In the Matter of Alberta Energy and Utilities Board
Bitumen Conservation Requirements
Phase 3 Final Proceeding

Staff Submission Group
Response Submission for the
Bitumen Conservation Phase 3 Final Hearing

May 9, 2005

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1 Introduction

This submission (and the attached CD) constitutes the Staff Submission Group (SSG) response to the declarations and supporting evidence filed by other parties on February 14, 2005, for the Alberta Energy and Utilities Board (EUB) Bitumen Conservation Phase 3 final hearing. Specifically, this submission responds to the evidence filed by Canadian Natural Resources Limited (CNRL) and/or ISH Energy Ltd. (ISH) respecting

- gas pooling and vertical association in the Kirby area; and
- the nature of the Wabiskaw B valley-fill bitumen deposit in the Kirby area.

2 Gas Pooling and Vertical Association in the Kirby Area

2.1 Kirby Upper Mannville B4B and Upper Mannville C4C Pools

ISH interprets the Upper Mannville B4B Pool to include the single-well Upper Mannville C4C Pool (10-4-74-8W4 well); three wells from the Upper Mannville U2U Pool (AA/06-35-73-8W4, 02/06-35-73-8W4 and AA/5-36-73-8W4 wells); the 7-36-73-8W4 well (Upper Mannville V2V Pool); and the 11-25-73-8W4 well (Upper Mannville J Pool).

CNRL interprets the regional McMurray A2 mudstone to be preserved at the 9-34-73-8W4 well such that the Upper Mannville B4B Pool is entirely underlain by a regional sealing mudstone. CNRL and ISH both interpret the 11-25 well to not be part of the Upper Mannville J Pool. ISH interprets the 11-25 well to be in the Upper Mannville B4B Pool and CNRL does indicate which pool the 11-25 well should be in.

The SSG agrees that the 11-25, AA/6-35 and 02/6-35 wells are part of the Upper Mannville B4B Pool on the basis of the following interpretations:

- The AA/6-35 and 02/6-35 wells are wet at an elevation higher than the gas at the 5-26-73-8W4 and 11-27-73-8W4 wells, the nearest offset wells in the Upper Mannville U2U Pool.
- The 11-25 well is wet at an elevation higher than the gas at the 10-24-73-8W4 and 1-25-73-8W4 wells, the nearest offset wells in the Upper Mannville J Pool.

The AA/5-36 well is interpreted to not have gas pay, but is in a common top water pool associated with the Upper Mannville B4B Pool.

The revised interpretation of the fluid contacts is provided in the following table.

Well ID	RGS Interpretation (m ss)	SSG Interpretation (m ss)	SSG Interpretation (m ss)
11-25-73-8W4	Gas/Bitumen: 239.8	Gas/Water: 239.8	Water/Bitumen: 238.0
AA/6-35-73-8W4	Gas/Bitumen: 239.7	Gas/Water: 239.2	Water/Bitumen: 238.0
02/6-35-73-8W4	Gas/Bitumen: 240.0	Gas/Water: 241.0	Water/Bitumen: 239.0
AA/5-36-73-8W4	Gas/Bitumen: 240.2	No Gas Pay	Water/Bitumen: 238.7

In Section 35, only the AA/6-35 well has pressure data. The available pressure data for this well is consistent with wells in the Upper Mannville B4B Pool with the exception of the pressure taken on January 29, 2004 (i.e., 1934 kPaa – static gradient). The reliability of this pressure is questionable since it is considerably higher than the previous pressure taken on October 25, 2001 (i.e., 616 kPaa – AWS) and the well had produced a total of about 44 10^6 m^3.

There is no pressure or production data available for either the AA/5-36 well or 11-25 well, and therefore, pressure analysis was not useful for pool delineation.

The SSG disagrees with the ISH interpretation that the 7-36 well is in the Upper Mannville B4B Pool as there are five intervening wells with no gas pay between the 7-36 well and the 02/6-35 and 11-25 wells (see table below). Therefore, the RGS interpretation that the 7-36 well is in the Upper Mannville V2V Pool is still the most reasonable interpretation.

