



Bernum Petroleum Ltd.
Application for an Off-Target Penalty
Evi Field

Harvest Operations Corp.
Application for Pool Delineation
Evi Field

December 20, 2011

ENERGY RESOURCES CONSERVATION BOARD

Decision 2011 ABERCB 036: Bernum Petroleum Ltd., Application for an Off-Target Penalty, Evi Field, and Harvest Operations Corp., Application for Pool Delineation, Evi Field

December 20, 2011

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ENERGY RESOURCES CONSERVATION BOARD

Calgary Alberta

**BERNUM PETROLEUM LTD.
APPLICATION FOR AN OFF-TARGET PENALTY
EVI FIELD**

**HARVEST OPERATIONS CORP.
APPLICATION FOR POOL DELINEATION
EVI FIELD**

**2011 ABERCB 036
Applications No. 1678691 and 1680933**

DECISION

The Energy Resources Conservation Board (ERCB/Board) has considered the findings and recommendations set out in the following examiner report, adopts the recommendations, and directs that Application No. 1678691 be denied, Application No. 1680933 be approved, and pool orders be issued in accordance with the pool delineation recommended by the examiners.

Dated in Calgary, Alberta, on December 19, 2011.

ENERGY RESOURCES CONSERVATION BOARD

<original signed by>

Dan McFadyen
Chairman

ENERGY RESOURCES CONSERVATION BOARD

Calgary Alberta

**EXAMINER REPORT RESPECTING
BERNUM PETROLEUM LTD.
APPLICATION FOR AN OFF-TARGET PENALTY
EVI FIELD**

**HARVEST OPERATIONS CORP.
APPLICATION FOR POOL DELINEATION
EVI FIELD**

**2011 ABERCB 036
Applications No. 1678691 and 1680933**

RECOMMENDATIONS

[1] Having considered all the evidence, the examiners recommend that Application No. 1678691 be denied, Application No. 1680933 be approved, and the three wells involved in this hearing be assigned to separate pools as described in this report.

INTRODUCTION

Applications

[2] In Application No. 1678691, Bernum Petroleum Ltd. (Bernum) applied, pursuant to Section 4.060 of the *Oil and Gas Conservation Regulations*, for an off-target penalty on oil production from the Gilwood Member (Gilwood) from the well located at Legal Subdivision (LSD) 8, Section 24, Township 87, Range 14, West of the 5th Meridian (8-24 well).

[3] In Application No. 1680933, Harvest Operations Corp. (Harvest) initially applied, pursuant to Section 33(2) of the *Oil and Gas Conservation Act*, to have the 8-24 well designated as being in a common pool with the well located at LSD 10-24-87-14W5M (10-24 well) and separate from the pool encountered by the well located at LSD 4-24-87-14W5M (4-24 well). Harvest also applied for the 8-24 well to be given “first well” status in the pool. Harvest subsequently amended its application and requested that the 4-24, 8-24, and 10-24 wells be designated as being in three separate single-well pools.

Background

[4] With respect to the three wells at issue in this hearing, the 10-24 well is licensed to Bernum and is in an undefined Gilwood pool, while the 4-24 and 8-24 wells are licensed to Harvest and are currently designated by the ERCB as being in the Evi Gilwood OO Pool.

[5] The wells referred to in this report are listed in Table 1.

Table 1. Wells in the application area

Unique well identifier	Current ERCB pool designation	Date on production	Licensee
00/01-24-087-14W5/2 (1-24 well)	Evi Slave Point A Pool	January 25, 2007	Harvest
00/04-24-087-14W5/0 (4-24 well)	Evi Gilwood OO Pool	December 4, 2006	Harvest
00/08-24-087-14W5/0 (8-24 well)	Evi Gilwood OO Pool	January 8, 2010	Harvest
00/10-24-087-14W5/0 (10-24 well)	Evi Gilwood Undefined Pool	January 29, 2011	Bernum

[6] *Interim Directive 94-2: Revisions to Oil and Gas Well Spacing Administration* describes the Board's "first well" in a pool policy and its administration. *ID 94-2* states that, upon a request to have an off-target penalty applied, the Board will review pool delineation using all available relevant information, such as geological and pressure data. Where the well in question is deemed the first well in the pool, the off-target penalty will not be applied.

