

# NEXEN KEG RIVER DISPOSAL WELLS

HISTORICAL PERFORMANCE, GEOLOGICAL  
INTERPRETATION AND LOCATION SELECTION



**WaterTech 2014**  
**April 10, 2014**  
**Banff, AB**



# FORWARD-LOOKING STATEMENT



Certain statements in this presentation constitute “forward-looking statements” or “forward-looking information”. All of the forward-looking statements in this presentation are qualified by the assumptions that are stated or inherent in such forward-looking statements. Although Nexen believes these assumptions are reasonable, the reader should not place an undue reliance on these assumptions and such forward-looking statements.

The forward-looking statements are subject to known and unknown risks and uncertainties and other factors that may cause actual results, levels of activity and achievements to differ materially from those expressed or implied by such statements. Except as required by law, Nexen undertakes no obligation to update publicly or revise any forward-looking statements, whether as a result of new information, future events or otherwise. The forward-looking statements contained herein are expressly qualified by this cautionary statement. Readers should also refer to the risk factors and uncertainties contained in our 2012 Annual Information Form and to the quantitative disclosures about market risk and our forward-looking statements contained in our 2012 Management Discussion and Analysis available at [www.nexeninc.com](http://www.nexeninc.com) or [www.sedar.com](http://www.sedar.com), or in CNOOC Limited’s Annual Report on Form 20-F, which is available at [www.cnooltd.com](http://www.cnooltd.com) or [www.sec.gov](http://www.sec.gov).

Any reserves estimates in this disclosure were prepared February 2013 with an effective date of December 31, 2012. The estimates of reserves and future net revenue have been prepared by an internal qualified reserves evaluator in accordance with National Instrument 51-101 Standards of Disclosure for Oil and Gas Activities (“NI 51-101”) and the Canadian Oil and Gas Evaluation Handbook (“COGE Handbook”). Nexen’s estimates of reserves are prepared in accordance with SEC requirements and are attached to our 2012 Annual Information Form.

All financial information contained within this presentation is in Canadian dollars unless noted otherwise.

Nexen Energy ULC is a wholly-owned subsidiary of CNOOC Limited, which is listed on the NYSE, the Stock Exchange of Hong Kong and the TSX. Information regarding CNOOC Limited is available at [www.cnooltd.com](http://www.cnooltd.com).

- Nexen is an upstream oil and gas company responsibly developing energy resources in some of the world's most significant basins:
  - UK North Sea
  - Offshore West Africa
  - United States
  - Western Canada
- We are a wholly-owned subsidiary of CNOOC Limited
- We're strategically focused on three businesses: conventional oil and gas, oil sands and shale gas/oil
- At Nexen, it's not just what we do that matters – it's how we get the job done. And the foundation of our growth strategy is the energy and expertise of our employees who are committed to working with integrity and engaging our stakeholders.

# ABOUT CNOOC LIMITED



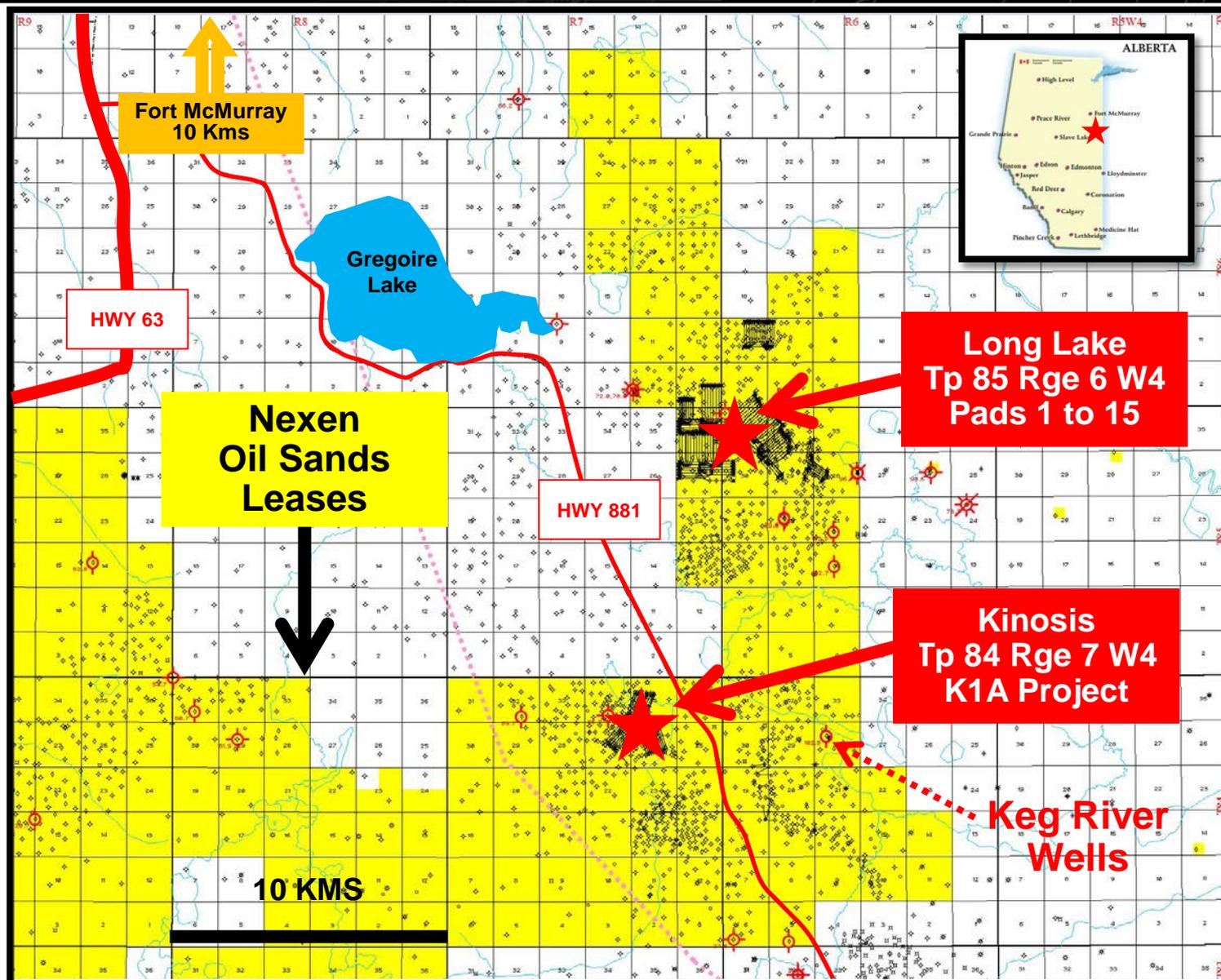
- One of the world's largest oil and gas companies, CNOOC Limited:
  - holds 3.49 billion barrels in net proved reserves (as of December 31, 2012)
  - average daily production in 2012 was 935,615 boe/d
  - invested US\$9.2 billion in capital in 2012
  - has about 10,000 employees
  - trades on the Hong Kong, New York and Toronto stock exchanges
- Headquartered in Beijing, China
- Operates in Asia, Africa, North & South America, Oceania & Europe
- Acquired Nexen in February 2013 for US\$15.1 billion
- CNOOC Limited established Calgary as an international headquarters; Nexen adds management of CNOOC Limited operations in North and Central America to our portfolio.