Well ID	SSG Interpretation (m ss)
AA/14-25-73-8W4	Bitumen: top at 239.9
AA/16-25-73-8W4	Bitumen: top at 240.3
10-35-73-8W4	Bitumen: top at 240.3
AA/5-36-73-8W4	Water: top at 240.2
6-36-73-8W4	Water: top at 238.6

A depleted pressure of 1522 kPaa (surface pressure) was taken at the 7-36 well on February 26, 2001 prior to any production. The expected virgin pressure in the area is about 2150 kPaa. Although both the Upper Mannville V2V and Upper Mannville B4B pools had commenced production in February 1992, given the geological interpretation, the SSG concludes that the source of drainage is the Upper Mannville V2V Pool.

The SSG disagrees with the ISH interpretation that the 10-4 well is in the Upper Mannville B4B Pool. Although the gas/bitumen contact at 237.1 m ss is within +/- 5 m of the bitumen contacts in the Upper Mannville B4B Pool, pressure data does not support the inclusion of the 10-4 well. The 10-4 well produced between February 1992 and August 1996. Five pressures were taken at the 10-4 well subsequent to August 1996 over a period of seven years indicating pressure rebound/stabilization while production continued from the Upper Mannville B4B Pool. The SSG maintains that the 10-4 well is

a single-well pool associated with Wabiskaw B valley-fill bitumen greater than 10 m thick.

The RGS interprets the McMurray A2 mudstone to be absent at the 9-34-73-8W4 well. The SSG reviewed the core from wells in the Upper Mannville B4B Pool to confirm the presence or absence of the McMurray A2 mudstone. The core photos and well logs are provided in Appendix 1.

The cores from the 6-34-73-8W4 and 02/7-3-74-8W4 wells show the Wabiskaw D valley-fill incising into the McMurray A2 sequence. The 6-34 core shows 3 m of the McMurray A2 sequence is present including the McMurray A2 mudstone. The 02/7-3 core shows 0.8 m of the McMurray A2 sequence is present (only the McMurray A2 mudstone is preserved), indicating deeper incision by the Wabiskaw D valley-fill. The core top from the 9-34 well occurs at the Wabiskaw D valley-fill – McMurray contact. The core captures the basal 0.8 m of the Wabiskaw D valley-fill overlying McMurray channel sediments. A photo of the bedding plane contact between the Wabiskaw and McMurray is provided in Appendix 1. Although core is missing in the upper cored interval, none of the McMurray A2 sequence is preserved. The SSG interprets the Wabiskaw D valley-fill to have incised deep enough at the 9-34 well such that the McMurray A2 sequence has been removed entirely. As such, the Upper Mannville B4B Pool is associated with both Wabiskaw B valley-fill and McMurray channel bitumen at the 9-34 well.

The SSG continue to recommend that the Upper Mannville B4B Pool and the Upper Mannville C4C Pool be shut in.

2.2 Kirby Upper Mannville II Pool

ISH interprets the Upper Mannville II Pool to be associated only with the thin bitumen resource of the Wabiskaw B valley-fill sand. It submits that the Wabiskaw C interval acts a regional seal between the Wabiskaw B valley-fill and the thicker bitumen resource within the underlying Wabiskaw D valley-fill and McMurray channel sands. ISH's interpretation of the Wabiskaw C interval as a regional seal in the area of the Upper Mannville II Pool is based on the following:

- To the north of the Upper Mannville II Pool are three wells (1-11, 1-13-75-9W4, and 14-18-75-8W4) that ISH interprets to encounter top gas and/or water in the Wabiskaw D valley-fill.

- ISH interprets the Wabiskaw C interval to be sealing at these wells trapping Wabiskaw D valley-fill gas and water below Wabiskaw B valley-fill bitumen.

ISH then extrapolates this interpretation of the Wabiskaw C interval southward to the Upper Mannville II Pool.

