

May 28, 2010

Manitoba Science, Technology, Energy and Mines  
Petroleum Branch  
Suite 360, 1395 Ellice Avenue  
Winnipeg, Manitoba  
R3G 3P2

**Attention: Mr. Keith Lowdon**  
**Director, Petroleum**

Dear Mr. Lowdon:

**RE: Proposed Sinclair Unit No. 5**  
**Unitization and Waterflood Enhanced Oil Recovery (EOR) Application**

As per Section 71 of the Drilling and Production Regulation, Tundra Oil and Gas Partnership (Tundra) hereby makes application to form Sinclair Unit No. 5 and implement a Waterflood EOR operation. Enclosed are 2 hard copies of the application and supporting information. An electronic copy of the entire Application document is forthcoming under separate cover.

Tundra is proceeding concurrently with Mineral Owner and Unitization negotiations for the proposed Sinclair Unit No. 5. Tundra has targeted completion and submission of a finalized Unit Agreement by July 2010.

Tundra proposes to target Unitization and EOR Application approval by September 01, 2010. Tundra intends to drill, complete, and tie-in the proposed new water injection wells in Q3/Q4 2010. Start of water injection is targeted for December 01, 2010 following a survey of reservoir pressure, and Petroleum Branch Approval to commence waterflood operations.

If you have any questions or require further discussion, please contact William Jenkins at 403-513-1018 or Alex Solberg at 403-513-1009.

Yours truly,

**TUNDRA OIL AND GAS PARTNERSHIP**



*for* Alex Solberg, P. Eng  
Vice President, Exploitation and Reservoir Engineering

enclosure

**Proposed Unitization of Sinclair Unit No. 5**  
**Application for Enhanced Oil Recovery Waterflood Project**  
**Sinclair Unit No. 5**

**Middle Bakken and Three Forks Formations**

**Bakken – Three Forks Pool (01 62B)**

**Daly Sinclair Field, Manitoba**

**May 28, 2010**

**Tundra Oil and Gas Partnership**

# **Proposed Sinclair Unit No. 5**

## **Application for Enhanced Oil Recovery Waterflood Project**

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## **SUBJECT**

**Middle Bakken / Three Forks Formations**

**Bakken – Three Forks Pool (01 62B)**

**Daly Sinclair Field, Manitoba**

**Proposed Unitization of Sinclair Unit No. 5**

**Application for Enhanced Oil Recovery Waterflood Project  
Sinclair Unit No. 5**

## **INTRODUCTION**

The Sinclair portion of the Daly Sinclair Oil Field is located in Ranges 28 and 29 W1 in both Townships 7 and 8. Since discovery in 2004, the main oilfield area was developed with vertical wells at 40 acre spacing on Primary Production. Since early 2009, a significant portion of the main oilfield has been Unitized and placed on Secondary Waterflood (WF) Enhanced Oil Recovery (EOR) Production, mainly from the Lyleton A & B members of the Three Forks Formation. Tundra Oil and Gas (Tundra) currently operates and continues to develop Sinclair Units 1, 2, and 3 as shown on Figure 1.

Horizontal producing wells have also been recently constructed in the eastern part of the Sinclair field within the same Three Forks and Middle Bakken formations. Within this area, potential exists for incremental production and reserves from a Waterflood EOR project in the Three Forks and Middle Bakken oil reservoirs. The following represents an application by Tundra to establish Sinclair Unit No. 5 and implement a Secondary Waterflood EOR scheme within the Three Forks and Middle Bakken formations as shown on Figure 2.

The proposed project area falls within the existing designated 01-62B Bakken - Three Forks pool of the Daly Sinclair Oilfield (Figure 3).

