Proposed Issuance of Underground Injection Control (UIC) Permit: Fact Sheet

April 2016

This cover sheet provides a brief overview of proposed Permit AK-1I017-A for the Operation of Class I Non-Hazardous Industrial Waste Injection Wells at the Oooguruk Unit, North Slope, Alaska.

For more information, please see the attached document, which contains comprehensive, technical details about the proposed permit.

What is proposed in the permit?	The permit allows for the construction of wells and injection of non-hazardous waste over 1 mile below ground surface at the Oooguruk Unit Nuna Drill Site to support hydrocarbon development, North Slope, Alaska. This type of well is called a Class I well.
Will a new well be drilled?	Yes. The proposed injection wells well would be drilled to 8,800 feet true vertical depth subsea (TVDss).
Why do we need the well?	The well will eliminate the release of this waste onto the land or into surface waters.
What will be injected into the well?	The waste will include, but not be limited to: non-hazardous waste fluids, produced water, drilling muds and cuttings, stormwater, well workover fluids, camp wastewaters and other exempt and non-exempt non-hazardous fluids.
How can I comment?	EPA accepts public comments on the draft permit during the public comment period set in the public notice. For more information go to www.EPA.gov/Region10. Please send your comments to Thor Cutler at cutler.thor@epa.gov by the close of the public comment period. EPA may finalize the permit as drafted if no substantive comments are received by the close of the public comment period.
Questions?	Thor Cutler cutler.thor@epa.gov 206-553-1673

FACT SHEET

Proposed Issuance of Underground Injection Control (UIC) Permit AK1I017-A
For up to Two (2) Class I Non-Hazardous Industrial Waste Injection Wells
To Be Constructed and Drilled from the Onshore Nuna Project Drill Site
For Injection into the Oooguruk Unit (OU), North Slope, Alaska

U.S. Environmental Protection Agency, Region 10
Office of Compliance and Enforcement
Underground Injection Control (UIC) Program
Ground Water Protection Unit, OCE-101
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Background

U.S. Environmental Protection Agency (EPA) received a request for an Underground Injection Control (UIC) permit the construction and operation of up to two (2) Class I non-hazardous industrial waste injection wells, North Slope Borough, Alaska. The proposed well(s) will be drilled from the onshore Nuna drill site located in the Kuparuk River Unit (KRU) however the well(s) will inject below permafrost into the Oooguruk Unit (OU). The Nuna Project onshore drill site is located 250 miles above the Arctic Circle and forty (40) miles west of Deadhorse (Prudhoe Bay), Alaska. In Alaska, EPA is directly responsible for implementation and regulation of Class I injection wells under the UIC program, which is authorized by Part C of the Safe Drinking Water Act. Class I injection wells are used for the deep disposal of industrial waste into naturally saline ground water aquifers, beneath any aquifers that could serve as current or future underground sources of drinking water. The OU Class I UIC wells injection zones are proposed to be drilled from an onshore drill site to an offshore location over one (1) mile below the surface of the Beaufort Sea. The owner and operator, Caelus Natural Resources Alaska, LLC (Caelus), has requested a UIC permit to dispose non-hazardous fluids 7,400 +/- 50 feet true vertical depth (TVD) in reference-to-Kelly-bushing TVD(RKB) to 8,700 +/- 50 feet TVD(RKB). Caelus would utilize new UIC wells constructed at an onshore Nuna drill site gravel pad in the KRU to inject fluids below permafrost into portions of the hyper-saline Sag River Formation (SRF) and Ivishak Formation (IF) in the OU.

The operation of the Class I injection well(s) at the OU will meet the objective of "zero discharge" of most wastewaters into waters of the U.S. Approved production and domestic waste that is suitable for deep injection will be confined below hydrocarbon producing formations in an area which meets or exceeds the requirements for protecting health, safety and the environment. The onsite Class I disposal systems offer a controlled, permanent, deep subsurface disposal option that reduces handling, storage and transportation activities. This reduction of activities reduces risks of spills, risks to the environment and improves safety. The EPA has prepared a draft UIC permit and earlier, on September 19, 2014, determined there are

no underground sources of drinking water below the permafrost in this drill site area.