The SSG does not believe that the Wabiskaw C interval acts as a regional seal in this area. The SSG reviewed the cored wells in the area of the Upper Mannville II Pool to determine the nature of the Wabiskaw C interval. Core photos and logs of the wells are provided in Appendix 2 and are discussed below.

- The 14-18 well encountered 0.65 m of Wabiskaw C sands and muds that are cemented.

- The 1-13 well did not encounter the Wabiskaw C interval, such that the Wabiskaw B valley-fill rests directly on Wabiskaw D valley-fill.

- The 1-11 well encountered 0.67 m of Wabiskaw C interval, consisting of sands and muds that are highly bioturbated and bitumen-stained, but not cemented.

- Photos of cored wells to the south of the Upper Mannville II Pool show that where the Wabiskaw C interval is thicker, it consists of highly bioturbated and bitumen-stained sands and muds.

- There is no gas or top water in the units immediately underlying the Wabiskaw B valley-fill in any of the four wells in the Upper Mannville II Pool that would indicate a seal is present.

- Of the four wells in the Upper Mannville II Pool, potential for vertical association with Wabiskaw D valley-fill and McMurray channel bitumen occurs at only the 10-2-75-9W4. The remaining three wells have McMurray A2 sequence underlying the Wabiskaw B valley-fill.

Based on the inconsistent cementation of the Wabiskaw C interval and the potential for it to be absent, the Wabiskaw C interval cannot be relied upon as a regional seal. Therefore, the Upper Mannville II Pool is associated with McMurray channel bitumen due to the absence of a regional sealing mudstone at the 10-2 well.

Static gradients were conducted at all four wells in the Upper Mannville II Pool in February 2005. The pressures were all between 1126 and 1153 kPaa, which supports the pooling interpretation.

The SSG continues to recommend that the Upper Mannville II Pool be shut in.

2.3 Kirby Upper Mannville J Pool

ISH and CNRL interpret the 11-25-73-8W4 well to not be in the Upper Mannville J Pool. As discussed in Section 2.1, the SSG interpret the 11-25 well to be in the Upper Mannville B4B Pool.

The 11-25 well was the only well in the Upper Mannville J Pool in association with McMurray channel bitumen. With the removal of the 11-25 well, the Upper Mannville J Pool is wholly underlain by regional sealing mudstones. However, the Upper Mannville J Pool is still associated with Wabiskaw B valley-fill bitumen greater than 10 m in the eastern portion of the pool.

The SSG continue to recommend that the Upper Mannville J Pool be shut in.

2.4 Kirby Upper Mannville O3O and Upper Mannville U2U Pools

ISH interprets the 9-3-74-9W4 well to be part of the Upper Mannville O3O Pool. The RGS includes the 9-3 well in the Upper Mannville U2U Pool.

The SSG interprets the 9-3 well to have a gas/bitumen contact at 233.2 m ss which is within +/- 5 m of the bitumen contacts in both the Upper Mannville O3O Pool and the Upper Mannville U2U Pool. The geological evidence is inconclusive as to which pool the 9-3 well is in.

A depleted initial pressure of 1788 kPaa (surface pressure) was taken at the 9-3 well on January 4, 1996 prior to any production. The expected virgin pressure in the area is about 2125 kPaa. The source of drainage is inconclusive since adjacent wells in both the Upper Mannville U2U Pool and Upper Mannville O3O Pool commenced production in January/February 1995.

The SSG maintains that both the Upper Mannville O3O Pool and Upper Mannville U2U Pool are associated with McMurray channel bitumen. Therefore, regardless which pool the 9-3 well is in, the production status recommendation for the 9-3 well is unchanged. As stated in Section 5.2 of the SSG February 14, 2005 submission, the Upper Mannville O3O Pool is associated with McMurray channel bitumen at the 16-5-74-9W4 well. The Upper Mannville U2U Pool is associated with Wabiskaw B valley-fill bitumen greater than 10 m and is associated with McMurray channel bitumen at the 7-36-73-9W4, 3-5, 1-6 and 6-6-74-8W4 wells. Although the McMurray channel sediments contain less than 10 m bitumen at each of these wells, the accommodation space is as high as 27.5 m (see table below).