# OIL SANDS

## LONG LAKE SAGD AND UPGRADER OPERATIONS



# LONG LAKE/KINOSIS AREA

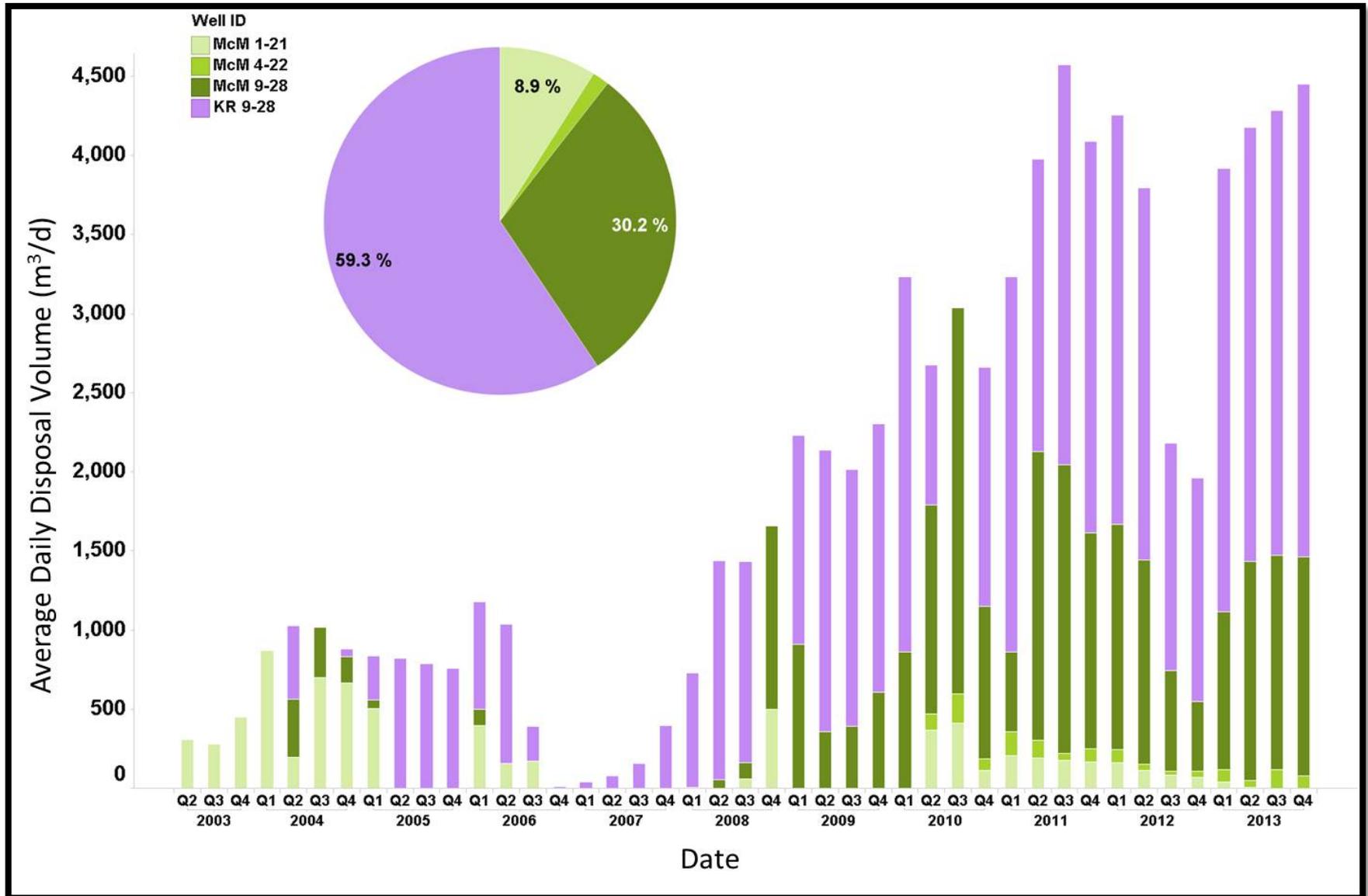


- In-situ oil sands extraction project 40 km south east of Fort McMurray
- Uses steam assisted gravity drainage and integrated upgrading on site
- OrCrude technology and hydrocracking/gasification used to produce Premium Synthetic Crude (PSC™)
- First production of bitumen in 2008, first PSC™ production in 2009



- **Most water is recycled but some cannot be recycled and has to be disposed of in a safe and economic manner.**
- **Middle Devonian Keg River dolomite is a preferred site over the McMurray Formation because of no interaction with hydrocarbon zones and potentially higher capacities.**
- **Understanding the reservoir is essential for a successful operation.**

# LONG LAKE WATER DISPOSAL



- **The Keg River is hydrocarbon free throughout the area**
- **The reservoir water is saline and unsuitable for other uses**
- **It is more than 50 kms to the outcrop on the Clearwater River**
- **The reservoir is regionally underpressured and takes fluid on vacuum.**
- **A regional caprock of limestone, shale and anhydrite provides excellent hydraulic isolation from shallow aquifers.**
- **Where properly located Keg River wells have excellent disposal characteristics**
- **Keg River wells are less prone to plugging than McMurray Formation wells.**

- **Second exploratory well found a great disposal well at Long Lake (103/09-28-085-06W4/0)**
- **After that Nexen drilled 13 more Keg River wells in 4 different leases with mostly poor results. Only 3 had economic disposal rates. Only 1 was capable of > 1000 m<sup>3</sup>/d**
- **Study of Keg River geology initiated in 2011**