## **CONCLUSIONS**

1. The proposed Sinclair Unit No. 5 will include 6 producing wells within one section of the Middle Bakken / Three Forks producing reservoir. The project is located east of the existing Sinclair Unit No. 3 in section 06-008-28 W1 (Figure 2).
2. Total Net Original Oil in Place (OOIP) in the project area has been calculated to be 1,975,300 Barrels (bbls) for an average of ~ 123,500 gross bbls OOIP per 40 acre LSD.
3. Cumulative production to end April 2010 from the 6 wells within the proposed Sinclair Unit No. 5 project area was 213,000 bbls of oil, and 91,400 bbls of water, representing a 10.8 % Recovery Factor (RF) of the Net OOIP.
4. Estimated Ultimate Recovery (EUR) of Primary Proved Producing oil reserves in the proposed Unit 5 project area has been calculated to be 370,500 bbls, with 157,500 bbls remaining as of the end of April 2010.
5. Ultimate oil recovery of the proposed Unit 5 OOIP, under the current Primary Production method, is forecasted to be 18.8 %.
6. Production from the proposed area peaked in January 2009 at 480 bbls of oil per day (OPD) when the last well was placed on production. As of February 2010, production was 240 bbls OPD, and 92 bbls water per day (WPD), at a relatively stable 28 % watercut (Figure 4).
7. In January 2009, production averaged 80 bbls OPD per well (from the 2 vertical and 4 horizontal wells). As of February 2010, average per well production has declined to 40 bbls OPD. Decline analysis of the group primary production data forecasts total oil to continue declining at an initial annual rate of approx. 43 % in the project area.
8. Although no recent Middle Bakken reservoir pressure surveys are available in the project area, production declines indicate potential significant reservoir pressure depletion.
9. Based on waterflood response in the adjacent main portion of the Sinclair field, the Three Forks and Middle Bakken Formations in the project area are believed to be suitable reservoirs for WF EOR operations.
10. Estimated Ultimate Recovery (EUR) of proved oil reserves under Secondary WF EOR for the proposed Unit 5 has been calculated to be 533,300 bbls, with 320,300 bbls remaining. An incremental 162,800 bbls of proved oil reserves, or 8.2%, are forecasted to be recovered under the proposed Unitization and Secondary EOR production vs the existing Primary Production method.
11. Horizontal injectors, with multi-stage hydraulic fractures, will be constructed between existing vertical and horizontal producing wells, within the proposed Unit 5, to complete waterflood patterns with effective 20 acre spacing similar to that of Sinclair Unit No.1 (Figure 5).

## **DISCUSSION**

### **RESOURCE POTENTIAL IN PROPOSED SINCLAIR UNIT 5**

The proposed Sinclair Unit No. 5 project area is located entirely within Section 6, Township 8, Range 28 W1 of the Daly Sinclair oil field. The proposed Unit 5 currently consists of 2 existing producing vertical wells and 4 existing producing horizontal wells (Figure 2). A project area well list complete with recent production statistics is attached as Table 1.

Tundra believes that the waterflood response in the adjacent main portion of the Sinclair field demonstrates potential for incremental production and reserves from a WF EOR project in the subject Middle Bakken and/or Three Forks oil reservoirs.

### **Geology**

A structural cross-section through the subject project area producing interval is attached as Appendix 1. The producing intervals in Unit 5 in descending order are the Middle Bakken formation, the Lyleton A (Upper and Lower) and Lyleton B members of the Three Forks formation. The line of section passes through Unit 5 in an east-west direction at about the midpoint of the proposed Unit. The Lyleton B reservoir underlies the Red Shale Marker and is present throughout the proposed Unit 5. The cross section provides evidence that there is reservoir continuity between the wells over the proposed Unit 5 area. This is an essential requirement to facilitate successful waterflood operations.

Structure maps provided for the project area are for the top of Middle Bakken, the top of the Upper Bakken, and the top of the Lyleton B member of the Three Forks formation. These are attached as Appendices 2, 3 and 4 respectively. An isopach map of the Red Shale marker which lies between the Lyleton A and B reservoir is provided as Appendix 5. A similar isopach map of the Lyleton A reservoir is attached as Appendix 6.

Porosity ( $\Phi$ -h in por\*m) and Permeability (k-h in mD\*m) maps for the Lyleton A are included as Appendices 7 and 8. Lyleton B member of the Three Forks formation Porosity ( $\Phi$ -h in por\*m) and Permeability (k-h in mD\*m) maps for the project area are also included as Appendices 9 and 10.

### **OOIP Estimates**

Total volumetric OOIP for the Middle Bakken, Lyleton A, and Lyleton B members of the Three Forks formation, within the proposed Sinclair Unit No. 5 area, has been calculated at 1,975,300 bbls. Table 2 outlines the proposed Unit 5 volumetric OOIP estimates on an individual LSD basis by formation. Average OOIP by individual LSD was determined to be ~123,500 bbls. OOIP values were calculated with 1.0 millidarcy (mD) permeability and 12% porosity net pay cutoffs applied.