Well ID	McMurray Channel Bitumen Accommodation Space (m ss)	McMurray Channel Bottom Water Interval (m ss)
7-36-73-9W4	458.0 – 485.5 (27.5 m)	485.5 – 510.0 (24.5 m)
3-5-74-8W4	483.0 – 505.0 (22.0 m)	505.0 – 526.0 (21.0 m)
1-6-74-8W4	471.5 – 493.0 (21.5 m)	493.0 – 515.0 (22.0 m)
6-6-74-8W4	(0.0 m)	465.3 – 507.0 (41.7 m)

The SSG continues to recommend that the Upper Mannville O3O Pool and the Upper Mannville U2U Pool be shut in.

2.5 Kirby Upper Mannville V2V Pool

ISH interprets the 12-16-74-7W4 well to be a single-well pool and the 7-36-73-8W4 well to be part of the Upper Mannville B4B Pool. The RGS includes both of these wells in the Upper Mannville V2V Pool. ISH interprets the Wabiskaw C to be a sealing unit between the Wabiskaw B valley-fill and the Wabiskaw D valley-fill.

The SSG agrees that the 12-16 well is not part of the Upper Mannville V2V Pool. The 12-16 well has a gas/water contact at 245.5 m ss, which is above the base of gas at the 10-13-74-8W4 well (242.2 m ss). The gas/water at the 12-16 well is 3 m lower than the gas/water contact at the offsetting 3-21-74-7W4 well in the Upper Mannville K4K Pool.

Based on fluid contacts, the SSG interprets the gas at the 12-16 well to be in a single-well pool associated with greater than 10 m of Wabiskaw B valley-fill bitumen. Further, the SSG interprets the 12-16 well to be in the same top water zone as the 3-21 well.

A depleted initial pressure of 1668 kPaa (static gradient) was taken at the 12-16 well on January 21, 2001 prior to any production. The expected virgin pressure in the area is about 2125 kPaa. Given the depleted pressure, the SSG interpret the 12-16 well to be in the same region of influence as the Upper Mannville I Pool with communication occurring through underlying water.

The adjacent 3-21-74-7W4 well did not commence production until March 2001, and therefore, could not have caused the initial depletion at the 12-16 well. However, the depletion at the 12-16 well further supports the SSG interpretation that the initial pressure at the 3-21 well is a depleted pressure (see Section 5.1 of the SSG submission dated February 14, 2005), and that the 3-21 well is in the same region of influence as the Upper Mannville I Pool. It should be noted that the initial pressure for the 3-21 well of 2027 kPaa on the EUB database appears to be in error due to a double accounting of atmospheric pressure (i.e., 93 kPa). The initial pressure taken at the 3-21 well on February 13, 1994 should be 1934 kPaa (static gradient).

The SSG continues to recommend that the 12-16-74-7W4 well be shut in.

As discussed in Section 2.1, the SSG maintains that the 7-36 well is in the Upper Mannville V2V Pool.

The SSG has reviewed the core from four of the wells in Upper Mannville V2V Pool to determine if the Wabiskaw C interval is a seal between the Wabiskaw B valley-fill and the underlying Wabiskaw D valley-fill. The core photos and logs for the wells are provided in Appendix 3.

The core photos of the Wabiskaw C interval at the 9-14, 12-14, 15-14 and 6-24-74-8W4 wells all indicate that it consists of highly bioturbated and bitumen-stained sands and muds. Large vertical burrows are also present. Further, there is no evidence from the logs in this area that gas or water is being trapped below the Wabiskaw C interval. The SSG concludes that the Wabiskaw C is not a seal and the Upper Mannville V2V Pool is associated with Wabiskaw B valley-fill and McMurray channel bitumen.

The SSG continues to recommend that the Upper Mannville V2V Pool be shut in.