# KEG RIVER GEOLOGY

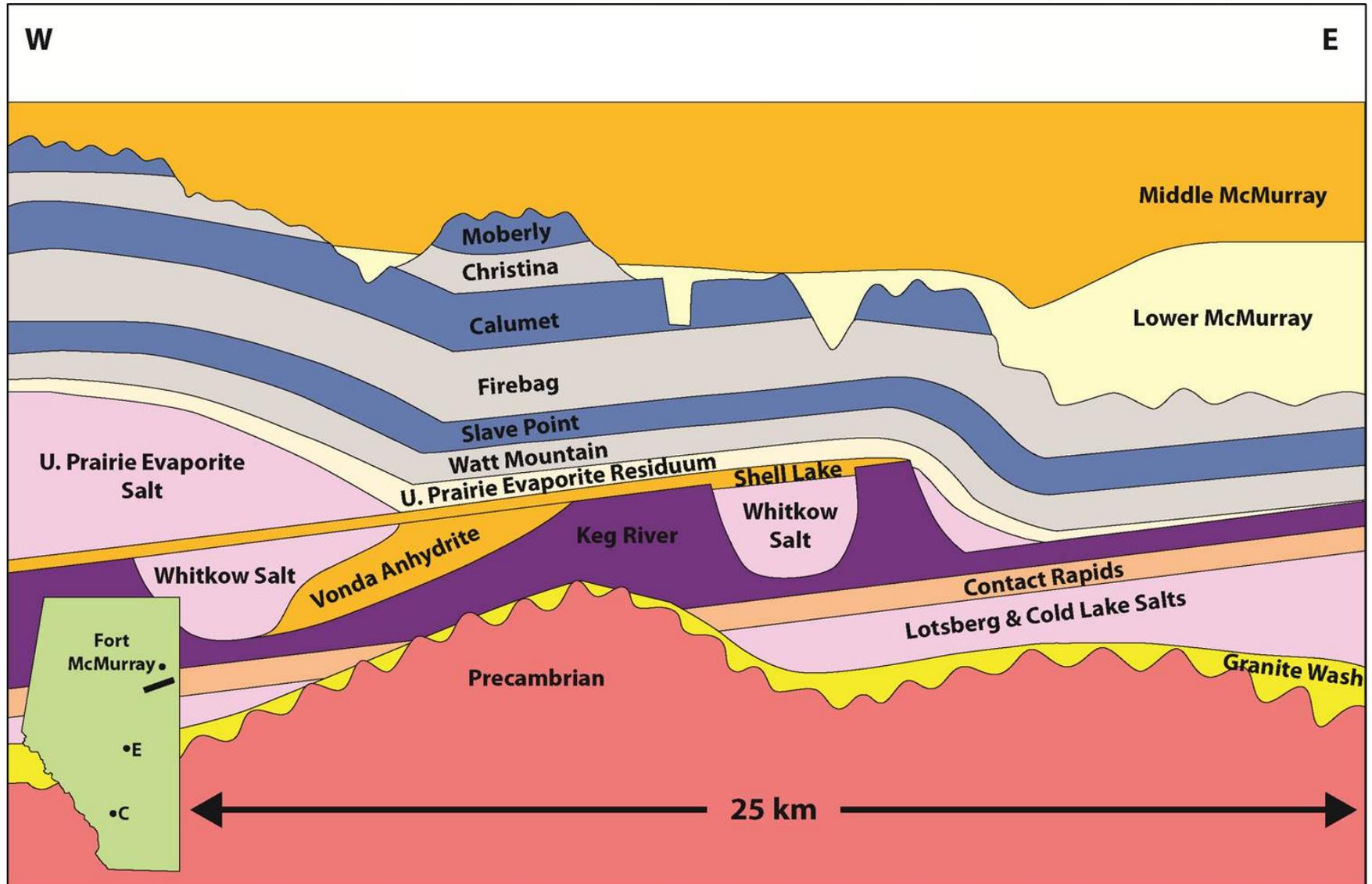


# STRATIGRAPHIC COLUMN

| Age            | Group           | Sub-Group | Formation         | Member             |
|----------------|-----------------|-----------|-------------------|--------------------|
| Cretaceous     |                 |           | McMurray          |                    |
| Devonian       | Beaverhill Lake |           | Waterways         | Moberly Member     |
|                |                 |           |                   | Christina Member   |
|                |                 |           |                   | Calumet Member     |
|                |                 |           |                   | Firebag Member     |
|                |                 |           | Slave Point       |                    |
|                |                 |           | Fort Vermillion   |                    |
|                | Elk Point       | Upper     | Watt Mountain     |                    |
|                |                 |           | Dawson Bay        |                    |
|                |                 |           | Prairie Evaporite | Upper Salt Member  |
|                |                 |           |                   | White Bear Marker  |
|                |                 |           |                   | Middle Salt Member |
|                |                 |           |                   | Shell Lake Member  |
|                |                 |           |                   | Whitkow Member     |
|                |                 |           |                   | Vonda Member       |
|                |                 |           | Keg River         |                    |
|                |                 |           | Lower             | Contact Rapids     |
| Cold Lake      |                 |           |                   |                    |
| Ernestina Lake |                 |           |                   |                    |
| Lotsberg       |                 |           |                   |                    |
| Granite Wash   |                 |           |                   |                    |
| Precambrian    |                 |           | Precambrian       |                    |

-  Minor Disposal Capacity
-  Major Disposal Capacity
-  Possible Disposal Capacity

