Appendix B
Historical Project Development

Appendix B – Historical Project Development

B-1 Regulatory Instruments

Norman Wells Operations (NWO) has been in operation since the 1920s and underwent a major expansion in the early 1980s. Below is a brief history of the approvals issued for the NWO since 1980 under the *Canada Oil and Gas Drilling and Production Regulations* (COGDPR, 2009) (formally the *Canada Oil and Gas Production Regulations*) and the *Mackenzie Valley Resource Management Act* (MVRMA, 1998).

B-1.1 Development Plan Approval (COGOA S 5.1)

On October 27, 1980, Imperial received a tentative Development Plan Approval (DIAND-#1-80) under Section 6 of the COGPDR (September 1980 draft) from Indigenous and Northern Affairs Canada (now Crown-Indigenous Relations and Northern Affairs Canada; CIRNAC) (Attachment B-1). On September 15, 1992, approval was granted by the Minister of Indian Affairs and Northern Development to amend the Norman Wells Development Plan to incorporate an enhanced oil recovery pilot project to inject propane into the H-31X well (Attachment B-2).

B-1.2 Production Operations Approvals

On October 18, 1983, the Canada Oil and Gas Lands Administration issued an interim Production Operations Approval which applied to the mainland and natural island portion of the Norman Wells expansion project to permit the start-up of the processing facilities (Attachment B-3).

On February 27, 1985, Imperial received Conditional Production Operations Approval, which was superseded by the final Production Operations Approval on May 10, 1985 (Attachment B-4).

B-2 Historical Project Development

The following sections provide a summary of the historical development of Imperial's NWO.

B-2.1 Early Development of the Reservoir

Imperial has been conducting operations at Norman Wells since 1920 when the first well on the banks of the Mackenzie River east of the Bosworth Creek delta was drilled. This discovery well

was drilled to test a series of oil seams previously observed on the banks and shoreline of the Mackenzie River (Link, 1919). A producing horizon was found at a depth of approximately 150 metres (m).

More extensive drilling in the 1920s and 1930s led to the discovery of the main reservoir, a carbonate reef at a depth of approximately 400 m (Kee Scarp Formation) (Imperial Oil Resources NWT Limited, 2014). The stratigraphy of the Kee Scarp Formation is structurally tilted isolated carbonate buildup. The reservoir is predominantly recrystallized limestone. The depth from the top reef varies from approximately 320 metres below ground surface (mbgs) (mainland portion of the reservoir) to approximately 625 mbgs (reservoir depth on the far side of Goose Island) with an average thickness of approximately 100 m, an average porosity 8%, an oil gravity 38.5 American Petroleum Institute (API) standards, and reservoir temperature of approximately 25 degrees Celsius.

In 1921, Imperial installed enough equipment at Norman Wells to refine the crude oil into fuel suitable for use by the Mackenzie River outposts and fishing boats. This operation proved to be uneconomic and was shutdown in 1925. Seven years later, to provide fuel for the goldmines that were developing in the Territories, Imperial built an 80 m^3 per day refinery. In 1939, as northern mining continued to develop this was replaced with a prefabricated 133 m^3 per day refinery. At that time, the NWO consisted of four wells on the mainland and one well on Bear Island (Esso Resources Canada Limited, 1980).

In 1942, the Canol Project was initiated to provide fuel to American armed forces in Alaska during the second World War. The Alaska Highway was being built and petroleum supply was a strategic concern. The United States Army Corp of Engineers constructed a 2600 km long, 10 cm diameter crude-oil pipeline from Norman Wells to Whitehorse, Yukon, the NWO field was expanded to sixty-two wells (fifty-six production wells) as part of this project. The Canol Project had a brief operating period but was discontinued shortly after construction due to the end of the war (Esso Resources Canada Limited, 1980).

Other major infrastructure constructed around this time included Batteries #1 and #3 (both located on the mainland), and the Bear Island Battery. Battery #1 was operational from around 1950 to 1983; Battery #3 was operational from around 1940 to 1990; and the Bear Island Battery was operational from around 1950 to 1983 (Imperial Oil Resources N.W.T. Limited, 2014).