3 Nature of the Wabiskaw B Valley-fill Bitumen Deposit in the Kirby Area

3.1 Wabiskaw B Valley-fill Mineralogy and Cemented Zones

ISH submitted that the Wabiskaw B sandstone is a poor candidate for a SAGD bitumen project due to high clay content and increased water saturation, factors that ISH states would decrease the production rate and increase the amount of steam required to produce a unit of bitumen. ISH also states that the Wabiskaw B reservoir quality is further reduced by the presence of clays that would swell in contact with steam and migrate with fluid movement within the reservoir.

The SSG compared the mineralogical/petrographic evidence filed by ISH to similar analyses for both the McMurray Formation and Clearwater Formation found in a literature review. The SSG also conducted a literature review on the impact of clays on steam injection/SAGD. A summary is provided in Appendix 4. The SSG concludes that:

- the mineralogy of the Wabiskaw B valley-fill sands at Kirby is similar to the mineralogy of the Clearwater sands at Cold Lake;
- the mineralogy of the Wabiskaw B valley-fill clays at Kirby is similar to the mineralogy of the Clearwater clays at Cold Lake; and
- the clay content in the Clearwater and other sites have not precluded steam injection/SAGD.

ISH further submitted that the Wabiskaw B contains several persistent cemented horizons that would severely inhibit the growth of steam chambers thereby limiting recovery for well pairs and making economic recovery unfeasible. The SSG, based on a core, log and literature review concludes that the tight intervals within the Wabiskaw B valley-fill are discontinuous concretions that do not create a seal and would not preclude SAGD development.

The review consisted of:

- the examination of 112 cores within and along the margins of the ISH study area;
- preparation of six cross-sections to determine the degree of correlatability of the tight intervals; and
- a literature review to determine the potential impact of concretions on bitumen recovery.

A summary of the core study, cross-sections and literature review is provided in Appendix 5.

3.2 Wabiskaw B Valley-fill Bitumen Cutoffs

CNRL submits that the mapping cutoffs used in the RGS to evaluate the bitumen resource within the Wabiskaw B valley-fill are inappropriate. CNRL states that it is concerned with the approach used to determine bitumen saturation where the entire Wabiskaw-McMurray interval is evaluated using a single set of parameters, such as formation water resistivity (Rw) for both formations. CNRL further states that it is inappropriate to use a 6 weight per cent cutoff (wt %) as a proxy for the 50 per cent saturation stipulated in *ID 99-1*.

The SSG believes that CNRL may have misinterpreted the bitumen evaluation method described in Section 4.1 of the RGS. The input parameters are adjusted as necessary to attain a match between the answer curves and the core analysis data. In particular, the Rw is often adjusted vertically for the reasons described by CNRL in their February 14, 2005 submission.

The SSG supports the use of a wt % cutoff because of the ease of calibrating core analysis results to logs. The core analysis method performed in unconsolidated bitumen sands is the Dean Stark analysis. This method measures the actual weight of the bitumen relative to the weight of the sample. The bitumen and water saturations that are also reported are subsequently calculated values, not measured. These calculated saturations are based on the total water recovered from the sample resulting in a bias to lower bitumen saturations.

The Dean Stark method measures total water from the sample. The total volume of water includes the water within the effective porosity as well as the bound water which makes up the irreducible water saturation The resulting bitumen saturation derived from this method is the relative portion of bitumen to the total volume of water. As such, the relative portion of bitumen in the effective porosity is underestimated.

The SSG maintains that the bitumen evaluation method described in Section 4.1 of the RGS provides an accurate assessment of the bitumen as it compares the log calculated values to the amount of bitumen that was actually measured in the core analysis without introducing known biases.

Attachment 1	Explanation of Appendices (CD only)
Appendix 1	Upper Mannville B4B Pool – Core Photos (CD only)
Appendix 2	Upper Mannville II Pool – Core Photos (CD only)
Appendix 3	Upper Mannville V2V Pool– Core Photos (CD only)
Appendix 4	Wabiskaw B Valley-fill Mineralogy (CD only)
Appendix 5	Wabiskaw B Valley-fill Cemented Zones (CD only)
Enclosure A	Computer Disk containing the SSG Response Submission and all Attachments and Appendices