



December 12, 2016

8140-7400-32640-02

Christine Beermann
Field Regulatory Coordinator
Penn West Petroleum Ltd.
Bay 203, 8026 Edgar Industrial Crescent
Red Deer, AB, T4P 3R3

Dear Ms Beermann:

**RE: PRODUCED WATER DISPOSAL SPECIAL PROJECT APPROVAL, AMENDMENT #1
PENN WEST THETLAANDOA c-24-L/94-P-06; WA# 13463
THETLAANDOA FIELD – DEBOLT 'A' POOL**

Approval for disposal of produced water, Order 01-02-012, was issued for the subject well, Debolt formation, on November 26, 2001. The Commission is presently amending disposal well approvals to conform to current requirements.

The Thetlaandoa Debolt 'A' pool has been producing gas since March 2001. The subject well has disposed mostly continuously into the pool since June 2007. A static gradient on the subject well from March 2016 indicates that the reservoir pressure is still well below initial pool pressure. Integrity testing indicates good casing integrity and hydraulic isolation of disposal fluids.

Attached please find **Order 01-02-012 Amendment #1**, designating an area in the Thetlaandoa field – Debolt 'A' pool as a Special Project under section 75 of the *Oil and Gas Activities Act*, for the operation and use of a storage reservoir for the disposal of produced water. This Order contains a number of detailed operational conditions including a maximum wellhead injection pressure, reservoir pressure fill-up limit, and continuous tubing and casing pressure monitoring. Additional general information regarding disposal wells is available on the Commission's website at <http://www.bcogc.ca/industry-zone/documentation/Subsurface-Disposal>.

The top of the disposal zone (Debolt Formation, 476 mKB) is below, but within 100 m of, the Base of Usable Groundwater as determined by the BC OGC Geology staff at the disposal well location (410.5 mKB), where the Base of Usable Groundwater means the top of "deep groundwater" as defined in the BC Water Sustainability Regulation (enacted February 2016). As such, a groundwater monitoring program is required to be implemented, involving the installation of a single monitoring well, to establish reference groundwater chemistry and to demonstrate consistency in groundwater chemistry over time at the monitoring well location. Specific groundwater monitoring program requirements are outlined in Appendix A.

In certain circumstances, disposal well operation may induce seismicity. The Commission advises that disposal well permit holders monitor seismic events in proximity to the well and be prepared to modify operations to mitigate induced seismicity. Permit holders may monitor seismic events through the Natural Resources Canada seismic monitoring network at <http://www.earthquakescanada.nrcan.gc.ca/recent/index-eng.php>

Should you have any questions, please contact Michelle Harding at (250) 419-4493 or the undersigned at (250) 419-4430.


Sincerely,

Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

Attachment

ORDER 01-02-012 Amendment #1

- 1 Under Section 75(1)(d) of the *Oil and Gas Activities Act*, the Commission designates the operation and use of a storage reservoir for the disposal of produced water, including flowback from fracturing operations, into the Debolt 'A' pool – Thetlaandoa field as a special project in the following area:
NTS 94-P-06 Block L Unit 24
- 2 Under section 75(2) of the *Oil and Gas Activities Act*, the special project designation in this Order is subject to the following conditions. The Permit Holder shall:
 - a) Inject produced water only into the well Penn West Thetlaandoa c-24-L/94-P-06; WA# 13463 – Debolt 'A' pool (perforations from 498.0 – 511.5 mKB).
 - b) Not exceed an injection pressure, measured at the wellhead on the subject well, of 3,000 kPag or the pressure required to fracture the formation, whichever is lesser.
 - c) Inject only through tubing with a packer set as near as is practical above the injection interval.
 - d) Continually measure and record the wellhead casing and tubing pressures electronically.
 - e) Cease injection and notify the Commission immediately if hydraulic isolation is lost in the wellbore or formation.
 - f) Submit the annual packer isolation test report to the Commission within 30 days of the completion of the test.
 - g) Include the disposal operating hours and the maximum injection pressure value on the monthly BC-S18 disposal statement.
 - h) Conduct an annual reservoir pressure test on the formation in the subject well, with a shut-in period of sufficient length to provide data for calculation of the reservoir pressure, and submit a report of the test within 60 days of the end of the test.
 - i) Cease injection upon reaching a maximum formation pressure of 4,910 kPaa, measured at 504.75 mKB.
 - j)
 - i) Perform a casing inspection log on the subject well and submit results to the Commission within 30 days of the completion of logging, at an interval of not more than every 10 years.
 - ii) Perform a hydraulic isolation temperature log on the subject well and submit results to the Commission within 30 days of the completion of logging, at an interval of not more than every 5 years.
 - k) Not conduct a hydraulic fracture stimulation on any formation in the subject well without prior Commission approval.
 - l) Implement a groundwater monitoring program as detailed in Appendix A.