# GENERALIZED DEVONIAN STRATIGRAPHY



# REGIONAL KEG RIVER GEOLOGY

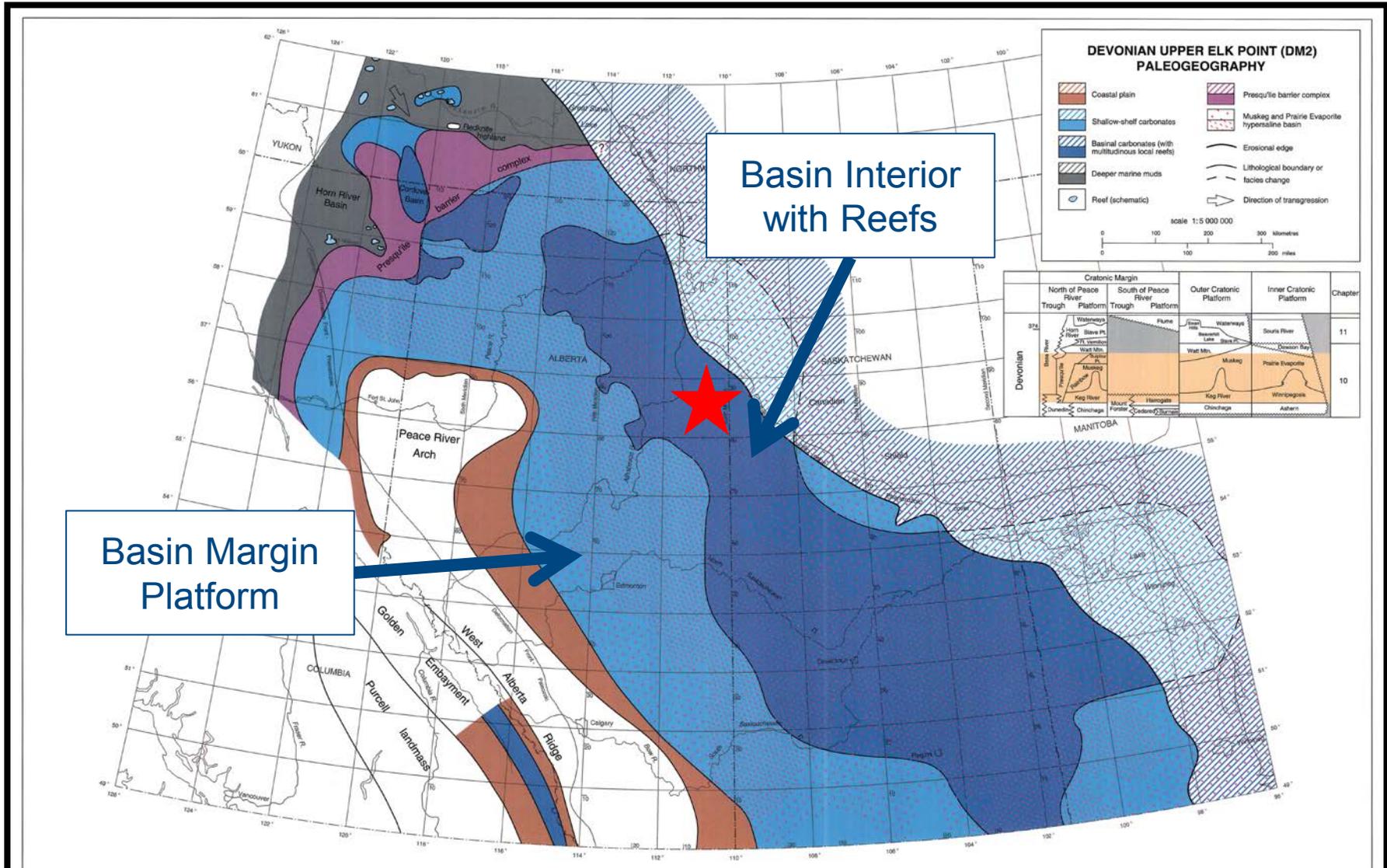
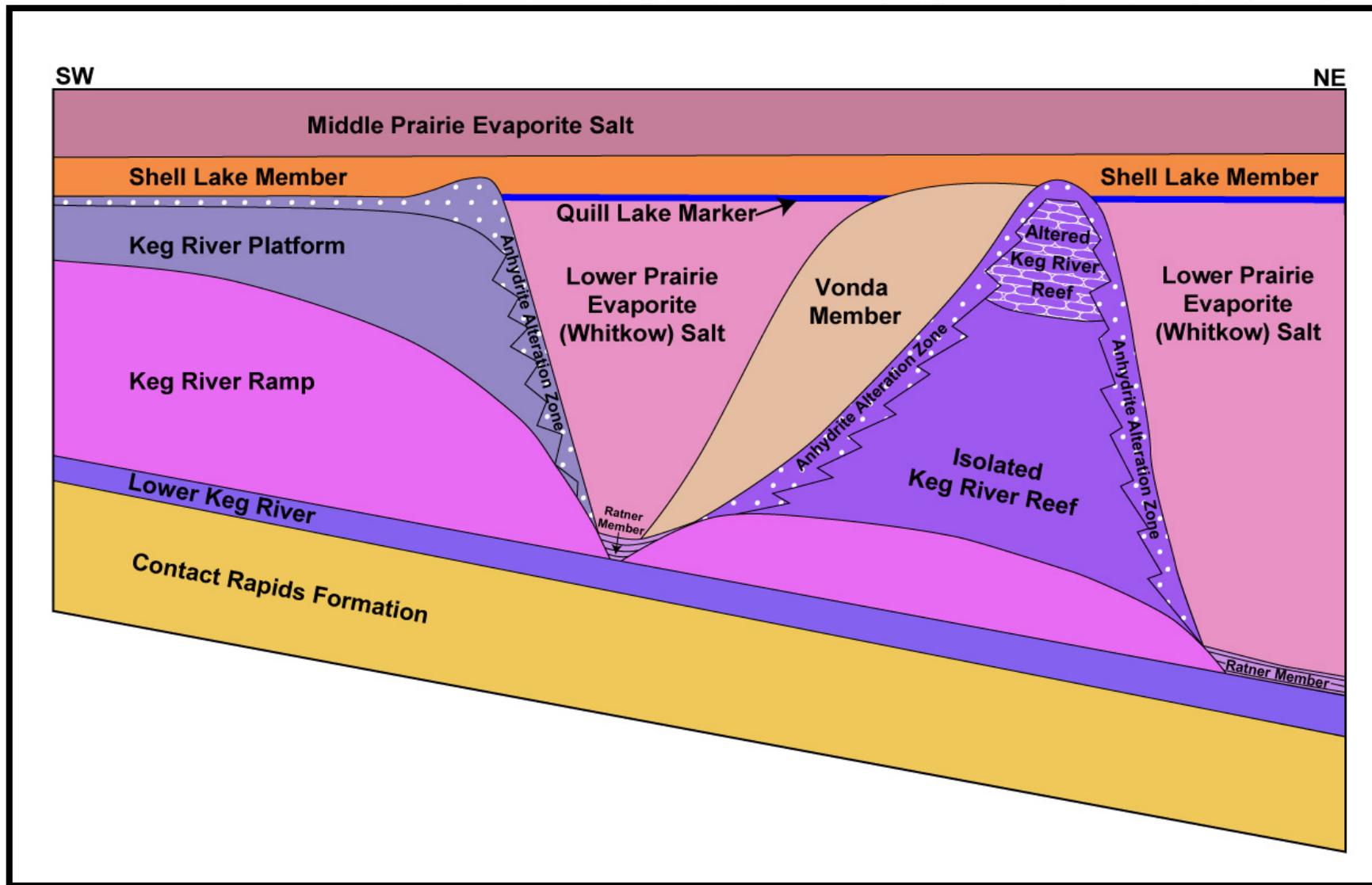
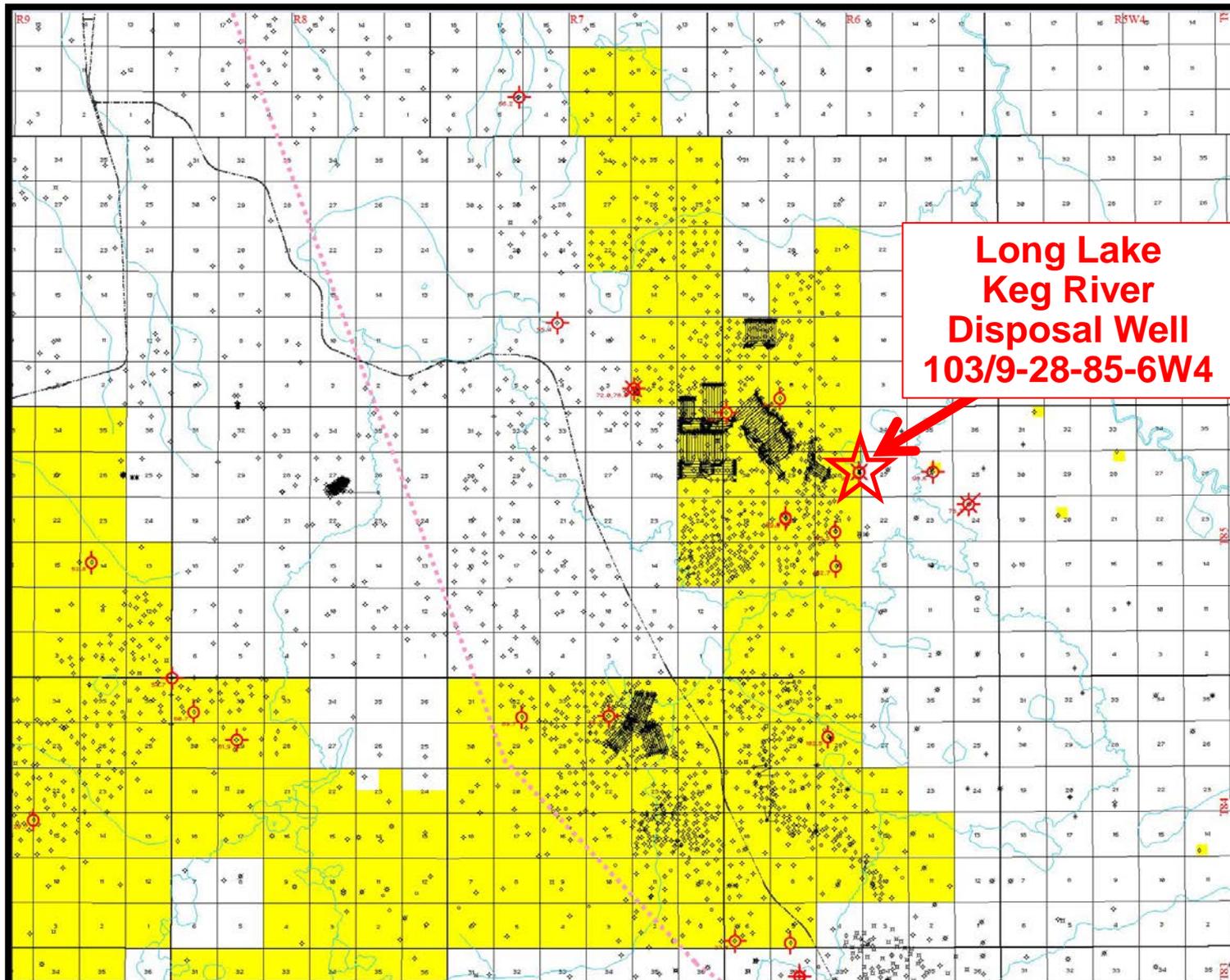