The OOIP values were determined independently by GLJ Petroleum Consultants of Calgary.

A listing of Middle Bakken / Three Forks formation rock and fluid properties used to characterize the reservoir are provided in Appendix 11.

## **Historical Production**

A historical group production history plot for the proposed Sinclair Unit No. 5 is shown as Figure 4. Oil production commenced from the proposed Unit area in March 2005 and peaked during January 2009 at 480 bbls of oil per day (OPD) when the last well was placed on production.

As of February 2010, production was 240 bbls OPD, and 92 bbls water per day (WPD), at a relatively stable 28 % watercut (Figure 4).

From peak production in January 2009 to date, oil production is declining at annual rate of approx. 43 % under the current Primary Production method as plotted to point A on Figure 6.

## **Proposed Unit 5 Reserves Recovery Profiles and Production Forecasts**

### **Primary Production (current)**

Cumulative production in the Sinclair Unit No. 5 project area, to end April 2010, was 213,000 bbls of oil, and 91,400 bbls of water for a recovery factor of 10.8 % of the calculated OOIP.

Ultimate Proved Producing oil reserves recovery for Unit 5 has been estimated to be 370,500 bbls, or an 18.8% Recovery Factor (RF) of OOIP (Table 2.1).

Remaining Producing Primary Reserves to end April 2010 has been estimated to be 157,500 bbls. The expected production decline and forecasted cumulative oil recovery under continued Primary Production is shown at point A on Figure 7.

### **Secondary EOR Production (proposed)**

The forecasted project oil production profile under Secondary Waterflood over time is plotted to point C on Figure 6.

Total Proved EOR recoverable reserves in the proposed Unit 5 project under Secondary WF has been estimated at 533,300 bbls (Table 2.1), resulting in a 27 % RF of calculated OOIP. Remaining Secondary Total Proved Reserves as of end April 2010 has been estimated at 320,300 bbls. Overall total RF may approach 33% (Table 2.1) as shown to point I on Figure 7.

An incremental 162,800 bbls of oil reserves are forecasted to be recovered under the proposed Unitization and Secondary EOR production scheme vs. the existing Primary Production method. Incremental Secondary RF is forecasted to be 8.2 % of the calculated OOIP. Incremental reserves recovery per project producing well is forecasted to average 27,130 bbls.

The initial production decline rate is forecasted to be approx. 26 % (Table 2.2) after peak secondary production as shown to point C on Figure 7.

All reserves recovery estimates were generated independently by GLJ Petroleum Consultants.

## **Technical Studies**

The waterflood performance predictions for the proposed Unit 5 are based on recent geological and engineering studies.

Geological work included internal Tundra and Independent reviews of the available open-hole logs, core data, seismic, and completion information. These were used to develop a suite of geological maps and establish reservoir parameters to support the independent review and calculation of the proposed Unit 5 OOIP (Appendices 1 – 11).

A project area-specific Independent Geological and Engineering review was also conducted by GLJ Petroleum Consultants of Calgary and a discussion of the geological considerations and reserves estimates methodology is described within Appendix 12.

## **UNITIZATION and EOR DEVELOPMENT**

Unitization and implementation of a Waterflood EOR project is forecasted to increase overall recovery of OOIP from the proposed project area.

### **Unit Name**

Tundra proposes that the official name of the new Unit shall be Sinclair Unit No. 5.

### **Unit Operator**

Tundra Oil and Gas Partnership (Tundra) will be the Operator of record for Sinclair Unit No. 5.

### **Unitized Zone**

The unitized zone(s) to be waterflooded in the Sinclair Unit No. 5 will be the Middle Bakken and Three Forks formations.

### **Unit Wells**

The 6 wells to be included in the proposed Sinclair Unit No. 5 are outlined in Table 1.

### **Unit Lands**

The Sinclair Unit No. 5 will consist of 1 Section as follows:

Section 6 of Township 8, Range 28, W1M

Sinclair Unit No. 5 will consist of 16 LSD's. The lands included in the 40 acre tracts are outlined in Appendix 13.



