000' to 9,000' within the reservoir, and will be parallel to one another. Three central, north-trending injection wells will be arranged end-to-end and flanked on both sides by outboard production wells; this alternating arrangement will form a line-drive flood pattern. Individual wells will be spaced about 2,700' to 3,400' apart. The wells will be oriented to maximize use of the expansion drive and minimize gas influx from the gas cap, which lies to the east. Additional producers and injectors may be added at a later date based on net oil pay and reservoir performance.

CPAI proposes to develop the pool utilizing water injection as the enhanced recovery mechanism, supplemented by expansion drive from the gas cap. Water injection is scheduled to begin in the third quarter of 2008. Production from the Qannik Oil Pool and other CRU oil pools will be commingled on the surface prior to processing and custody transfer.

- Hydrocarbon Recovery: Estimates of original oil-in-place and recovery (in units of one million stock tank barrels or MMSTB) within the Qannik Oil Pool development area are:

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<sup>2</sup> This index map is for illustration purposes only. Please refer to the legal description for the precise representation of the proposed affected area.

Hydrocarbon Volume	Nine-Well Development (MMSTB)	Eighteen-Well Development (MMSTB)
Original Oil-in-Place (OOIP)	79	127
Primary Recovery with Gas Cap Expansion (15% of OOIP)	12	19
Primary + Waterflood (a total of 22% of OOIP)	17	28

The annualized peak production rate for the Qannik Oil Pool is expected to be between about 3,000 and 6,000 barrels of oil per day (BOPD). The expected maximum and average waterflood injection rates are 12,000 barrels of water per day (BWPD) and 5,000 BWPD, respectively.

7. Geology:

a. Stratigraphy: The Qannik Oil Pool encompasses late Cretaceous-aged sediments deposited as top-set beds in a shallow, north-trending, eastward-migrating marine shelf environment that is the age-equivalent to the Nanushuk Group of the central Arctic Slope. The Qannik sediments consist of very fine-to fine-grained sandstone deposited as a thin (up to 35' of gross sand), elongate deposit that extends at least 12 miles north-to-south, along depositional strike, and about 6 miles west-to-east, along depositional dip.

Within the CRU, the Qannik sandstone is very fine-grained and lithic-rich. Net pay is up to 22' thick, and averages 10' to 15'. Porosity is 20 to 25 percent, and permeability ranges from 10 to 50 millidarcies. Qannik core averages 38 percent water saturation.

b. Structure: Within the proposed development area, the Qannik reservoir sandstone occurs in a north-south, very low-relief syncline. No seismically mappable faults are present.

c. Trap Configuration: Well log and seismic information indicate that the Qannik accumulation is a stratigraphic trap. The Qannik sandstone is truncated to the west and shales out to the east. A gas-oil contact exists at about -4,000 feet true vertical depth subsea (TVDSS). An oil-water contact has not been observed in the proposed development area.

d. Confining Intervals: The Qannik Oil Pool is overlain and underlain by thick accumulations of marine shale and siltstone that are assigned to the Torok Formation and laterally continuous throughout the proposed development area.

8. Well Logs: Logs of injection wells will be filed with the Commission according to the requirements of 20 AAC 25.

9. Mechanical Integrity and Design of Injection Wells: The casing and cementing programs for all injection wells will comply with 20 AAC 25.030.

Cement-bond logs will be run to demonstrate the isolation of injected fluids to the Qannik reservoir as required by 20 AAC 25.412(d). Mechanical integrity tests will be performed in accordance with 20 AAC 25.412(c). To facilitate wireline access, CPAI requests an exception to 20 AAC 25.412(b) to allow packers in injection wells to be located more than 200' measured depth above the top of the injection zone; however, packers will not be located above the confining zone.

10. Type of Fluid / Source: Fluids requested for injection are:

- a. source water from the Kuparuk sea water treatment plant;
- b. produced water from other pools within the Colville River Field; and
- c. produced water from the Qannik Oil Pool.

11. Water Compatibility with Formation: CPAI conducted a formation damage study using Qannik reservoir core and high salinity brine (149,000 ppm total dissolved solids (TDS)) and low salinity brine (24,600 ppm TDS). No catastrophic loss of permeability was observed with either brine; however, the injection of low-salinity brine caused a gradual reduction in permeability, which was attributed to the migration of fines.

12. Injection Rates and Pressures: Injection rates will be adjusted to manage reservoir voidage. The maximum expected injection well rate is 12,000 BWPD, and the average expected injection well rate is 5,000 BWPD. Injection pressures are expected to average approximately 2,400 psi at the wellhead. Injection wells may be choked to lower wellhead pressures to manage injection rate.

Original pressure of the Qannik reservoir was measured at about 1,850 psi at 4,000' TVDSS, and the bubble point is about 1,850 psi. The proposed project will be operated to attempt to maintain the average Qannik Oil Pool pressure within plus or minus 200 psi of original pressure.

13. Fracture Information: Normal water injection pressure will exceed the Qannik reservoir rock parting pressure. Computer modeling indicates fractures will propagate into, but not through, the Torok shale beds that bound the pool above and below. Injection fluids will remain within the Qannik reservoir.