Ron Stefik, Eng.L.
Supervisor, Reservoir Engineering
Oil and Gas Commission

DATED AT the City of Victoria, in the Province of British Columbia, this 12th day of December, 2016.



ORDER 01-02-012 Amendment #1

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Advisory Guidance for Order 01-02-012 Amendment #1

- I. A production packer must be set above the injection interval and the space between the tubing and casing filled with corrosion and frost inhibiting fluids, as per section 16(2) of the Drilling and Production Regulation.
- II. Annual packer isolation tests are required to be submitted, as per section 16(3) of the Drilling and Production Regulation.
- III. Injected fluids must be metered and the injection pressure measured at the wellhead, as per section 74 of the Drilling and Production Regulation.
- IV. A monthly disposal statement must be submitted to the Commission not later than the 25th day of the month following the reported month, as per section 75 of the Drilling and Production Regulation.
- V. Seismic events must be reported and disposal operations suspended as per section 21.1 of the Drilling and Production Regulation.

Appendix A – Groundwater Monitoring Requirements**PENN WEST Thetlaandoa c-24-L/94-P-06 (WA 13463) Produced Water Disposal**

1. One groundwater monitoring well shall be installed by March 31, 2017 (unless otherwise authorized by the Commission) within 50 m of the disposal well. The monitoring well shall be installed to a depth within the saturated groundwater zone, below the water table, to enable the collection of representative samples of groundwater from the well.
2. During drilling of the monitoring well, geological conditions shall be logged.
3. A minimum of one representative “reference” groundwater sample shall be collected from the monitoring well following installation and appropriate development/purging – timeline to be discussed with the Commission by April 18, 2017.
4. The sample shall be submitted for laboratory analysis for analytical parameters including: pH, hardness, total dissolved solids, electrical conductivity, color, turbidity, alkalinity, and cations and anions, total and dissolved metals; dissolved hydrocarbons including dissolved gases (C1-C3), benzene, ethylbenzene, toluene, and xylenes (BETX), volatile petroleum hydrocarbons (VPHw) and volatile hydrocarbons (VHw), and light and heavy extractable hydrocarbons (LEPHw/HEPHw).
5. The static water level shall be measured following development/purging and prior to sampling.
6. A reference groundwater monitoring report shall be submitted to the Commission within 90 days of the reference groundwater sample collection from step 3. The report, pdf format, shall include: a graphical monitoring well log showing construction details and geological conditions, a site plan showing the location of the monitoring well relative to the disposal well and any other site facilities, documentation of the UTM coordinates of the monitoring well (NAD1983) and monitoring well elevation, descriptions of the procedures used in drilling and installing the monitoring well and for sampling, record of the measured static water level in the well, tabulated analytical results, and the laboratory analytical report.
7. Long term monitoring shall involve the collection and analysis of a representative groundwater sample on an annual basis, commencing one year after the collection of the reference groundwater sample. The analytical results shall be submitted to the Commission annually within 60 days of sample collection by eSubmission, if available, or by Email to Hydrogeology@bcogc.ca. Long term groundwater monitoring shall be implemented over the period extending from the date of reference groundwater sampling until one year after ceasing disposal and until authorized by the Commission.
8. Monitoring well installation and groundwater sampling procedures for this program shall be consistent with standard practices for environmental investigations such as those outlined in the British Columbia Field Sampling Manual (2013) http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/field_sample_man2013.pdf
9. At any time during this program, the Commission may require re-sampling to confirm a result or further investigation.