Figure 7.7 Paleogeography of the cratonic platform and margin during subinterval DM2. Moore (1989) showed the La Crete sub-basin isolated from both the Black Creek sub-basin and the Saskatchewan sub-basin by extensive carbonate banks. This map depicts a more conservative interpretation. The evaporite infill in the basin includes anhydrite on the floor and enclosing the reefs, and halite and potash across the central portion of the Saskatchewan sub-basin.

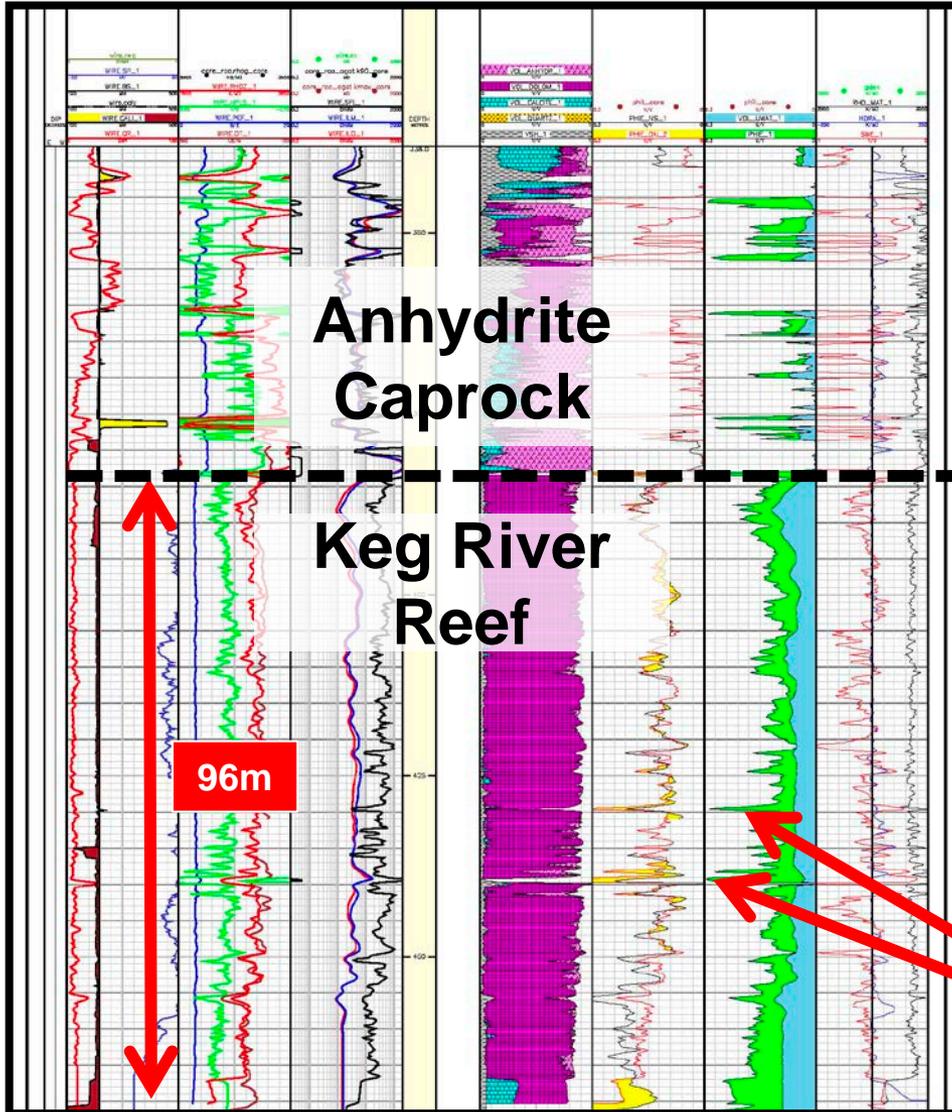
# KEG RIVER/PRAIRIE EVAPORITE DEPOSITIONAL MODEL



# LONG LAKE KEG RIVER DISPOSAL WELL



# LONG LAKE KEG RIVER DISPOSAL WELL



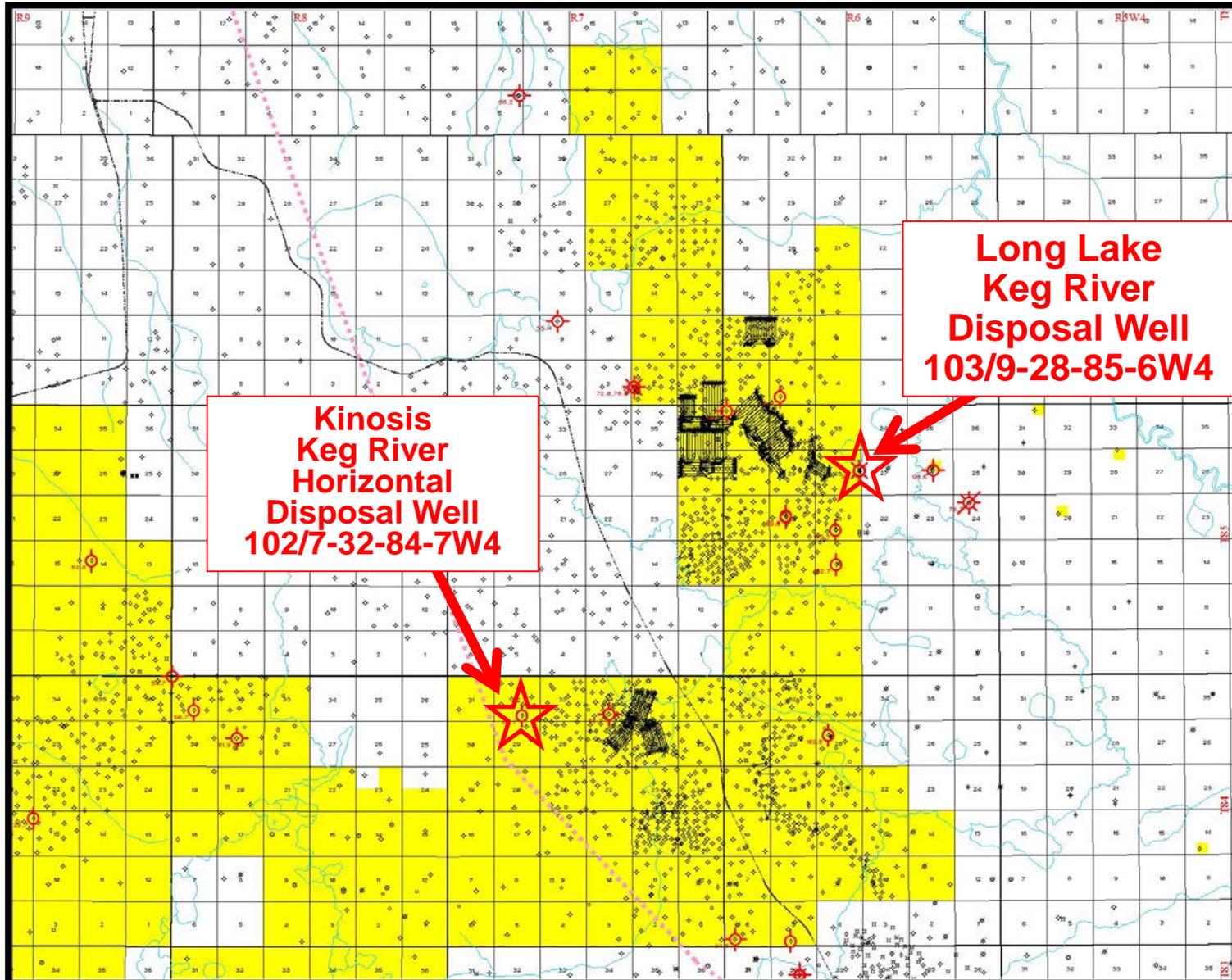