Regulatory Framework

The UIC program is authorized by Part C of the Safe Drinking Water Act for the principal purpose of protecting Underground Sources of Drinking Water (USDW) from pollution by injection through wells. Primary responsibility for the UIC program in Alaska is shared between EPA and the Alaska Oil and Gas Conservation Commission (AOGCC). The AOGCC regulates Class II injection wells, which are defined as those wells used (1) to dispose of waste fluids brought to the surface from oil and gas production operations, (2) for enhanced recovery of oil and gas, or (3) for storage of hydrocarbons which are liquid at standard temperature and pressure (*see* 40 Code of Federal Regulations (C.F.R.) § 144.6). EPA regulates the other five classes of UIC wells. The UIC regulations allow Class II well eligible fluids to be disposed of into Class I or II injection wells. Fluids eligible for Class I injection, however, may not necessarily be eligible for injection into Class II wells.

The UIC regulations broadly define USDW (*see* 40 C.F.R. § 144.3) as any aquifer capable of supplying a public water system with water of less than 10,000 milligrams per liter (mg/l) Total Dissolved Solids (TDS). If injection does not occur above, into, or through a USDW, then less stringent injection well permit conditions may be imposed than would otherwise be required (*see* 40 C.F.R. § 144.16). Within one-half (1/2) mile radius of the proposed disposal wells, the portions of the aquifers in the SRF and IF contain TDS at an average concentration of 18,924 mg/l which is greater than 10,000 mg/l, and these portions of the aquifers in the SRF and IF do not qualify under 40 C.F.R. § 144.3 as an USDW. Under these circumstances, the EPA Director (*i.e.*, Regional Administrator) may authorize injection with less stringent requirements than would otherwise be required (*see* 40 C.F.R. § 144.16). Based on the documented natural conditions, EPA intends to grant several waivers requested by Caelus, which are described under the "Geologic Setting and Injection Issues" portion of this fact sheet.

EPA Permit and General Project Overview

EPA's 10-year term permit would allow Caelus to inject non-hazardous waste fluids including, but not limited to, camp greywater, produced water, drilling muds and cuttings, flush water, stormwater, well workover fluids, wastewaters, and other exempt and non-exempt non-hazardous fluids (that did not come up from down hole) through the injection well(s). On September 19, 2014 EPA determined the portions of aquifers in the IF and SRF near the proposed wellbores do not qualify under 40 C.F.R. § 144.3 as an USDW. The data shows the mean salinity values of the SRF aquifer and the IF aquifer are 14,204 ppm and 23,645 ppm respectively. Therefore an average mean value of 18,924 mg/l TDS is representative of the portions of aquifers within one-half (1/2) mile radius of the wellbore(s) of the proposed well(s) and is significantly greater than 10,000 mg/l. Under these circumstances, the EPA Director (i.e., Regional Administrator) may authorize injection with less stringent requirements than would otherwise be required (see 40 C.F.R. § 144.16). EPA intends to grant several waivers requested

by Caelus, which are described under the "Geologic Setting and Injection Issues" portion of this Fact Sheet. The geologic setting for the OU underground injection is very compatible with the proposed deep disposal process. The deep injection zone is into the naturally hyper-saline SRF and IF between 7,400 +/-50 feet TVD(RKB) and 8,700 +/-50 feet TVD(RKB).

Caelus submitted a permit application for not to exceed two (2) class I UIC wells. Caelus proposes the UIC Class I disposal well(s) be drilled from the onshore drill site vertically or to an offshore location west-northwest from the drill site surface location. The disposal intervals will be located approximately one (1) mile below sea level and under a layer of permafrost. The base of permafrost is 1,500 feet below sea level in this area. The approximate surface onshore location for the initial injection well is latitude 70.420072 degrees (º) North and longitude 150.266341º West (North American Datum 1983). The proposed wellbore is vertical upon penetrating the disposal intervals. The top of the disposal interval will be approximately 7,400 feet TVD(RKB) feet true vertical depth subsea (TVDss) and will be located at latitude 70.422443º North and longitude 150.324629º West. For purposes of this determination, a second well, if drilled, is assumed to be in near vicinity of the initial well.