In 1969, the refinery was expanded to 500 m^3 per day. Prior to the Norman Wells Oilfield Expansion (Section B-2.2) there were approximately 50 production wells and 12 injection wells distributed on the mainland, Bear Island and Goose Island. Crude oil produced on Bear and

Goose Islands was transported to the mainland by barge in the summer and via a temporary pipeline laid over the ice in the winter. Production was discontinued on the islands during river ice breakup and freezing periods as the island had no storage facilities (Esso Resources Canada Limited, 1980). Prior to Norman Wells Pipeline Project (see Section B-2.3), refinery products were barged via the Mackenzie River to traditional markets in the upper Mackenzie Valley region and north to Western Arctic coastal settlements (Esso Resources Canada Limited, 1980).

B-2.2 Norman Wells Oilfield Expansion

In 1979, Esso Resources Canada Limited initiated discussions with regulatory agencies and local communities about a proposed major expansion of its Norman Wells Operations which would increase production to 4000 m^3 per day on an annual averaged basis (Esso Resources Canada Limited, 1980). The expansion project description included six artificial islands constructed in the Mackenzie River, 178 new wells (developed in clusters) for production and water injection, flowlines and gathering lines from well clusters and a Central Processing Facility (CPF) on the mainland with equipment for separation of the inflowing reservoir fluid stream, produced water disposal, gas processing and compression, fresh water injection and electrical power generation (Esso Resources Canada Limited, 1980).

Following approvals associated with the regulatory applications filed in 1980, site preparation and mobilization began in 1982. Most of the construction occurred during 1983 with completion in 1985 when operations commenced.

B-2.3 Norman Wells Pipeline Project

The Norman Wells Pipeline (Line 21) owned by Enbridge Pipelines (NW) Inc. was commissioned in 1985 to transport crude oil from Imperial's NWO to Zama in northern Alberta, where it connects with the Alberta oil pipeline network (CER, 2021).

B-2.4 NWO Development

Since the completion of the Norman Wells Oilfield Expansion described above, key developments related to well work, flowline work, installation of groundwater treatment systems, progressive reclamation work, and other operational improvements to the NWO are described in Section 1.8 of the main Application.

Key operational improvement projects at NWO that occurred from the late 1980s to July 2014 included:

- Re-grading the berm of the waterflood pond for increased pond capacity and control at the former refinery tank farm,
- Enhanced oil recovery using propane injection,
- Installation of three heat exchanges at compression,
- Construction of the Waste Heat Recovery Unit (see Appendix D),
- Construction of engineered biocells for treatment of soils (see Appendix D), and
- Construction of the F-31X Treatment and Injection Facility (see Appendix D).

Three groundwater remediation systems were constructed in 2003 and have been operating annually since (refer to Appendix D). Progressive reclamation work at NWO is discussed in Section 12.0 of the main Application document.

Following the NWO oilfield expansion in the 1980s, there was a pause in drilling until 1995 and then approximately 30 more wells were drilled between 1995 and 2001. Since 2001, only five wells have been drilled, the last in 2009; see Appendix M for the NWO Well List.

References

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Exemption List Regulations, SOR/99-13. (n.d.). *last amended April 4, 2014*.

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Link, T. A. (1919). *Lower Mackenzie River Basin.* Northwest Territories: Report for Inperial Oil Limited.

MVRMA. (1998). Mackenzie Valley Resource Management Act, S.C. 1998, c. 25. *last amended August 28, 2019*.

Attachment B-1 *Tentative Development Plan Approval (Oct 27, 1980)*

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RESOURCE MANAGEMENT BRANCH
ENERGY, MINES AND RESOURCES
To Mr. Baber
Jun 2 1981
FILE #
REPLY SENT

Mr. M.C. Arnett, P. Eng.,
Norman Wells Project Manager,
Esso Resources Canada Limited,
500 Sixth Avenue S.W.,
Calgary, Alberta.
T2P 0S1

Dear Mr. Arnett:

Development Plan Approval, DIAND-#1-80 - Norman Wells Field Expansion

We refer to your submission relevant to the subject item as annexed (A) and to discussions between program officials of this Department with project officers of Esso Resources, principally in our offices on 80-07-15, as well as to other written and oral communications between our offices during recent months.