Interventions

[7] Bernum, as licensee of the 10-24 well, objected to Harvest's application and submitted that the 4-24, 8-24, and 10-24 wells were in the same pool.

[8] Harvest, as licensee of the 8-24 well, objected to Bernum's application and submitted that since the 8-24 well was in a separate pool from the 4-24 and 10-24 wells, it should not be subject to an off-target penalty.

Hearing

[9] The Board held a public hearing in Calgary, Alberta, commencing on September 28, 2011, before Board-appointed examiners G. W. Dilay, P.Eng. (Presiding Member), B. A. Austin, P.Geol., and T. L. Byrnes, P.Eng., and adjourning on September 30, 2011.

[10] At the adjournment of the hearing, Bernum and Harvest were required to complete undertakings. Both parties completed the undertakings by October 11, 2011. On October 14, 2011, the hearing was closed.

[11] Subsequent to the close of the hearing, the Board received a submission from Bernum responding to the undertakings submitted by Harvest. On October 19, 2011, the Board informed the parties that it would re-open the hearing to accept Bernum's submission and give Harvest an opportunity to respond to Bernum's submission and undertakings. Harvest responded to Bernum's submission but declined responding to Bernum's undertakings. The hearing was closed on October 27, 2011.

ISSUES

[12] The examiners consider the issues respecting the applications to be

- pool delineation, and
- off-target penalty for the 8-24 well.

[13] In reaching the determinations contained in this report, the examiners have considered all relevant materials constituting the record of this proceeding, including the evidence and

argument provided by each party. Accordingly, references in this report to specific parts of the record are intended to assist the reader in understanding the examiners' reasoning related to a particular matter and should not be taken to indicate that the examiners did not consider all relevant portions of the record with respect to that matter.

POOL DELINEATION

Analysis

[14] In analyzing the issue of pool delineation, the examiners considered the following factors: stratigraphic correlation, geologic structure, associated water, pressure data, recovery factors, and gas-oil ratios (GORs).

Stratigraphic Correlation

[15] Bernum recognized two distinct stacked sands in the Gilwood in the 10-24 well, an upper sand that it called the Gilwood A sand and a lower sand that it called the Gilwood B sand. Bernum contended that both the upper and lower Gilwood sands were correlatable in all three wells. Bernum submitted that there was good reservoir communication through the oil column in the lower sand and that originally there had been communication through the oil column in the upper sand. However, at the time the 10-24 well was drilled, the upper sand exhibited very high water saturation. Bernum interpreted that the high water saturation in the upper sand was from water encroachment due to the high rate of oil production at the 4-24 and 8-24 wells.

[16] Bernum disagreed with Harvest's mapping of the upper and lower Gilwood sands encountered by the 8-24 well. Bernum stated that Harvest's map of the pool encountered by the 8-24 well substantially overlapped the map of the pool encountered by the 10-24 well (see Figure 1). Bernum submitted that it was unlikely these two Gilwood pools were separate given the close proximity of the wells and relatively minor structural relief between the reservoir sands.

[17] Harvest described the Gilwood as an amalgamation of several smaller sand lenses or strand sands that were deposited on a wave-dominated delta, stating that the areal extents of the individual sand deposits were unpredictable. Harvest correlated the upper Gilwood sand in its 8-24 well with the upper Gilwood sand in the 10-24 well but disagreed with Bernum that this upper sand had been swept by water encroachment due to production. Using the well logs, Harvest calculated a water saturation of 86 per cent for the upper sand in the 10-24 well and stated that it was not possible for almost 100 per cent of the oil to be swept as a result of one year of production at the 8-24 well. Harvest contended that the reason the upper sand in the 10-24 well was wet was that it was the downdip water leg to the oil zone in the 8-24 well.

[18] Harvest submitted that the productive sand in the 10-24 well had been deposited within a low on the Precambrian surface and was, therefore, older than the Gilwood sands in the 4-24 and 8-24 wells, which had been deposited on separate Precambrian highs. Harvest interpreted that the productive sand in the 10-24 well pinched out before the 8-24 well as the sand overlapped against the Precambrian high. Furthermore, Harvest concluded that the presence of a wet sand overlying an oil bearing sand within the same geologic structure in the 10-24 well would best be explained by pinchout of the oil bearing sand against the Precambrian high. It contended that otherwise, all

the sands in the 10-24 well would have been either oil or water bearing if they were in communication with the 8-24 well.