The Class I well(s) will be completed in the IF and/or SRF between 7,400 +/- 50 feet TVD(RKB) to 8,700 +/- 50 feet TVD(RKB). Waste injection over the life of the project will be approximately 2.6 million bbl. During the drilling phase, the waste will consist of two million barrels of drilling waste and 200,000 bbl of camp waste water. The proposed injection intervals do not qualify as underground sources of drinking water, based on the review of data submitted to EPA in 2014. The same interval is used in the Alpine field for Class I disposal for over a decade. The confining zones are thick shales that are dense in nature and serve as a competent confining layer. Caelus requests three waivers of UIC program requirements. These waivers are consistent with 40 C.F.R. 144.16 which allows the EPA Director to waive program requirements when there are no recognized UDSW to protect. The geologic setting for the OU underground injection is very compatible with the proposed deep disposal process. The injection zone is below permafrost and into the naturally saline SRF and IF. The concentrations of total dissolved solids (TDS) in the aquifers of SRF and IF are higher than the required threshold (of 10,000 milligrams per liter) to qualify for an USDW. On September 19, 2014 EPA determined the portions of aquifers in the IF and SRF near the proposed wellbores do not qualify under 40 Code of Federal Regulations Section 144.3 as an USDW. The same geologic formations under OU have been successfully used to dispose of fluids in the area since 1999.

Oil production will come from the Torok oil reservoir at 4,700-5,400 feet. The Torok hydrocarbon reservoir is separated by more than 2,000 feet from the Sag River/Ivishak disposal interval at 7,500 feet by a dense shale interval. Caelus expects water production to increase steadily from 5,000 to 45,000 bbl of water per day over the life of the field. Caelus expects the drilling operations to last approximately three years with first production in 2017, ending 20 years later. No processing of produced fluid is planned at the site. All production will be routed to a three phase flow line connected to Oooguruk Tie-in Pad (OTP).

Types and Volumes of Injected Fluids

The majority of fluid wastes consist of camp waste water from the treatment plant, wastes from

the grind and inject plant, and other fluids generated up from down hole from the well fields. Caelus anticipates the wastes injected into the Class I well system will be generated at the drill site. At the end of the development drilling, about 2.6 million bbl will have been injected with the majority of the volume coming from drilling operations. The following years of production operations will generate little waste, with most coming from infrequent well workover operations. Disposal in a Class I well under a controlled system over the estimated 20-year life of the project and the estimated volumes/types are given below:

Disposal Volumes in bbl by Major Category (Estimated Life of the field: 20 years)	
Drill cuttings and mud	2,000,000 bbl
Well workover fluids and flush	300,000 bbl
Camp Greywater	200,000 bbl
Other exempt fluids	20,000 bbl
Stormwater and sumps	50,000 bbl
Class I non-hazardous waste	100 bbl
Total	2,570,100 bbl

Typical injection will consist of batches of approximately 1,000 bbl of fluids followed by a flush of clear water. This operation may be optimized so that freeze protection of the well can be minimized. Over the life of the project, waste streams will vary and an updated waste analysis plan (WAP) may be submitted to provide updated descriptions of waste products and fluids. Caelus has not applied for a hazardous waste injection well permit. Therefore, any listed hazardous wastes would need to be collected, stored, and transported to a RCRA-approved hazardous waste treatment or disposal facility. Those wastes which are hazardous only because of a characteristic (*i.e.*, ignitability, corrosivity, toxicity, etc.) may be treated to remove that characteristic, and then injected into a Class I UIC well. The only radioactive substance which may be injected under the proposed permit is naturally occurring radioactive material from sludge or pipe scale (a mineral precipitate formed during production) and radioactive tracer beads that are commonly used for tubular and pipe diagnosis.