- 103/09-28-085-06W4 drilled in 2003 for the Long Lake Pilot Project
- Cumulative water injection to Nov 2013 = 4,326,335 M<sup>3</sup> (27,225,064 bbls)
- 96 m of Keg River reef penetrated.
- Lost circulation in lower 1/3 of the reef.
- Regained circulation enough to run FMI log. Indicated large open fractures at depth where lost circulation occurred.

## Conclusions:

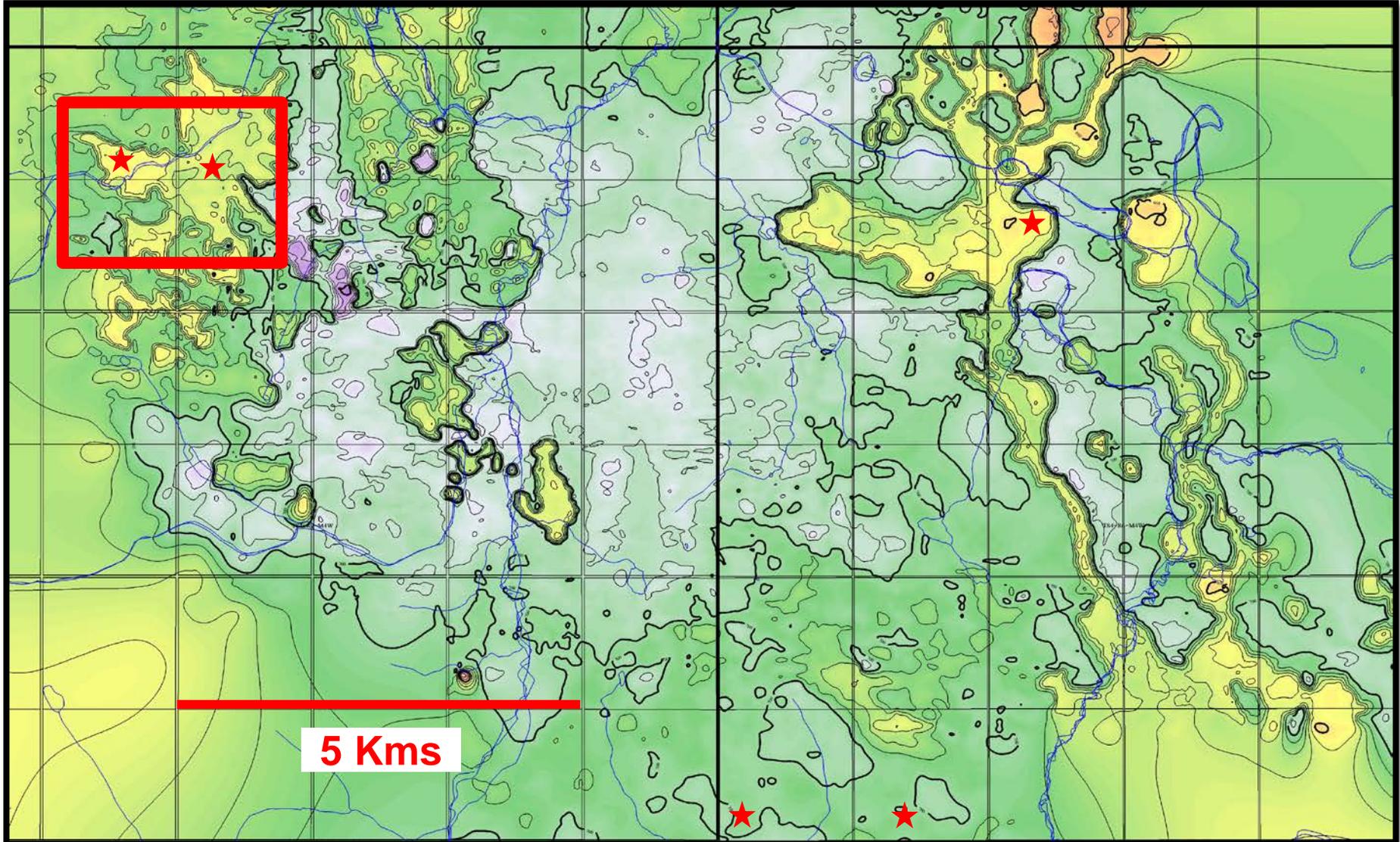
- **Need to be in good primary reef facies**
- **Need to be in area of significant evaporite dissolution**
- **Open fractures required in reservoir for near well-bore permeability**