[19] Harvest stated that the pool shown on its net pay map of the productive Gilwood sands encountered by the 8-24 well did not intersect, in three-dimensional (3D) space, with the pool for the productive Gilwood sand in the 10-24 well. Harvest contended that the close proximity of the 8-24 and 10-24 wells was not evidence that the wells encountered the same pool.

[20] From the stratigraphic cross section submitted by Harvest, the examiners interpret the Gilwood sands in the 8-24 well to have been deposited directly on a Precambrian high and that the Gilwood sands in the 10-24 well were deposited on the sediments of the older Muskeg and Granite Wash formations within a Precambrian low. The examiners agree with Harvest that sands deposited within the lows are older than those deposited on the highs. Therefore, the examiners interpret that it is unlikely that the productive sand in the 10-24 well correlates with the sands in the 8-24 well. Similarly, the examiners interpret that the Gilwood sands in the 4-24 well are younger than the productive sand in the 10-24 well because the Gilwood in the 4-24 well was deposited on a high that includes both the Precambrian and the Muskeg Formation. Therefore, the examiners interpret that the Gilwood sands in the 4-24 well are unlikely to correlate with the productive sand in the 10-24 well.

[21] The examiners observe from the well logs that there is a one-metre thick shale separating the upper wet sand from the underlying oil producing sand in the 10-24 well. The examiners believe that this one-meter shale must be both continuous and sealing in the area of the 10-24 pool to be able to keep the overlying water from displacing the underlying oil. The examiners observe that the one-meter shale in the 10-24 well does not correlate to a comparable one-meter shale in the 8-24 well. Therefore, the examiners conclude that the one-meter shale has pinched out towards the 8-24 well as a result of onlap against the Precambrian high. Since the productive sand in the 10-24 well is beneath the one-meter shale, the examiners believe that this sand also pinched out as a result of onlap against the Precambrian high, as submitted by Harvest. The examiners, therefore, believe that the productive sand in the 10-24 well is not continuous with the Gilwood sands in the 8-24 well.

[22] The examiners agree with Harvest that it is unlikely that the upper wet sand in the 10-24 well had been swept as a result of water encroachment from one year of oil production at the 8-24 well. The examiners believe that swept reservoirs generally exhibit a higher residual oil saturation than is evident in the 10-24 well. The examiners reviewed the well logs of the upper sand in the 10-24 well and conclude that Harvest's calculation of 86 per cent water saturation is reasonable. The examiners further observe that this sand is structurally lower than the productive sands of the 8-24 well. Therefore, the examiners agree with Harvest that the upper sand in the 10-24 well is a wet zone rather than a swept zone and that it is the downdip water leg to the oil zone in the 8-24 well.

[23] Although Harvest's 8-24 and 10-24 pools appear to overlap areally (see Figure 1), the examiners agree with Harvest that they do not overlap in 3D space because, as interpreted by the examiners, the productive sands in the 8-24 well are stratigraphically separate from the productive sand in the 10-24 well.

Geologic Structure

[24] Bernum constructed a map showing the areal extent of the pool by determining a net pay value for the Gilwood sands for each well and overlaying the net pay values on the interpreted structural trend associated with the Slave Point Formation (Slave Point). Bernum stated that the Gilwood event could not be picked from seismic. Therefore, Bernum used the structural closure of the Slave Point to define the pool boundaries of the Gilwood, contending that the Slave Point seismic marker could be picked with confidence and that there was very little variation in thickness between the top of the Slave Point and the top of the Gilwood. Based on its interpretation of the structure of the Slave Point, Bernum mapped the 4-24, 8-24, and 10-24 wells in the same pool (see Figure 1).

[25] Bernum noted that the seismic cross sections submitted by Harvest showed a deep low on the Precambrian surface between the well located at LSD 1-24-87-14W5M (1-24 well) and the 8-24 well. Bernum stated that because of this structural low, the pool encountered at the 8-24 well could not continue across the low to the south, as interpreted by Harvest, but would trend to the north.

