

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION
333 West 7th Avenue, Suite 100
Anchorage, Alaska 99501

Re: THE APPLICATION OF) Area Injection Order No. 27
CONOCO-PHILLIPS ALASKA)
INC. for an order authorizing) Colville River Field
underground injection of fluids for) Colville River Unit
enhanced oil recovery in the Nanuq-) Nanuq-Kuparuk Oil Pool
Kuparuk Oil Pool, Colville River)
Unit, North Slope, Alaska) February 16, 2006

IT APPEARING THAT:

1. By letter and application filed September 15, 2005, ConocoPhillips Alaska, Inc. (“ConocoPhillips”) in its capacity as Unit Operator of the Colville River Unit requested an order from the Commission authorizing the injection of fluids for enhanced oil recovery in the Nanuq-Kuparuk Oil Pool.
2. Notice of a public hearing was published in the Anchorage Daily News on September 27, 2005.
3. No protests, requests for hearing, or comments were submitted to the Commission during the 30-day public comment period.
4. The Commission vacated the public hearing on October 28, 2005.
5. The Commission requested additional information from ConocoPhillips on October 28, 2005, January 10, 2006 and January 11, 2006. Supplemental information was received from ConocoPhillips on November 2, 2005, January 10, 2006 and January 12, 2006.

FINDINGS:

1. Operator:

ConocoPhillips is the operator of the property in the area proposed for development. ConocoPhillips uses the name Nanuq-Kuparuk in reference to the development project.

2. Project Area Pool and Formations Authorized for Enhanced Recovery:

Enhanced recovery injection for the Nanuq-Kuparuk development is proposed within the Nanuq-Kuparuk Oil Pool. The target injection zone is correlative to the Nanuk No. 2 exploration well between 7,956 feet and 7,972 feet measured depth.

3. Proposed Injection Area:

ConocoPhillips requested authorization to inject fluids for the purpose of enhanced recovery operations on lands in the Colville River Unit within T10N-R4E, T10N-R5E, T11N-R4E, and T11N-R5E, Umiat Meridian.

4. Operators/Surface Owners Notification:

ConocoPhillips provided operators and surface owners within one-quarter mile of the proposed area with a copy of the application for injection. The only affected operator is ConocoPhillips, operator of the Colville River Unit. The State of Alaska, Department of Natural Resources and Kuukpik Corporation are the only affected surface owners.

5. Description of Operation:

The Nanuq-Kuparuk Oil Pool will be developed with a total of three horizontal wells, two producers and one injector. Water alternating with miscible gas injection (“MWAG”) will be implemented as the recovery mechanism for the pool. Water injection is scheduled to begin in late 2006 followed by miscible gas injection (“MI”) beginning in 2007. Prior to processing, production from the Nanuq-Kuparuk Oil Pool and the shallower Nanuq Oil Pool will be commingled on the surface at the Colville River Unit CD4 drill site and further commingled with production from the Alpine Pool and other Alpine satellite pools before separation at the Alpine Central Facility, located on the Colville River Unit CD1 drill site.

All production will be transported from the Alpine Central Facility using the existing pipeline to the Kuparuk River Field. Peak production rates are expected to be between 3,700 and 8,500 barrels of oil per day. Waterflood injection rates are estimated to peak between 3,500 and 7,900 barrels of water per day (“BWPD”) and miscible gas injection rates are estimated to peak at 3.5 to 8 million standard cubic feet of gas per day (“MMSCFPD”).

6. Hydrocarbon Recovery:

Estimates of original oil in place and recovery (in units of one million stock tank barrels or “Million STB”) within the Nanuq-Kuparuk development area are:

Hydrocarbon Volume	Low Estimate (Million STB)	High Estimate (Million STB)
Original Oil in Place	21	36
Primary Recovery (15%)	3	5
Primary + Waterflood (40 to 52%)	8	19
Primary + Waterflood + MWAG (57 to 77%)	12	28

7. Geologic Information:

a. Stratigraphy and Structure:

The Nanuq-Kuparuk reservoir consists of a thin, Cretaceous-aged shallow marine transgressive sandstone deposited atop the Lower Cretaceous Unconformity, a regional erosional surface that has cut down into the shale of the Miluveach Formation within the proposed development area. This reservoir sandstone is approximately 10 feet thick within the proposed development area, and it is situated about 900 feet true vertical feet beneath the overlying Nanuq Oil Pool. The Nanuq-Kuparuk reservoir is similar to the Kuparuk “C” Sands developed in the nearby Kuparuk River and Milne Point Units.

The Nanuq-Kuparuk structure is a homocline that dips gently from east to west at approximately 0.7 degrees. The trap is stratigraphic in nature, with the reservoir sandstone encased in shale and mudstone. A single, small fault has been mapped in the northern portion of the development area, but is not expected to affect recovery.