## **Tract Factors**

The proposed Sinclair Unit No. 5 will consist of 16 Tracts, based on the 40 acre Legal Sub Divisions (LSD) within section 06-08-28 W1.

The Tract Factor contribution for each of the LSD's within the proposed Sinclair Unit No. 5 was calculated as follows:

- Gross OOIP by LSD, minus cumulative production to date for the LSD as distributed by the LSD specific Production Allocation (PA) % in the applicable producing horizontal or vertical well (to yield Remaining Gross OOIP)
- Tract Factor by LSD = the product of Remaining Gross OOIP by LSD as a % of total proposed Unit Remaining Gross OOIP

Tract Factor calculations for all individual LSD's based on the above methodology are outlined within Appendix 14.

## **Working Interest Owners**

Appendix 13 also outlines the working interest % (WI) for each recommended Tract within the proposed Sinclair Unit No. 5. Tundra Oil and Gas Partnership holds a 100 % WI ownership in all the proposed Tracts.

Tundra Oil and Gas Partnership will have a 100 % working interest in the proposed Sinclair Unit No. 5.

## **Waterflood EOR Development**

New horizontal injection wells will be constructed between the existing vertical and horizontal producing wells and will terminate within Section 6 (Figure 5). Tundra proposes to construct 3 new horizontal injection wells which will result in an effective 20 acre line drive waterflood pattern within Unit 5.

### **Estimated Fracture Pressure**

Completion data from the 6 existing producing wells within the project area indicate an actual fracture pressure gradient range of 18.5 to 22.0 kPa/m true vertical depth (TVD). Tundra expects the fracture gradient encountered during completion of the proposed horizontal injection well will be somewhat lower than these values due to expected reservoir pressure depletion.

## **Waterflood Operating Strategy**

### **Water Source and Injection Wells**

The injection water for the proposed Sinclair Unit 5 water will be supplied from the existing Sinclair Unit No. 1 source and injection water system. All Unit 1 injection water is obtained from the Lodgepole formation in the 102 / 16-32-7-29 W1 licensed water source well. Lodgepole water from the 102 / 16-32 source well is pumped to the main Unit 1 Water Plant at 3-4-8-29 W1, filtered, and pumped up to injection system pressure.

A diagram of the Sinclair water injection system and new pipeline connection to the proposed Sinclair Unit No 5 project area injection wells is shown as Figure 8.

Produced water is not currently used for any water injection in the Tundra operated Sinclair Units and there are no current plans to use produced water as a source supply for Unit 5 injection.

Since all producing Middle Bakken / Three Forks wells in the Daly Sinclair areas, whether vertical or horizontal, have been hydraulically fractured, produced waters from these wells are inherently a mixture of Three Forks and Bakken native sources. This mixture of produced waters has been extensively tested for compatibility with 102/16-32 source Lodgepole water, by a highly qualified third party, prior to implementation by Tundra in Sinclair Unit 1. All potential mixture ratios between the two waters, under a range of temperatures, have been simulated and evaluated for scaling and precipitate producing tendencies. Testing of multiple scale inhibitors has also been conducted and minimum inhibition concentration requirements for the source water volume determined. At present, continuous scale inhibitor application is maintained into the source water stream out of the Sinclair injection water facility. Review and monitoring of the source water scale inhibition system is also part of an existing routine maintenance program. Injection well rates vs. time plots are routinely monitored for evidence of any injection restriction due to scaling and Tundra sees no operational problems with the system design at this time.

New water injection wells for the proposed Sinclair Unit 5 will be drilled, cleaned out, and configured downhole for injection as shown in Figure 9. The horizontal injection wells will be stimulated by multiple hydraulic fracture treatments to obtain suitable injection rates. Tundra has extensive experience with horizontal fracturing in the area, and all jobs are rigorously programmed and monitored during execution. This helps ensure optimum placement of each fracture stage to prevent, or minimize, the potential for out-of-zone fracture growth and thereby limit the potential for future out-of-zone injection.

The new water injection well will be placed on injection after Application and Approval to inject. Wellhead injection pressures will be maintained below the least value of either:

1. the area specific known and calculated fracture gradient, or
2. the licensed surface injection Maximum Allowable Pressure (MOP)

Tundra has a thorough understanding of area fracture gradients. A management program will be utilized to set and routinely review injection target rates and pressures vs. surface MOP and the known area formation fracture pressures.