[26] Bernum agreed with Harvest that there was a structural low in part of LSD 6-24-87-14W5M and LSD 11-24-87-14W5M and that this structural low was also evident on Bernum's structure map of the Slave Point. Based on its geologic mapping, Bernum interpreted that there was a narrow communication path between the 4-24 well and the 8-24 and 10-24 wells located in the northwest corner of LSD 11-24-87-14W5M, as illustrated in Figure 1. Bernum submitted that this narrow communication path connected all three wells in one continuous Gilwood pool.

[27] Harvest submitted that structural highs defined the Gilwood pools and that structural lows separated the Gilwood pools. Harvest stated that there was insufficient well control to define pools but that 3D seismic coverage was necessary to establish pool closure. Harvest constructed its Gilwood structure map based on its interpreted 3D seismic time picks at the Gilwood level using the Gilwood tops from well logs and its interpretation of the seismic character between the wells. Harvest interpreted that the 4-24 and 8-24 wells were on separate structural highs with a significant structural low extending through LSDs 6-, 7-, and 11-24-87-14W5M. Harvest stated that the structural low separated the oil pool discovered by the 4-24 well from the Gilwood oil pool discovered by the 8-24 well.

[28] Harvest contended that the seismic map presented by Bernum was not representative of the Gilwood subsurface. It stated that because the thickness of the interval between the Gilwood and the Slave Point was not constant throughout the area, the structure of the Slave Point could not represent the structure of the Gilwood. Harvest contended that Bernum's Gilwood pool outline defined by structural closure of the Slave Point did not represent the Gilwood pools at issue.

[29] The examiners believe that there are limitations with using either the Slave Point or Gilwood seismic structure maps to determine the structural closure and areal extent of the Gilwood pools. The examiners note that the Slave Point is not the zone of interest, and interpret that the top of the Slave Point is a significant distance above the top of the Gilwood and that the thickness between the top of the Slave Point and the top of the Gilwood is not constant. The examiners note as evidence of the latter that although Bernum's structure map of the Slave Point showed the 8-24 and the 10-24 wells to be at approximately the same structural elevation,

Gilwood elevations from well logs posted on the same map indicated a difference in elevation of 5.4 metres (m) between the two wells. The examiners recognize that the Gilwood is difficult to pick on seismic but note that this limitation can be reduced by tying the Gilwood seismic picks to the Gilwood well log picks, as was done by Harvest. The examiners believe that it is important to recognize the variation in thickness between the top of the Slave Point and the top of the Gilwood. Therefore, on balance, the examiners believe that using the Gilwood structure, as was done by Harvest, is better than using the Slave Point structure, as was done by Bernum, for the Gilwood pool delineation.

[30] The examiners agree with Bernum that there is a deep structural low evident on the seismic cross section between the 1-24 and 8-24 wells. The examiners also agree with Bernum that the pool encountered by the 8-24 well would not likely continue to the south through this structural low as was interpreted by Harvest. The examiners agree with Bernum that the pool encountered by the 8-24 well does not extend into the area of the 1-24 well.

[31] The examiners note that Bernum interpreted a narrow pathway in the northwest quadrant of LSD 11-24-87-14W5M that allows communication between the 4-24 well and the 8-24 and 10-24 wells, as illustrated in Figure 1. The examiners reviewed the seismic cross section and the Gilwood structure map showing the seismic shot-point locations submitted by Harvest and observe that there is a structural low where Bernum interpreted a communicating pathway, and this structural low is deeper than the structural low found between the 1-24 and 8-24 wells. Considering that the examiners believe the pool at the 8-24 well would not extend across the structural low to include the 1-24 well, the examiners also believe that the pool would not extend across the deeper structural low evident on Harvest's seismic cross section in the northwest quadrant of LSD 11-24-87-14W5M to include the 4-24 well, as interpreted by Bernum.

Associated Water

[32] Bernum stated that the well logs did not show evidence of an oil-water contact in the Gilwood sands in any of the wells at issue. However, Bernum submitted that the 10-24 well was very close to the oil-water contact in the upper Gilwood sand. Based on the production of water and the spill point on the Gilwood structure, Bernum interpreted that there would be an oil-water contact below the base of the lower Gilwood sand in the 10-24 well, somewhere below -1004.5 m subsea (SS).