This letter shall constitute tentative approval under Section 6 of the Canada Oil and Gas Production Regulations (September, 1980 draft) annexed (B) (to be issued pursuant to the Oil and Gas Production and Conservation Act). The terms and conditions of the Development Plan Approval are subject to review and modification if there are significant implications in relevant government reports yet to be completed including, among others, the Environmental Assessment Review Panel report. Also, the approval is conditional upon possible Government granting of a Certificate of Public Convenience and Necessity in respect of the proposed Norman Wells - Zama pipeline.

Drilling Program Approval, as required by Part I of the Canada Oil and Gas Drilling Regulations, will be issued separately. Your application for Approval to Construct, in respect of the proposed gathering system, will be reviewed upon receipt of design specifications for the gathering system.

Your application for Development Plan Approval, limited as noted above, is approved subject to the following conditions:

...2

RF 6993

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Reservoir Description

1. Oriented cores, which are representative of the reservoir, shall be obtained from at least 10% of the total number of development wells.

2. The Operator shall, prior to the commencement of crude oil delivery to the Norman Wells - Zama pipeline, conduct selective production tests on the K1 and K2 zones in at least two wells, one to be located on Bear Island and one to be located on Artificial Island #3.

3. The Operator shall carry out extensive micro-facies studies on all cores to improve reservoir description and shall submit to the Chief Conservation Officer, within six (6) months after the commencement of crude oil delivery to the Norman Wells - Zama pipeline, a comprehensive report on those studies and net porosity-metre and permeability-metre maps for each of the K1, K2, K3 and K4 zones based, in part, on log and core data obtained from the development wells.

Conservation

4. No crude oil shall be delivered to the Norman Wells - Zama pipeline until the portion of the water injection system directly offsetting the wells producing that crude is fully operational. An injection well shall be deemed to be fully operational when cumulative water injection into the well exceeds the product of (i) the daily injection rate at a wellhead injection pressure of 4000 KPa and (ii) 30 days.

5. The Operator shall submit to the Chief, on a monthly basis, during the first year of operation of the Norman Wells - Zama pipeline, a summary of the water injection and reservoir withdrawal rates and cumulative volumes for each water injection pattern.

6. The average total field crude oil production rate (the assigned rate) shall be limited to 4000 m^3/day during any calendar month in which over 2% of the natural gas produced, determined on a volumetric basis, is not conserved.

7. The Operator shall submit to the Chief, on a monthly basis, during the period in which more than 2% of the natural gas produced is not conserved, a summary of the individual well test rates and actual production from each well to demonstrate that, to the extent practicable, the field is being produced to minimize the total amount of natural gas produced.

8. Raw (unprocessed) natural gas may be flared only during emergency situations and the duration of such flaring shall not exceed 48 hours unless otherwise approved in writing by the Chief Conservation Officer.

...3

9. The quantity of (processed) natural gas flared shall not exceed 300 x 10^3 m^3 per day.

10. The cumulative amount of (processed) natural gas flared over the 5-year period commencing on the date of initial oil delivery to the Norman Wells - Zama pipeline shall not exceed 300 x 10^6 m^3.

11. No liquid hydrocarbons shall be flared except during emergency situations and the duration of such flaring shall not exceed 24 hours unless otherwise approved in writing by the Chief.

Reservoir Performance Monitoring

12. In addition to the requirements of Section 159 of the Production Regulations, the Operator shall submit a comprehensive evaluation of the reservoir performance of the Mainland Waterflood for the period January 1, 1980 to June 30, 1983 to the Chief at least 60 days prior to the date of initial oil delivery to the Norman Wells - Zama pipeline. This report shall discuss the implications of the Mainland Waterflood performance to the Norman Wells Field Development Plan.