14. Absence of Underground Sources of Drinking Water: According to the findings and conclusions of Area Injection Orders 18, 18A, and 18B, there are no underground sources of drinking water beneath the permafrost in the Colville River Unit area. Examination of well log data from exploratory wells in and near the proposed Qannik development confirms that there are no aquifers within the affected area that could serve as underground sources of drinking water.

15. Mechanical Condition of Adjacent Wells: There are 20 penetrations of the Qannik reservoir within a ¼-mile radius of the proposed injection well trajectories. 1 penetration is a plugged and abandoned exploration well; 9 penetrations are active Alpine development wells; 9 penetrations are active Alpine service wells; and 1 penetration is an active Qannik service well (CD2-404). With the exception of one recently drilled Alpine service well and CD2-404, the Qannik reservoir is not cemented in any of the remaining wellbores. Where

uncemented annuli exist, there is a potential for fluids to migrate from the Qannik reservoir.

CPAI does not believe that migration from the Qannik is likely due to the presence of dehydrated mud in the annuli, collapse of shales in the intervals above and below the Qannik due to exposure to water based drilling mud, and the need for any applied hydraulic pressure to exceed formation leakoff pressures.

CPAI is proposing to expand the annuli pressure monitoring program required by Enhanced Recovery Injection Order No. 4 (ERIO 4) for the well CD2-404 Pilot Injection Project in what was referred to at that time as the Qannik accumulation.. The outer annuli (OA) of all wells within ¼ mile of the proposed injection well trajectories will be equipped with wireless pressure transducers to allow continuous monitoring of OA pressures. No pressure anomalies were identified during the ERIO 4 pilot injection project.

### **CONCLUSIONS:**

1. The requirements of 20 AAC 25.402 have been met.
2. The injection of water will significantly improve oil recovery from the Qannik Oil Pool.
3. There are no underground sources of drinking water beneath the proposed affected area.
4. The proposed injection operations will be conducted in permeable strata, which can reasonably be expected to accept injected fluids at pressures less than the fracture pressure of the confining strata.
5. Injected fluids will be confined within the appropriate receiving intervals by impermeable lithology, cement isolation of the wellbores and appropriate operating conditions.
6. Setting the packers in the injection wells more than 200' MD above the injection interval to facilitate wireline access will not increase the risk of an injection fluid confinement failure. Provided that the packer is set at least 300' MD below the top of the production casing cement and is not above the confining zone.
7. Laboratory testing has shown that the fluids proposed for injection are compatible with the Qannik reservoir.
8. Reservoir pressure will be maintained within plus or minus 200 psi of original reservoir pressure.
9. Reservoir and well surveillance, coupled with regularly scheduled mechanical integrity tests, will demonstrate appropriate performance of the enhanced oil recovery project or disclose possible abnormalities.
10. The Qannik is not cemented in 18 of 20 penetrations within a ¼-mile radius of the proposed injection well trajectories. In order to ensure injection fluid confinement, an outer annular pressure monitoring program is necessary.
11. Sufficient information has been provided to authorize injection of water into the Qannik Oil Pool for the purposes of pressure maintenance and enhanced oil recovery.

**NOW, THEREFORE, IT IS ORDERED** that:

The underground injection of fluids for pressure maintenance and enhanced oil recovery is authorized in the following area, subject to the following rules and, to the extent not superseded by these rules, the statewide requirements of 20 AAC 25:

**Affected Area:**

**Umiat Meridian**

<u>Township, Range</u>	<u>Sections</u>
T10N, R04E	1 - 4
T10N, R05E	4 - 6
T11N, R04E	1 - 4; 9 - 16; 21 - 28; 33 - 36
T11N, R05E	4 - 9; 16 - 21; 28 - 33
T12N, R04E	1 - 4; 9 - 16; 21 - 28; 33 - 36
T12N, R05E	4 - 9; 16 - 21; 28 - 33

**Rule 1 Authorized Injection Strata for Enhanced Recovery**

Authorized fluids (under Rule 3, below) may be injected for purposes of pressure maintenance and enhanced oil recovery within the Affected Area into strata that are common to, and correlate with, the interval between the measured depths of 6,086' and 6,249' on the EWR log recorded in well CRU CD2-11.

**Rule 2 Well Construction**

To facilitate wireline access, packers in injection wells may be located more than 200' measured depth above the top of the Qannik Oil Pool; however, packers shall not be located above the confining zone. The production casing cement volume must be sufficient to place cement a minimum of 300' measured depth above the planned packer depth.

**Rule 3 Authorized Fluids for Enhanced Recovery**

Fluids authorized for injection are:

- a. source water from the Kuparuk sea water treatment plant; and
- b. produced water from the Colville River Field.

Any other fluids shall be approved by separate administrative action.

**Rule 4 Authorized Injection Pressure for Enhanced Oil Recovery**

Normal injection pressures must be maintained such that the injected fluids do not fracture the confining zones or migrate out of the approved injection strata.