[33] Harvest also stated that there was no oil-water contact evident on the well logs but interpreted underlying water to be associated with the Gilwood oil pools in all of the wells at issue. Harvest submitted that the structural closure on the Gilwood defined the location of the oil-water contact, below which any oil would have migrated away. Harvest interpreted the structural closure intersected by the 4-24 well to be at -1004 m SS and the structural closure intersected by the 8-24 well to be at -1002 m SS.

[34] The examiners observe that although there is no oil-water contact evident on the well logs, both parties interpreted downdip water to be associated with the Gilwood oil pools. The examiners agree with Bernum and Harvest that water would be present below the structural closure on the Gilwood, concluding that the Gilwood sands would be saturated with water in the structural lows. The examiners accept Harvest's estimate that the oil-water contact at the 4-24 well is at -1004 m SS based on water production and the structural closure at the well. Since the

examiners agree with Harvest that the upper wet sand in the 10-24 well is the downdip water leg to the oil zone in the 8-24 well, the examiners agree that the oil-water contact at the 8-24 well is approximately at -1002 m SS. The examiners agree with Bernum that the lower sand of the 10-24 well has an oil-water contact somewhere below the base of the lower Gilwood sand, which is at -1004.5 m SS.

[35] Considering the elevations of the interpreted oil-water contacts and the deeper structural low between the 4-24 well and the 8-24 and 10-24 wells, as shown on Harvest's seismic cross section and Gilwood structure map, the examiners believe that the Gilwood sands are water saturated in this structural low. As discussed in paragraph 31, the examiners believe that this structural low extends into the northwest quadrant of LSD 11-24-87-14W5M, where Bernum has interpreted a narrow communication pathway. Therefore, the examiners conclude that the wet Gilwood sands in the intervening structural low separate the oil pool in the 4-24 well from the oil pools in the 8-24 and 10-24 wells.

Pressure Data

[36] Bernum stated that it was difficult to construct any geological model that explained why the initial pressures at the 8-24 and 10-24 wells were 2000 kilopascals (kPa) and 2738 kPa, respectively, less than the initial pressure at the 4-24 well unless all three wells were in communication through a common oil column. Bernum acknowledged that since the three wells shared a common aquifer, some of the pressure depletion occurred through the aquifer. However, because of the magnitude and rapid rate of the pressure depletion, Bernum argued that most of the pressure depletion occurred through a common oil column. Bernum estimated that the 4-24 well only produced 0.3 per cent of the aquifer volume, as mapped by Harvest, during the three years it was on production before the 8-24 well was drilled and stated that this could not account for the 17 per cent difference between the initial pressures of the 4-24 and 8-24 wells. With respect to the regional initial Gilwood pool pressure trend provided by Harvest, Bernum contended that the trend could not be relied on because it did not include all the pressure data and some of the points shown on the trend had been interpolated to generate a smooth trend. Bernum provided regional initial Gilwood pool pressure plots that showed much more scatter in the data.

[37] Bernum also submitted that its plots of the pressure data for the three wells at issue versus time and versus cumulative fluid production showed a consistent trend, indicating that the wells were likely in the same pool. With respect to the March 2011 pressure test of the 4-24 well, Bernum interpreted the pressure to be 8288 kPa rather than the 7746 kPa used by Harvest because it believed an inappropriate fluid gradient had been used by the well testing company to convert the wellhead pressure to a reservoir pressure. Bernum argued that this higher pressure fit well with the pressure trend exhibited by the other pressure data for the wells at issue.