Geologic Setting and Injection Issues

Deposition/Lithology/Stratigraphy

The planned disposal zone is the Permo-Triassic interval including the Ivishak and Sag River sands. This interval is part of the Ellesmerian sequence composed of cyclic transgressive-regressive clastic accumulations on a passive margin ramp, south of a stable platform to the north. The gross interval of interest incudes the proposed disposal and confining intervals made up, from bottom to top, of the Permo-Triassic Kavik, Ivishak, Shublik, Sag River Formations and the Jurassic Kingak Formation. These formations are seen on the Texaco Colville Delta-1 type log. Stratigraphic correlations regionally are made from Prudhoe Bay and Kuparuk River Unit fields to the east, Alpine Field to the west, and Oooguruk Field to the north. Seismic sections show continuity in the region. The gross interval, including the Kavik through Kingak Formations, was deposited as sediment was shed from a broad stable platform to the north onto a slowly subsiding ramp to the south. The Permian Kavik Formation is interpreted to be deposited as shelfal and prodelta sedimentation. The IF was deposited as a thick fluvial-deltaic marginal

marine interval during Permo-Triassic low-stand. Subsequent transgression deposited the organic-rich calcareous shale of the Triassic Shublik Formation. As well as the shelfal sandstones of the Triassic SRF across the region. Finally, the Jurassic Kingak Formation was deposited as a thick sequence of prodelta and shelfal shales.

Injection and Confining Zones

The primary disposal zone, the Ivishak sand in nearby wells varies between 600 and 700 feet in thickness with an average thickness of 665 feet. The secondary disposal zone is the Sag River sand. The thickness in nearby wells varies in thickness between 40 and 90 feet with an average thickness of 66 feet. The intervening Shublik Formation varies between 230 and 250 feet with an average thickness of about 235 feet. The interval is best mapped on the seismic response at the top Sag River structure that shows Permo-Triassic section exhibits northwest-southeast striking normal faults that are down-thrown to the northeast. A second set of faults trend north-south with minor displacement. Faults commonly show a displacement of less than 50 feet. The laterally extensive Kingak Shale is 500 to 1,000 feet thick across the area and serves as the upper confining zone (UCZ). The Kingak is a regional marine shale that correlates well over the region. The top of the Kingak Shale is defined by the base of the Nechelik sand. The base of the Kingak Shale is defined by the top of the SRF.

Descriptions of cuttings and cores commonly note hydrocarbon shows in the Upper Ivishak Formation and more often in the Sag River sandstone. A drill stem test showed a small amount of gas after 49 minutes into the test. These beds acted as ancient migratory routes for hydrocarbons that accumulated elsewhere. Wireline shows the disposal zones are now wet; there are no hydrocarbon accumulations within the Permo-Triassic proposed injection intervals in the Nuna area.

The primary disposal zone, the Triassic Ivishak sand, was deposited as low-stand fluvial-deltaic marginal marine sediments accumulated along the south facing Ellesmerian ramp during cyclic marine transgression/regressions. The lithologies of the Ivishak interval at the Texaco Colville Delta#1 well are described as minor and varied conglomerates, mostly sandstone (very fine to lower coarse grained, quartz sands with some chert, lithic and occasional glauconitic grains, sub-angular to sub-rounded), siltstones and shale. The Ivishak was deposited on the top of the Kavik marine shale. Above the Ivishak is the Shublik Formation. The Shublik Formation is organic-rich shale that is deposited during continued transgression. The Sag River Sand was deposited after the Shublik Shale as shelf sandstones during the later portion of the Jurassic and is considered a secondary disposal zone. In the Colville Delta #1 well, the Sag River sandstone is very fine to fine grained quartz, sub-angular, medium sorted sandstone, silts, and shales. The Ivishak varies between 600 and 700 feet in gross thickness and the Sag River sand varies from 40 feet to 90 feet in gross thickness. A drill stem test in the Sag River recovered 2 bbl of fluid. A drill stem test from the Upper Ivishak recovered a small amount of gas and 70 bbl of water to the surface. A test of the lower Ivishak recovered about 29 bbl of formation water.

Log analysis of wells show the proposed disposal site shows total porosity (PHITT) values range from less than 10 percent (%) to 29% with a mean of 20% for the SRF. The Ivishak PHITT

ranges from near zero to 28% with a mean of 13%. Permeability from logs of the Sag River sandstone range from 0.2 to 179 millidarcies (md) with a mean of about 5 md. Permeability from logs for the Ivishak range from 0.02 md to 4170 md with a mean of about 8 md.