No gas or water contacts have been identified in the Nanuq-Kuparuk reservoir within the proposed development area.

b. Confining Intervals:

The Nanuq-Kuparuk Oil Pool is overlain by about 440 feet of shale and mudstone assigned to, in ascending order, the Kuparuk "D" interval, the Kalubik Formation and the HRZ interval. The reservoir is underlain by approximately 250 feet of silty mudstone assigned to the Miluveach Formation.

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 Well Design of Injection Wells:

The casing programs for all injection wells will comply with 20 AAC 25.030.

ConocoPhillips requests packers be located more than 200 feet measured depth above the top of the injection zone to facilitate wireline access. Tubing or other equipment will be designed and installed in accordance with 20 AAC 25.412.

Cement-bond logs will be run to demonstrate isolation of injected fluids to the Nanuq-Kuparuk reservoir. Mechanical integrity tests will be performed on all injection wells in accordance with 20 AAC 25.402(c). Casing-tubing annulus pressures will be monitored during injection operations in accordance with 20 AAC 25.402(e). In the event that pressure observations or the tests indicate communication or leaking of any tubing, casing, or packer, ConocoPhillips will notify the Commission within 24 hours of the observation to obtain Commission approval of appropriate corrective actions.

10. Type of Fluid / Source:

Fluids requested for injection are:

- a. source water from the Beaufort Sea;
- b. miscible gas obtained from the Alpine Central Facility;
- c. produced water from the Nanuq-Kuparuk Oil Pool;
- d. produced water from the Alpine Oil Pool and other Alpine satellite pools; and
- e. small amounts of fluids collected from sumps, hydrotests, rinsate from washing mud hauling trucks, excess well-work fluids, and treated camp waste water.

11. Water and MI Composition and Compatibility with Formation:

Seawater will be the initial waterflood source water for the proposed Nanuq-Kuparuk Oil Pool. The Nanuq-Kuparuk reservoir is analogous to the nearby Kuparuk oil reservoir in the Kuparuk River Unit ("KRU"). Water sensitivity tests performed on core samples from the KRU Kuparuk reservoir showed no significant problems with formation plugging or clay swelling over a range of salinities from 5,000 ppm TDS to 100,000 ppm TDS (AIO 2

Application, page 22).

Later in the life of the field, waterflood source water is expected to change from seawater to some combination of seawater, produced water from the Nanuk-Kuparuk and Nanuq Oil Pools, produced water from other oil pools with in the Colville River Unit, small volumes of non-hazardous fluids collected from sumps, hydrotests, well-work, rinsate from washing mud hauling trucks, and treated camp waste water. The operator reports there is no evidence that treated seawater or treated produced waters will be incompatible between any of the existing or proposed pools in the Colville River Field.

Numerical simulation, laboratory experiments and PVT modeling demonstrate that MI obtained from the Alpine Central Facility will be miscible with Nanuq-Kuparuk crude oil at initial reservoir conditions, and will significantly reduce residual oil saturations below that achievable by waterflooding.

12. Injection Rates and Pressures:

Injection rates will be adjusted to manage voidage for the reservoir. Injection of water and MI will alternate in each injection well. Expected maximum and average injection rates are:

Oil Pool	Maximum MI Rate (MMSCFD)	Average MI Rate (MMSCFD)	Maximum Water Rate (BWPD)	Average Water Rate (BWPD)
Nanuq-Kuparuk	16	5	15,000	5,000

Seawater injection pressures from the Alpine Central Facility pump discharge are expected to average approximately 2,500 psi. Wellhead pressures during water injection cycles are expected to be about 2,400 psi. MI pressure available from the Alpine Central Facility is expected to be approximately 4,000 psi, and wellhead pressures during MI injection cycles are expected to be about 3,800 psi. Injection rates may be managed by choking injection wells.

MI composition may vary and, as a result, minimum miscibility pressure may vary from 1,900 to 2,600 psia. The proposed project will be operated so that the average pressure in the Nanuq-Kuparuk reservoir will be maintained at 3,000 psi, which is significantly above the minimum miscibility pressure.

13. Fracture Information:

Although maximum water injection pressure will exceed the Nanuq-Kuparuk reservoir rock parting pressure, computer modeling using injection rates 50% greater than planned indicates:

- a. fractures will propagate into but not through the shale and mudstone beds of the overlying Kuparuk "D" interval, Kalubik Formation and HRZ or the mudstone of the underlying Miluveach Formation, and
- b. injection fluids will remain within the Nanuq-Kuparuk 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 Nanuq-Kuparuk 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:

The Nanuk No. 1, Nanuk No. 2, Nanuq No. 3, and Nanuq No. 5 exploration wells all penetrate the proposed Nanuq and Nanuq-Kuparuk injection intervals within the project area. Nanuk No. 1 and Nanuk No. 2 have been plugged and abandoned. Nanuq No. 3 and Nanuq No. 5 were drilled through the injection intervals, cased and suspended. All four of these wells have sufficient mechanical isolation to confine injected fluids to the target reservoirs and prevent cross flow into other intervals.