[38] Harvest agreed that there was a decreasing trend in the pressures of the three wells at issue. However, Harvest contended that this trend was regional and not unique to the three wells at issue but instead affected all the pools in the area. Harvest provided a plot of the regional initial Gilwood pool pressures, which showed that the overall initial pool pressures had been declining over time. Harvest acknowledged that it had not used all the initial Gilwood pool pressures, including some of the pressures that were not on the trend. Harvest indicated that it had limited its data to a nine-township area around the area of interest and pointed out that the regional initial Gilwood pool pressure plots provided by Bernum showed the same trend of declining pressures

over time. Harvest stated that the initial pressures of the 8-24 and 10-24 wells were in line with the expected values from the regional trend. Although the initial pressure of the 4-24 well was above the trend, it was still a depleted pressure. Harvest contended that the higher initial pressure of the 4-24 well was due to the nearest known Gilwood pool being more than 5200 m from the 4-24 well; the local drawdown of the regional aquifer had, therefore, not occurred to the extent it had in other areas of the aquifer. Harvest submitted that the local drawdown of the Gilwood by the 4-24 well brought the overall local pressure in line with the regional trend, resulting in initial pressures of the 8-24 and 10-24 wells that were in line with the regional trend. Harvest concluded that the pressure communication between the three wells at issue was through a common water zone. Harvest argued that Bernum's calculation, which showed that the 4-24 well had only produced 0.3 per cent of the aquifer volume during the three years it was on production before the 8-24 well was drilled, appeared to assume that the Gilwood was laterally and vertically homogeneous and that the aquifer was in perfect communication throughout its entire extent. However, Harvest contended that this was not reasonable because of the complex nature of the Gilwood.

[39] Harvest also provided a plot of the pressure data for the three wells at issue versus cumulative fluid produced, submitting that the initial pressure for the 10-24 well did not follow the same trend as the pressure data for the 4-24 or 8-24 wells. With respect to the March 2011 pressure test for the 4-24 well, Harvest used the pressure of 7746 kPa reported by the well testing company since that pressure was based on what the well testing company considered the most representative fluid gradient.

[40] The examiners believe that the regional initial Gilwood pool pressures have declined over time. Even though the regional initial Gilwood pool pressures versus time plot submitted by Harvest did not include all available data and showed a smooth curve fitting the included data, the examiners note that the plots provided by Bernum also showed a declining trend, notwithstanding the significant scatter in the data. The examiners agree with Harvest that Bernum's calculation that the 4-24 well had only produced 0.3 per cent of the aquifer volume during the three years it was on production before the 8-24 well was drilled, appeared to assume the Gilwood was laterally and vertically homogeneous enough to allow the aquifer to be in good communication throughout its entire extent. Based on their understanding that the geology of the Gilwood is complex, the examiners do not believe that this is a reasonable assumption. The examiners agree with Bernum that the plots of pressure versus time and cumulative fluid production for the three wells at issue indicate a reasonably consistent decline in pressure. However, because the pressure communication between the wells could be through a common aquifer or through a common oil column or both, the examiners are not convinced, in this case, that pool delineation can be determined from the pressure data.

Recovery Factors

[41] Based on its net pay map of the pool containing the three wells at issue and its estimated recoveries for the three wells, Bernum calculated the recovery factor for the pool to be 17 per cent. Bernum submitted that the mapping provided by Harvest for its three separate pools was unreasonable and should not be relied on because it resulted in recovery factors that were too high. Bernum noted that the recovery factors set by the ERCB for the Evi Field had an average of 21 per cent, with the highest recovery factor being 45 per cent.

[42] Based on its net pay maps of the 4-24 and 8-24 pools and its estimated recoveries for these two wells, Harvest calculated the recovery factors to be 36.9 per cent and 40.1 per cent, respectively, and submitted that these recovery factors were reasonable. Harvest did not provide an estimate of the recovery for the 10-24 well.

[43] Using Bernum's estimated recoveries for the three wells at issue and Harvest's initial oil volume in place for its three separate pools, the examiners calculate the recovery factors to be 36.9 per cent, 40.1 per cent, and 57.8 per cent for the 4-24, 8-24, and 10-24 pools, respectively. Except for Harvest's 10-24 pool, the examiners note that the recovery factor estimated by Bernum for its 3-well pool, the recovery factors estimated by Harvest for its 4-24 and 8-24 pools, and the recovery factors calculated for Harvest's 4-24 and 8-24 pools using Bernum's estimated recoveries for the 4-24 and 8-24 wells are within the range of recovery factors set by the ERCB for the Evi Field. With respect to the 57.8 per cent recovery factor estimated for the 10-24 pool being above the ERCB's highest recovery factor for the pools in the Evi Field, the examiners note that very little production data are available for the 10-24 well on which to estimate the recovery for the well. Considering that either the estimated recovery factors are within the range of recovery factors set for the pools in the Evi Field or there are limited data on which to estimate the recovery factor for the pool that is above the range of recovery factors set for pools in the Evi Field, the examiners do not believe the estimated recovery factors provide a strong basis on which to determine pool delineation.