Subsurface Aquifers/USDWs/Aquifer Exemption/No USDW Ruling

A USDW is defined as an aquifer which is currently serving as a source of potable water or which, by virtue of its potential productivity and natural water quality, could serve as a public water supply. Because aquifer conditions indicate that portions of aquifers are not an USDW (see aquifer determination dated September 19, 2014) at the proposed injection well locations, EPA intends, to grant two (2) waivers of UIC regulatory program requirements ([40 C.F.R. §§ 146.12 (e) and 146.14 (a) (8)] and [40 C.F.R. § 146.13 (a) (1), (b) and (d) (1) and (2)]) The EPA received a letter dated August 26, 2014 related to the Caelus UIC permit application to EPA to construct and operate Class I non-hazardous injection disposal well(s) at the onshore Nuna drill site. Caelus sought EPA's concurrence with Caelus' findings that specific portions of aquifers in the SRF) and IF do not qualify under 40 C.F.R. §144.3 as Underground Sources of Drinking Water (USDW) because the concentrations of total dissolved solids (TDS) exceeds 10,000 milligrams/liter (mg/l) in these portions of the aquifers. Caelus reported the proposed UIC Class I disposal well(s) will be drilled from the onshore drill site location. The disposal intervals will be located approximately one (1) mile below sea level and below the base of permafrost which is commonly 1,500 feet below sea level in the drill site area. Caelus reviewed log data from five wells located within six miles of the proposed EPA UIC Class I wells to estimate the TDS concentration in the proposed injection zone. The log data was used to calculate mean sodium chloride (NaCl) equivalent salinity values (expressed in parts per million (ppm)) for portions of aquifers in the SRF and the IF that will be proposed for the injection zone. The salinity values (in ppm) approximate the TDS content expressed in mg/l. Well logs provided by Caelus identify the geologic sequence. From top to bottom they include: the Nechelik Formation, Kingak Shale, SRF, Shublik Shale, IF and Kavik Formation. Caelus specifically calculated salinities for the SRF and IF because they are the proposed injection zones. Caelus' calculations show SRF and IF aquifer salinities are consistent in the drill site area and exhibit TDS concentrations greater than 10,000 mg/l. Based on well log data from Texaco Colville Delta #1 well located four miles northwest of the drill site, the SRF (7,579-7,659 feet measured depth (MD)) aquifer calculated average salinity is 16,348 ppm and the IF (7,894-8,582 feet MD) aquifer calculated average salinity is 23,683 ppm. Based on well log data from ARCO Kalubik #1 well located five miles north of the Nuna drill site, the SRF (7,637-7,721 feet MD) aquifer calculated average salinity is 12,916 ppm and the IF (7,965-8,273 feet MD) aquifer calculated average salinity is 21,299 ppm. Based on well log data from Pioneer Sikumi #1 well located four and one-half (1/2) miles north of the Nuna drill site the IF (7,756-8,443 feet MD) aquifer calculated average salinity is 24,922 ppm. Based on well log data from Sinclair Colville #1 well located four (4) and one-half (1/2) miles south of the Nuna drill site, the SRF (7,709-7,752 feet MD) aquifer calculated average salinity is 12,170 ppm and the IF (7,984-8,650 feet MD) aquifer calculated average salinity is 23,430 ppm. Based on well log data from Union Kalubik Creek #1 well located six miles east of the Nuna drill site, the SRF (7,721-7,777 feet MD) aquifer calculated average salinity is 15,382 ppm and the IF (7,999-8,698 feet MD) aquifer calculated average salinity is 24,890 ppm. Based on the data provided by Caelus, the mean salinity value of the SRF aquifer is 14,204 ppm and the

mean salinity value of the IF aquifer is 23,645 ppm. Therefore, an average mean value of 18,924 mg/l TDS is representative of the portions of aquifers within one-half (1/2) mile radius of the wellbore(s) of the proposed Nuna drill site UIC Class I well(s). This TDS value of 18,924 mg/l is greater than 10,000 mg/l.