CONCLUSIONS:

1. The application requirements of 20 AAC 25.402 have been met.
2. Injection of water and miscible gas will significantly improve recovery.
3. There are no underground sources of drinking water beneath the permafrost in the Colville River Unit or the proposed affected area.
4. Increasing the distance between the packer and top of the injection zone will not compromise well integrity, so long as the top of production casing cement is at least 300 feet measured depth above the packer.
5. 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.
6. Injected fluids will be confined within the appropriate receiving intervals by impermeable lithology, cement isolation of the wellbore and appropriate operating conditions.
7. Seawater waterflood source water will be compatible with the Nanuq-Kuparuk reservoir. Compatibility has not been demonstrated for produced waters, mixtures of waters, non-hazardous liquids collected from sumps, hydrotests, well work, rinsate from washing mud-hauling trucks, and treated camp waste water.
8. Reservoir pressure will be maintained to ensure gas miscibility.
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. Sufficient information has been provided to authorize injection of water and miscible gas into the Nanuq-Kuparuk 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 the statewide requirements under 20 AAC 25 (to the extent not superseded by these rules).

Umiat Meridian

<u>Township, Range, UM</u>	<u>Sections</u>
T10N, R4E	1, 2
T10N, R5E	3, 4, 5, 6
T11N, R4E	1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26, 27, 28, 33, 34, 35, 36
T11N, R5E	3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28, 29, 30, 31, 32, 33, 34

Rule 1 Authorized Injection Strata for Enhanced Recovery

Authorized fluids may be injected for purposes of pressure maintenance and enhanced recovery within the Nanuq-Kuparuk development area into strata that are common to, and correlate with, the interval between the measured depths of 7,956 feet and 7,972 feet in the Nanuk No. 2 well.

Rule 2 Fluid Injection Wells

The underground injection of fluids must be through a well that has been permitted for drilling as a service well for injection or through a well approved for conversion to a service well for injection in conformance with 20 AAC 25.

Rule 3 Well Construction

To facilitate wireline access, packers in injection wells may be located more than 200 feet measured depth above the top of the Nanuq-Kuparuk zone; however, packers shall not be located above the confining zone. Since Nanuq-Kuparuk wells will also penetrate the shallower Nanuq Oil Pool, the top of production casing cement must be a minimum of 500 feet measured depth above the Nanuq Pool.

Rule 4 Authorized Fluids for Enhanced Recovery

Fluids authorized for injection are:

- a. source water from a sea water treatment plant;
- b. miscible gas obtained from the Alpine Central Facility with the condition that the reservoir pressure must be maintained to ensure the miscibility of the injectant;
- c. tracer survey liquid to monitor reservoir performance; and
- d. small amounts of other non-hazardous liquids: sump liquid, hydrotest liquid, rinsate from washing mud hauling trucks, excess well work liquids, and treated camp waste water.

Prior to injection of any liquid other than seawater or any mixture of liquids, compatibility with the Nanuq-Kuparuk reservoir must be demonstrated and administrative approval to inject must be obtained from the Commission. Sampling, analysis and reporting protocols shall conform to those listed in AIO 18B.002.

Rule 5 Monitoring Tubing-Casing Annulus Pressure

The tubing and casing annuli pressures of each injection well must be monitored at least daily, except if prevented by extreme weather condition, 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

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 1,500 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

Injection operations must ensure that injected fluids do not fracture or migrate out of the approved injection zone.

Whenever any pressure communication, leakage or lack of injection zone isolation is indicated by injection rate, operating pressure observation, test, survey, log, or other evidence, 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.

Rule 9 Plugging and Abandonment of Fluid Injection Wells

An injection well located within the affected area must not be plugged or abandoned unless approved by the Commission in accordance with 20 AAC 25.112.

Rule 10 Other conditions

- a. It is a condition of this authorization that the operator complies with all applicable Commission regulations.
- b. The Commission may suspend, revoke, or modify this authorization if injected fluids fail to be confined within the designated injection strata.

Rule 11 Administrative Actions

Unless notice and public hearing are otherwise required, the Commission may administratively waive or amend the requirements of any rule stated above 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 February 16, 2006.

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

Daniel T. Seamount, Jr., Commissioner
Alaska Oil and Gas Conservation Commission

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

AS 31.05.080 provides that within 20 days after receipt of written notice of the entry of an order, a person affected by it must file with the Commission an application for rehearing. A request for rehearing must be received by 4:30 PM on the 23rd day following the date of the order, or next working day if a holiday or weekend, to be timely filed. The Commission shall grant or refuse the application in whole or in part within 10 days. The Commission can refuse an application by not acting on it within the 10-day period. An affected person has 30 days from the date the Commission refuses the application or mails (or otherwise distributes) an order upon rehearing, both being the final order of the Commission, to appeal the decision to Superior Court. Where a request for rehearing is denied by non-action of the Commission, the 30-day period for appeal to Superior Court runs from the date on which the request is deemed denied (i.e., 10th day after the application for rehearing was filed).