Gas-Oil Ratios

[44] Bernum submitted that the higher GOR of the 4-24 well compared with the GORs of the 8-24 and 10-24 wells did not indicate that the 4-24 well was in a different pool. Bernum contended that the higher GOR could be explained by the 4-24 well being the structurally highest well in the pool containing all three wells and most of the gas migrating to this structurally highest well, or it could be explained by measurement and accounting practices for wells producing small amounts of gas.

[45] Harvest submitted that the current GOR of the 4-24 well was 4.6 times greater than the GORs of the 8-24 and 10-24 wells, indicating that the 8-24 and 10-24 wells were not in the same pool as the 4-24 well. Harvest stated that since the 4-24 and 8-24 wells were tied in to the same pipeline system, the back pressures on the wells were similar and could not cause the large difference between the GORs of the wells. Harvest noted that it did not know what the operating conditions were for the 10-24 well. While Harvest acknowledged that there could be measurement and/or operator errors, it believed that such errors were minimized because the 4-24 and 8-24 wells were tested at the same separator.

[46] The examiners agree with Harvest that the physical properties of oil, such as the GOR, produced from wells in the same pool should be similar and that the large difference between the GORs of the 4-24 and 8-24 wells could indicate that the wells are not in the same pool. However, considering the possibility that there could be measurement, accounting, and/or operator errors, the examiners do not believe the difference between the GORs provides a strong basis on which to determine pooling.

Findings

[47] The examiners find that the geological information is more reliable for determining pool delineation than the pressure data, the recovery factors, or the GORs.

[48] Based on their interpretation of the geological information, the examiners find the following regarding pool delineation:

- the oil producing sand in the 10-24 well pinches out towards the 8-24 well by onlap against the Precambrian high and therefore is separate from the oil producing sands in the 8-24 well;
- the oil pool encountered by the 4-24 well is separated from the oil pools encountered by the 8-24 and 10-24 wells by wet Gilwood sands in the intervening structural low in LSDs 6-, 7-, and 11-24-87-14W5M; and
- the downdip water associated with the three wells at issue is in communication with a large aquifer that is present throughout the Gilwood in the Evi Field and pressure depletion through a common aquifer can explain the low initial pressures measured at the 4-24, 8-24, and 10-24 wells.

In summary, the examiners find that the 4-24, 8-24, and 10-24 wells each encounter separate, single-well pools.

OFF-TARGET PENALTY FOR THE 8-24 WELL

Analysis

[49] Bernum interpreted the 8-24 well to be in the same pool as the 4-24 and 10-24 wells, so it was not the first well in the pool, and since the 8-24 well was drilled off target, Bernum submitted that an off-target penalty should be applied to the 8-24 well.

[50] Harvest acknowledged that it had drilled the 8-24 well off target. However, since Harvest interpreted the 8-24 well to be in a separate pool from the pools encountered by the 4-24 and 10-24 wells, it submitted that no off-target penalty should be applied to the 8-24 well.

Findings

[51] Since the examiners find that the 4-24, 8-24, and 10-24 wells each encounter separate, single-well pools, the examiners conclude that no off-target penalty should be applied to the 8-24 well.

Dated in Calgary, Alberta, on December 20, 2011.