All new water injection wells will be surface equipped with injection volume metering and rate/pressure control (Figure 10). An operating procedure for monitoring water injection volumes and meter balancing will also be utilized to monitor the entire system measurement and integrity on a daily basis.

The proposed Unit 5 horizontal water injection well rates are forecasted to average 15 – 35 m<sup>3</sup> WPD based on expected reservoir conditions.

#### Reservoir Pressure

No recent or representative pressure surveys are currently available for the proposed Unit 5 project area. The extremely long shut in and build up times required to obtain any possible representative surveys from the producing wells have been economically prohibitive. Proposed Unit 5 project area current reservoir pressure has been estimated to range between 4000 – 7000 kPa.

For each proposed injection well, a measured and interpreted reservoir pressure will be obtained prior to water injection. Tundra expects useful reservoir pressure data can be obtained from an existing vertical well within the project area after WF start up. These pressures will be reported within Annual Progress Reports for Sinclair Unit No. 5 as per Section 73 of the Drilling and Production Regulation.

Tundra expects to inject water for a minimum 2 – 4 year period to re-pressurize the reservoir due to cumulative primary production voidage and pressure depletion. Initial monthly Voidage Replacement Ratio (VRR) is expected to be approximately 1.25 to 2.00 within the patterns during the fill up period. As the cumulative VRR approaches 1, target reservoir operating pressure for waterflood operations will be 75 – 90 % of original reservoir pressure.

#### Waterflood Surveillance and Optimization

Unit 5 EOR response and waterflood surveillance will consist of the following:

- Regular production well rate and WCT testing
- Daily water injection rate and pressure monitoring vs target
- Water injection rate / pressure / time vs cumulative injection plot
- Reservoir pressure surveys as required to establish pressure trends
- Pattern VRR
- Potential use of chemical tracers to track water injector / producer responses
- Use of some or all of: Water Oil Ratio (WOR) trends, Log WOR vs Cum Oil, Hydrocarbon Pore Volumes Injected, Conformance Plots

The above surveillance methods will provide an ever increasing understanding of reservoir performance, and provide data to continually control and optimize the Unit 5 waterflood operation. Controlling the waterflood operation will significantly reduce or eliminate the potential for out-of-zone injection, undesired channeling or water breakthrough, or out-of-Unit migration. The monitoring and surveillance will also provide early indicators of any such issues so that waterflood operations may be altered to maximize ultimate secondary reserves recovery from the proposed Unit 5.

#### Water Injection Facilities

The Sinclair Unit No. 5 waterflood operation will utilize the existing Tundra operated source well supply and water plant (WP) facilities located at 3-4-8-29 W1M. Low pressure water will be transferred from 3-4 water plant to a new proposed Water Injection Pump Station (IP) at 04-01-008-29W1M. The Pump Station will increase the downstream system pressure to wellhead injection requirements, and deliver the water to a new Unit 5 high pressure pipeline system and each injection well. The proposed new water injection system, subject to future detailed engineering, is outlined on Figure 8.

Tundra proposes to construct the Pump Station and major water injection distribution pipelines in Q2Q3 2010. Construction of in-field water pipelines for individual wells will coincide with the injector well drilling schedule.

A complete description of all planned system design and operational practices to prevent corrosion related failures is shown on Figure 11.

### **Wells to be Converted**

No existing producer wells within the proposed Unit 5 project are planned for conversion to water injection. Three injection wells are planned to be drilled for purpose as described in Waterflood Development.

### **Notification of Mineral and Surface Rights Owners**

Tundra is in the process of notifying all mineral rights and surface rights owners of the proposed EOR project and formation of Sinclair Unit No. 5. Copies of the Notices, and proof of service, to all surface rights owners will be forwarded to the Petroleum Branch, when available, to complete the Unit 5 Application.

Sinclair No. 5 Unitization, and execution of the formal Unit 5 Agreement by affected Mineral Owners, is expected during Q3/Q4 2010. Copies of same will be forwarded to the Petroleum Branch, when available, to complete the Unit 5 Application.

### **TUNDRA OIL & GAS PARTNERSHIP**

Calgary, AB