13. Reservoir pressures shall be measured on a representative number of wells, as approved by the Chief, prior to the date of initial water injection into any well located on any of the proposed artificial islands, Bear Island or Goose Island and again prior to the date of initial crude oil delivery to the Norman Wells - Zama pipeline.

Artificial Islands

14. The design of the artificial islands shall be modified from that shown in Figure 2.4 of the "Norman Wells Development Plan" dated 80-02-28 by including two mounds of rock, 1.5 metres or more high, on the upstream end of the ice storage berm, sufficient to minimize the possibility of ice riding up onto the island surface.

15. The Operator shall submit the final design, specifications and construction timetable for each of the six (6) artificial islands, for approval in writing, to the Chief at least forty-five (45) days prior to commencement of island construction.

16. The Operator shall submit for approval a program to monitor and record the condition of the island and the physical environmental conditions in the vicinity of the islands, in writing, to the Chief at least forty-five (45) days prior to commencement of island construction. The program shall contain provision for monitoring, as a minimum, the following:

    a) scouring of the channel bottom and erosion on the below and above water portions of the islands;

b) deposits and build-up of material near the islands;

c) current and water velocities near the islands;

d) ice cover formation, ice movement, pile-up, ice break-up, and ice scour of the river bed.

17. Final as-built drawings and specifications of each island shall be submitted to the Chief within ninety (90) days of completion of each island. Differences between island design and constructed island and the potential effect of these differences on the safety of operations to be conducted on the island shall be fully documented and explained.

18. A supplement to the Annual Production Report (Section 159 of the Regulations) shall include:

a) a summary comparison of design and actual physical environmental conditions based in part upon the monitoring program referenced in Condition 16;

b) a summary of remedial action taken to correct any movement or settlement of any part of the islands affecting their stability;

c) a summary of routine maintenance conducted on the islands;

d) an outline of a continuing maintenance program required as a result of degradation of island stability.

Well Completions

19. Each wellhead cellar shall be designed to provide for the drilling of one (1) well in addition to those "future production and injection wells" shown on Map #F20,260-8 titled "Mid K2 Target Location, July, 1980".

20. No well located on an artificial island shall be completed in the Kee Scarp formation until it has been demonstrated to the satisfaction of the Chief that the integrity of the wells on the island will be maintained during spring break-up. The Chief will not be assured of the integrity of the wells until at least one (1) island has satisfactorily survived a spring break-up.

Production Facilities

21. The Operator shall make application for a Production Facilities Construction Approval in accordance with Section 61 of the Regulations prior to contractual commitment to purchase equipment and/or prior to calling of tenders.

22. Applicable design standards for production facilities shall include those generally specified in the Regulations.

General

23. All operations shall be conducted in accordance with the Canada Oil and Gas Production Regulations (September, 1980 draft).

24. In accordance with Section 11 of the Regulations, the Operator shall submit an application to the Chief for an amendment to the Development Plan Approval when significant changes are proposed in the nature or timing of development activities.

Yours sincerely,

H.W. Woodward,
(Chief Conservation Officer)
Director,
Northern Non-Renewable Resources
Branch.

FELDMAN/cr

Attachment B-2 *Approval to Amend Development Plan (Sept 15, 1992)*

TWZ
- need to put names to be responsible for terms & conditions
D.P.

Minister of Indian Affairs and Northern Development

Ministre des Affaires indiennes et du Nord canadien

CANADA

SEP 15 1992

CONTROL COPY

Mr. Peter Singbeil
Norman Wells Division Technical
Imperial Oil Resources Limited
Esso Plaza West
237 - 4 Avenue S.W.
Box 2480, Station M
Calgary, Alberta
T2P 3M9

Dear Mr. Singbeil:

This is in response to your letter of May 25, 1992, requesting approval to amend the Norman Wells Development Plan to incorporate an enhanced oil recovery pilot project involving the injection of propane into the H-31 X well in the Norman Wells pool.