ENERGY RESOURCES CONSERVATION BOARD

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G. W. Dilay, P.Eng.
Presiding Member

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B. A. Austin, P.Geol.
Examiner

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T. L. Byrnes, P.Eng.
Examiner

APPENDIX 1 HEARING PARTICIPANTS

Principals and Representatives (Abbreviations used in report)

Witnesses

Bernum Petroleum Ltd. (Bernum)
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B. L. Robinson

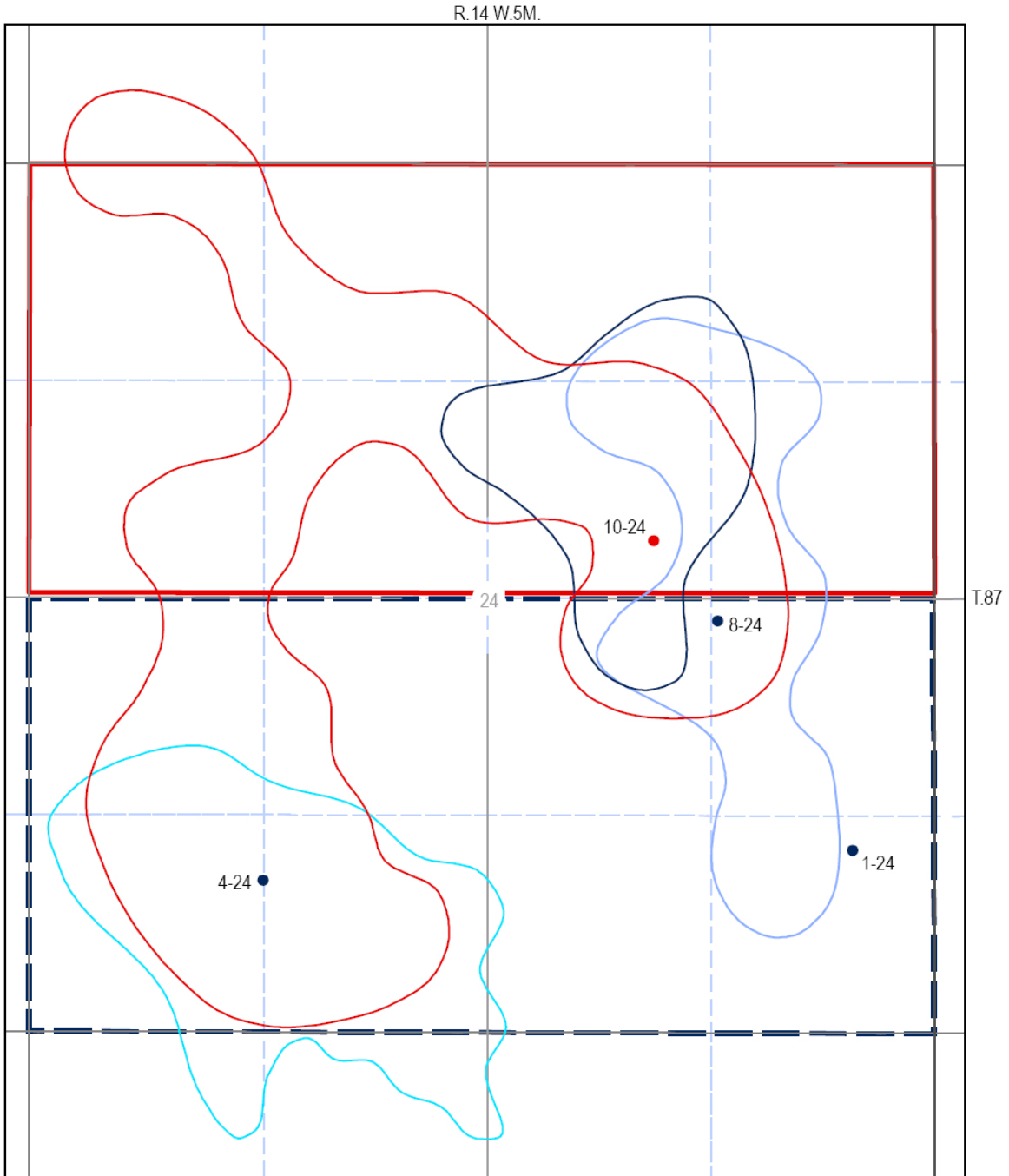
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Legend

- | | |
|----------------------|-------------------------------|
| ● Harvest well | <u>Pool outlines</u> |
| ● Bernum well | □ Harvest pool for 4-24 well |
| <u>Land interest</u> | □ Harvest pool for 8-24 well |
| □ Harvest | □ Harvest pool for 10-24 well |
| □ Bernum | □ Bernum pool |

Figure 1. Map of the application area