### **Rule 5 Monitoring Tubing-Casing Annulus Pressure**

The tubing and casing annuli pressures of each injection well and the OA pressures of all wells that are not cemented across the Qannik reservoir located within a ¼-mile radius of a Qannik injector must be monitored at least daily, except if prevented by extreme weather conditions, emergency situations, or similar unavoidable circumstances. Monitoring results shall be documented and made available for Commission inspection.

### **Rule 6 Demonstration of Tubing/Casing Annulus Mechanical Integrity**

The mechanical integrity of an injection well must be demonstrated before injection begins, and before returning a well to service following a workover affecting mechanical integrity. A Commission-witnessed mechanical integrity test must be performed after injection is commenced for the first time in a well, to be scheduled when injection conditions (temperature, pressure, rate, etc.) have stabilized. Subsequent tests must be performed at least once every four years thereafter (except at least once every two years in the case of a slurry injection well). The Commission must be notified at least 24 hours in advance to enable a representative to witness mechanical integrity tests. Unless an alternate means is approved by the Commission, mechanical integrity must be demonstrated by a tubing/casing annulus pressure test using a surface pressure of 1500 psi or 0.25 psi/ft multiplied by the vertical depth of the packer, whichever is greater, that shows stabilizing pressure and does not change more than 10 percent during a 30-minute period. Results of mechanical integrity tests must be readily available for Commission inspection.

### **Rule 7 Well Integrity and Confinement**

Whenever any pressure communication, leakage or lack of injection zone isolation is indicated by an injection rate, operating pressure observation, test, survey, log, or other evidence (including OA pressure monitoring of all wells within a ¼-mile radius of where the Qannik is not cemented), the Operator shall notify the Commission by the next business day and submit a plan of corrective action on a Form 10-403 for Commission approval. The Operator shall immediately shut in the well if continued operation would be unsafe or would threaten contamination of freshwater, or if so directed by the Commission. A monthly report of daily tubing and casing annuli pressures and injection rates must be provided to the Commission for all injection wells indicating well integrity failure or lack of injection zone isolation.

### **Rule 8 Notification of Improper Class II Injection**

Injection of fluids other than those listed in Rule 4 without prior authorization is considered improper Class II injection. Upon discovery of such an event, the operator must immediately notify the Commission, provide details of the operation, and propose actions to prevent recurrence. Additionally, notification requirements of any other State or Federal agency remain the operator's responsibility.

If fluids are found to be fracturing the confining zone or migrating out of the approved injection stratum, the Operator must immediately shut in the injection wells. Injection may not be restarted unless approved by the Commission.

**Rule 9 Other Conditions**

The Commission may suspend, revoke or modify this authorization if injected fluids fail to be confined within the designated injection strata.

**Rule 10 Administrative Action**

Upon proper application, or its own motion, and unless notice and public hearing are otherwise required, the Commission may administratively waive the requirements of any rule stated herein or administratively amend this order as long as the change does not promote waste or jeopardize correlative rights, is based on sound engineering and geoscience principles, and will not result in an increased risk of fluid movement into freshwater.

**DONE at Anchorage, Alaska, and dated July 7, 2008.**



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Daniel T. Seamont, Jr., Chair  
Alaska Oil and Gas Conservation Commission

A handwritten signature in blue ink, appearing to read "John K. Norman", written over a horizontal line.

John K. Norman, Commissioner  
Alaska Oil and Gas Conservation Commission

A handwritten signature in blue ink, appearing to read "Cathy P. Foerster", written over a horizontal line.

Cathy P. Foerster, Commissioner  
Alaska Oil and Gas Conservation Commission

**RECONSIDERATION AND APPEAL NOTICE**

As provided in AS 31.05.080(a), within 20 days after written notice of the entry of this order or decision, or such further time as the Commission grants for good cause shown, a person affected by it may file with the Commission an application for reconsideration of the matter determined by it. If the notice was mailed, then the period of time shall be 23 days. An application for reconsideration must set out the respect in which the order or decision is believed to be erroneous.

The Commission shall grant or refuse the application for reconsideration in whole or in part within 10 days after it is filed. Failure to act on it within 10-days is a denial of reconsideration. If the Commission denies reconsideration, upon denial, this order or decision and the denial of reconsideration are FINAL and may be appealed to superior court. The appeal MUST be filed within 33 days after the date on which the Commission mails, OR 30 days if the Commission otherwise distributes, the order or decision denying reconsideration, UNLESS the denial is by inaction, in which case the appeal MUST be filed within 40 days after the date on which the application for reconsideration was filed.

If the Commission grants an application for reconsideration, this order or decision does not become final. Rather, the order or decision on reconsideration will be the FINAL order or decision of the Commission, and it may be appealed to superior court. That appeal MUST be filed within 33 days after the date on which the Commission mails, OR 30 days if the Commission otherwise distributes, the order or decision on reconsideration. As provided in AS 31.05.080(b), "[t]he questions reviewed on appeal are limited to the questions presented to the Commission by the application for reconsideration."

In computing a period of time above, the date of the event or default after which the designated period begins to run is not included in the period; the last day of the period is included, unless it falls on a weekend or state holiday, in which event the period runs until 5:00 p.m. on the next day that does not fall on a weekend or state holiday.