EPA has reviewed the information provided by Caelus in August 2014. Based on information provided by Caelus, the proposed disposal well(s) injection zone location is approximately 7,400 +/-50 feet TVD(RKB) to 8,700 +/-50 feet TVD(RKB). EPA concurs with Caelus that within one-half (1/2) mile radius of the proposed Class I wellbores, the portions of the aquifers in the SRF and IF below the base of the Kingak Shale at approximately 7,400 feet TVDss and above the mapped top of the Kavik Shale Formation at approximately 8,700 feet TVDss (referenced in the Colville Delta #1 well between 7,579 feet and 8,582 feet MD) contain TDS at an average concentration of 18,924 mg/l which is greater than 10,000 mg/l, and these portions of the aquifers in the SRF and IF do not qualify under 40 C.F.R. § 144.3 as Underground Sources of Drinking Water (USDW). Due to the absence of USDW at the proposed location(s), EPA intends, to grant the following waivers of UIC regulatory program requirements as listed below:

(1) Compatibility of Formation and Injectate [40 C.F.R. §§ 146.12 (e) and 146.14 (a) (8)]: Based upon the applicability of past injection studies, petrophysical logging data, existing rock and fluid samples plus successful injection practices into formations in the OU and North Slope vicinity, EPA is waiving the above two requirements for any additional sampling and characterization of formation fluids and injection rock matrix in order to determine whether or not they are compatible with the proposed injectate.

(2) Injection Zone Fracturing, Ambient Monitoring and Pressure Buildup [40 C.F.R. § 146.13 (a) (1), (b) and (d) (1) and (2)]: Based on log surveillance results into formations in the North Slope vicinity that consistently verify no significant upward movement of injected fluids, continuity of geologic formations and that transmission through faulting is not likely to transmit fluid above the confining zone, and there are no improperly sealed, completed, or abandoned wellbores in the area of review, EPA is waiving the above three requirements of an ambient monitoring of saline aquifers above the confining zone, monitoring the strata overlying the confining zone for fluid movement and a monitoring program including a pressure buildup of the injection zone annually. Also, based on the above, EPA is waiving the prohibition against fracturing the injection interval, and would instead allow fracturing to a minor extent at the injection well confined to the injection zone so long as new fractures are not initiated nor existing ones propagated within the upper and lower confining zone. However, in no case shall injection pressure initiate fractures in the confining intervals above and below the injection zone. Authorized injection will be limited to the permitted injection zones in the SRF, and IF. However, external mechanical integrity demonstrations are required to verify that all injected fluids are exiting in the injection interval and that there is no flow behind pipe due to channeling etc. [See Part II C.3.b (2)]

Summary of Proposed Action and Permit Conditions

EPA has primary enforcement authority in Alaska for Section 1422 of the UIC program (authorized by Part C of the Safe Drinking Water Act), which includes the regulation of Class I

injection wells. Class I wells are used to inject waste fluids for safe disposal beneath any existing USDW. EPA proposes to grant a permit to Caelus for up to two (2) (includes alternate/sidetrack/replacement) Class I non-hazardous waste injection wells at the OU, North Slope Borough, Alaska. The EPA considered disposal options, and concludes that underground injection is a disposal method for oilfield fluids, produced waters, and non-hazardous liquid wastes to be disposed at the OU facility during its estimated 20-year development and production lifetime. Based upon all available information, EPA has determined that the aquifers beneath the OU below permafrost do not qualify as an USDW. The permit contains general legal provisions common to EPA permits, specific technical requirements that apply to all Class I injection wells, and particular technical, monitoring and reporting requirements for the proposed injection operations at the OU, North Slope Borough, Alaska.

Public Comment Period will be announced in a Public Notice

The EPA encourages public review of the proposed permit issuance. Persons wishing to comment on the proposed permit re-issuance must so in writing by the close of the public comment period. Comments should be accompanied with a basis for the comments and substantiating facts. Please also include the name, address, and telephone number of the person making comment. A public hearing will be held upon request if EPA determines there is sufficient interest in a hearing; however EPA reserves the right to cancel the hearing absent sufficient interest and requests for a public hearing. All written comments and requests should be submitted during the public comment period to EPA to the attention of: Thor Cutler, Ground Water Unit, EPA (OCE-101) 1200 Sixth Avenue Suite 900, Seattle, WA 98101 or via electronic mail to cutler.thor@epa.gov. **After the public comment period,** EPA may choose to finalize the proposed 10-year EPA UIC Class I permit as drafted, if no substantive comments are received during the public comment period. For further information, please contact Thor Cutler at (206) 553-1673 or via e-mail: cutler.thor@epa.gov.