This letter shall constitute approval, under section 5.1 of the Oil and Gas Production and Conservation Act, for Imperial Oil Resources Limited to conduct this project. This approval is subject to the terms and conditions outlined in Appendix A.

Yours sincerely,

Tom Siddon, P.C., M.P.

Encl.

APPENDIX A

Terms and Conditions of Approval for the Propane Pilot Project in the Norman Wells Oil Pool

1. An initial report on the status of the pilot project shall be filed with the Engineering Branch of the National Energy Board six months after the start-up of the project. This can be part of the 1992 annual production report and review process.

2. Subsequent reports shall be on a yearly basis as was indicated in item 1 and can be part of the annual production reporting and review process on the Norman Wells field.

3. Reports submitted to the National Energy Board shall include:

   - production and injection data from the wells in pilot pattern;
   - a summary of results of densitometer readings on solution gas from each well as well as any tests on oil composition;
   - an analysis of the interim results, if any, from the project incremental oil production and any source of extra propane; and
   - a summary of tests, surveys and alterations in respect of well performance and production equipment for the project.

4. In addition to the above, the National Energy Board shall retain the right to request at any time an interim report based on the pilot performance.

Attachment B-3 *Interim Production Operations Approval (Oct 18, 1983)*

D.L. Bonin

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Mr. M.C. Arnett
Norman Wells Project Director
Esso Resources Canada Limited
237-4th Avenue Southwest
Calgary, Alberta
T2P 0H6

Dear Mr. Arnett:

Certificate of Fitness and Production Operations Approval

Reference the telephone conversation of Terry Baker (COGLA) and Brian Douey (ERCL) concerning the material which is required for a Certificate of Fitness and a Production Operations Approval. Attached please find a copy of the draft Canada Oil and Gas Structures Regulations, the requirements for these approvals are outlined in Sections 2.7, 2.9 (5) and 2.9 (6).

Since the Norman Wells Expansion Project is unique in that Esso Resources Canada Limited has had considerable production operating experience, we are prepared to issue an interim Certificate of Fitness and Production Operations Approval. These interim approvals will apply to the mainland and natural island portion of this project and therefore will permit start-up of the processing facilities.

For the artificial island part of this project please contact Ray Smith (993-3760) concerning the material required for a Certificate of Fitness and the Production Operations Approval.

.../2

62004 RF

NEB

Once all of the relevant information has been received and found to be acceptable to us, we will then be in a position to finalize these approvals.

Yours sincerely,

L.V. Brandon
Director-General
Engineering Branch

cc: Al Lepine
ERCL

T. Baker/R. Smith
COGLA

Attach.

Attachment B-4 *Final Production Operations Approval (Feb 27, 1985)*

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et du gaz des terres du Canada

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Ottawa (Ontario)
K1A 0E4

Canada Oil and Gas
Lands Administration

355 River Road
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K1A 0E4

COGLA records

PA

May 10, 1985

9251-2-0-J1
971-240

Mr. G.L. Haight
Vice President and General Manager
Esso Resources Canada Limited
Production Department
Esso Plaza
237 Fourth Avenue S.W.
Calgary, Alberta
T2P 0H6

Dear Mr. Haight:

Norman Wells Expansion Project
Production Operations Approvals

In response to Esso Resources Canada Limited's request, this letter shall constitute Production Operations Approval for the Norman Wells Expansion Project and shall supercede the Conditional Production Operations Approval given to Esso Resources Canada Limited on February 27, 1985. The Approval is subject to the following conditions:

- Esso Resources Canada Limited having a valid Certificate of Fitness for the production structures and production facilities.

- Esso Resources Canada Limited complying with the contingency plans and the operating manuals as filed with COGLA and promptly providing COGLA with information on any revisions that may occur.

We wish you every success on the expanded production of the Norman Wells field.

Yours sincerely,

M.E. Taschereau
Administrator

Énergie, Mines et Ressources Canada
Energy, Mines and Resources Canada

Affaires indiennes et du Nord Canada
Indian and Northern Affairs Canada

Canada