**Horizontal well is the best option to access sub-vertical fractures in reservoir**

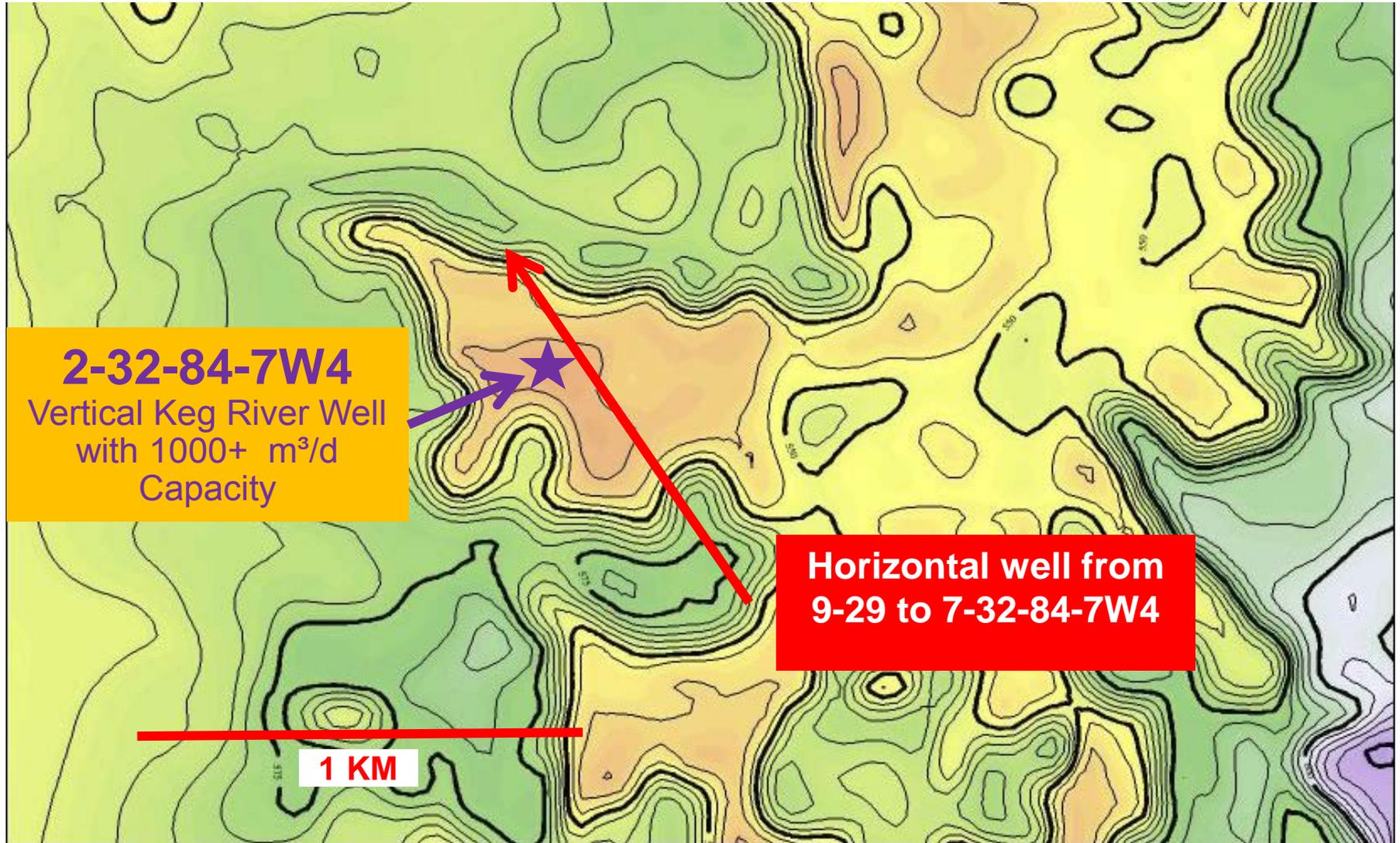
# LONG LAKE/KINOSIS AREA



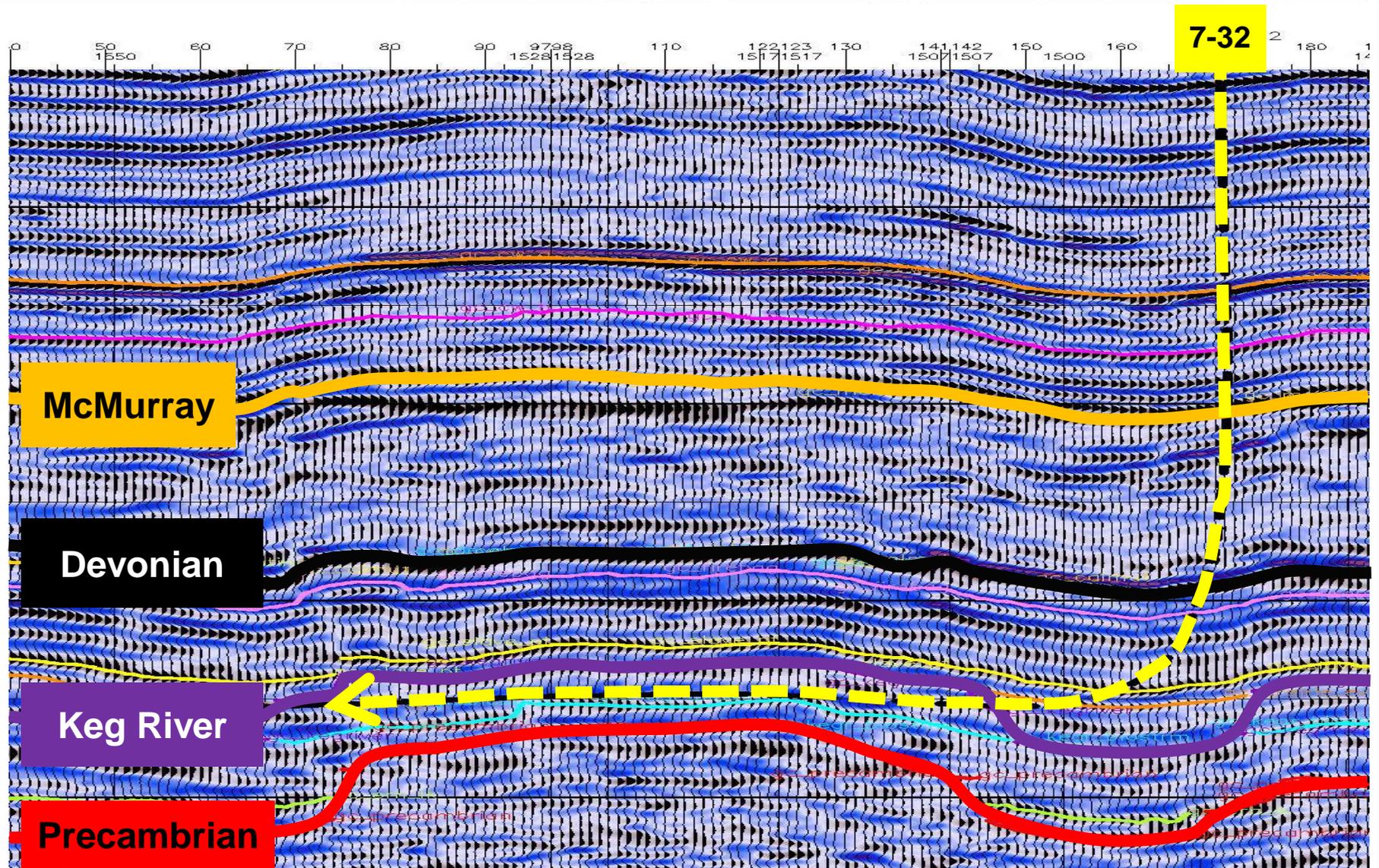
# KINOSIS KEG RIVER TIME STRUCTURE



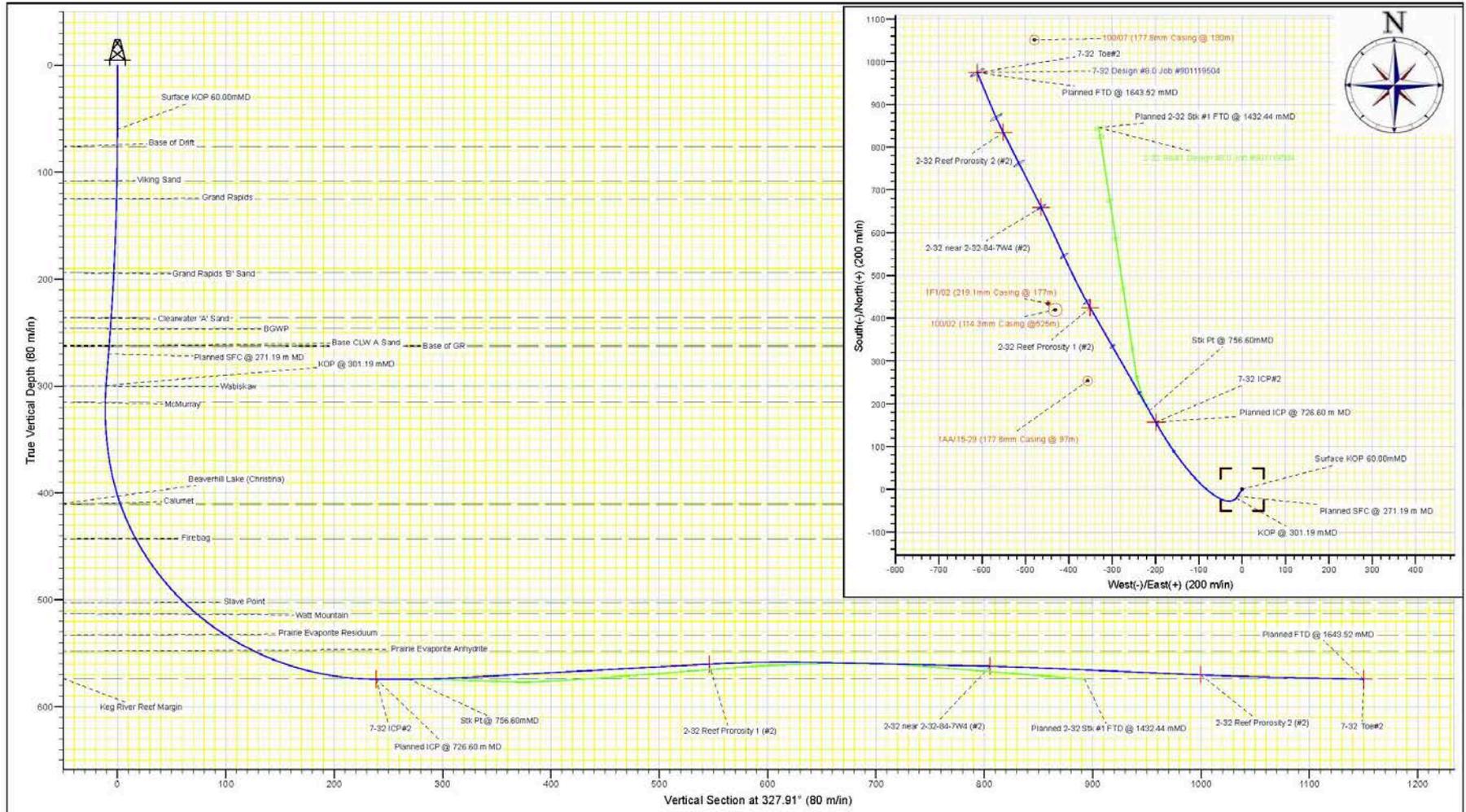
# 7-32-84-7W4 LOCATION



# SEISMIC PROFILE AND WELL TRAJECTORY



# WELLBORE TRAJECTORY



- Well was very carefully planned to maximize:
  - Well-bore length in the reef
  - Vertical trajectory targeting best porosity from the vertical well
  - Oriented parallel to direction of minimum horizontal stress
- Intermediate Casing Point (ICP) located in less porous and fractured part of the reservoir to avoid lost circulation prior to setting intermediate casing and to ensure good cement bond on intermediate casing
- Guar Gum based mud used that is bio-degradable after drilling. Adequate quantities of mud additive and water to maintain drilling with partial losses
- Adequate quantities of acid soluble lost circulation material (LCM) on hand to maintain drilling with partial losses
- A comprehensive plan to evaluate risk/reward decisions during drilling so that all eventualities were covered. A side-track was included in the plan in case no losses were encountered in the main hole.

# DRILLING IN MARCH – OFTEN MUDDY!!



- Well was successfully drilled to within 30m of Projected TD
- From Intermediate Casing Point:
  - First 400 m seepage losses at few m<sup>3</sup>/hour
  - At 1191m MD total losses were encountered
  - We were able to seal reservoir fracture with Lost Circulation Material (acid soluble)
  - Drilled ahead with several more interval of substantial fluid losses while maintaining LCM in mud
  - A total of 828 m<sup>3</sup> of fluid was lost to the formation during drilling
- Acid wash was conducted using coiled tubing and pumped away 50 m<sup>3</sup> of acid at 1 m<sup>3</sup>/min (1440 m<sup>3</sup>/day) with no returns.
- Testing to be conducted after freeze up next winter.



Questions?

