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Honorable Hazel Rollins O'Leary  
Secretary of Energy  
Department of Energy  
1000 Independence Avenue, S.W.  
Washington, D.C. 20585

Dear Madame Secretary:

A peer-reviewed paper published at the end of last year has extremely important policy implications. It reflects studies by Dr. Leigh Price, a creative USGS geologist/geochemist with a good track record of beating conventional wisdom, and Julie LeFever, a more conservative North Dakota state geologist. They identify a vast potential in-place crude oil resource base here in America which is currently omitted from all resource estimates. If that resource could be proven up, North Dakota alone might double our country's crude oil reserves.

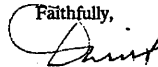
Needless to say, this kind of potential is by no means a certainty and it requires attention, evaluation and development to translate into real jobs, production and proven resources that could profoundly affect our lives, assuming the idea is right on track. And some will insist that government simply can not stimulate exploration or production progress that the private sector has thus far missed.

The potential scale is so great, however, that I feel confident you will want to assure intense and urgent examination of Price and LeFever's extraordinary ideas, at your personal direction. As a first step, I enclose three documents: (a) my four-page summary of the studies and some implications for DoE; (b) the Price-LeFever article: "Does Bakken Horizontal Drilling Imply a Huge Oil-Resource Base in Fractured Shales?" in *GEOLOGICAL STUDIES RELEVANT TO HORIZONTAL DRILLING: EXAMPLES FROM WESTERN NORTH AMERICA* (Rocky Mtn. Assoc. of Geologists, Denver: 1992) 199-214; and (c) Price's current c.v.

I trust the Department would find interest in an unsolicited proposal to advance concepts for enhanced recovery of the Price-LeFever in-place oil resource base.

Best personal wishes.

Faithfully,



David J. Bardin

Enclosures

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Summary

- New studies and a peer-reviewed article by Leigh Price, USGS, and Julie LeFever, N.D. Geol. Survey, indicate that enormous crude oil resources wait to be tapped in North Dakota:
  - \* at least 100-150 billion barrels in place -- perhaps 250.
  - \* this resource is omitted from all current resource base estimates -- just as coal-bed methane used to be omitted as a gas resource until a couple of years ago.
- North Dakota alone may double the U.S.A. oil reserves.
  - \* Applying similar analyses across the U.S.A. may add several times the reserves of Saudi Arabia to potential crude oil resources for the lower-48 contiguous states.
- DoE needs to examine whether technology currently exists or can be readily developed to enable commercial production.
  - \* There is enormous job-generating potential at generally low environmental costs and risks.
  - \* There are extraordinary international strategic stakes.
- This is a very desirable, marketable crude oil, at accessible and environmentally-acceptable locations.
  - \* This is a 40-45° API gravity crude.
  - \* It is mobile and found at depths up to 10-11,000 feet.
  - \* It is not waxy and thus easily producible.
- Some has been produced already from non-optimum areas (but not in great quantities) despite use of production techniques inappropriate for the resource base.
- Much of the in-place oil could be produced -- in all probability -- but the well drilling and completion and production techniques, including pressure maintenance, have to be tailored to this resource, or operators will miss most of their opportunity, making many prospects uneconomical.
  - \* Like coal-bed methane, the correct techniques may be quite simple, yet seem radically innovative at first.
  - \* Each North Dakota well will cost hundreds of thousands of dollars. Recoverable reserves may be 1-5 million barrels per well or even more. However much remains to be tested and demonstrated.
- DoE could spark private and public sector attention and debate, and sponsor testing and demonstration projects.

1. Price & LeFever studies identify possible vast in-place oil resource bases

US Geological Survey senior geologist/geochemist Leigh Price and North Dakota Geological Survey geologist Julie LeFever have just published a peer-reviewed article suggesting enormous crude oil resources waiting to be tapped. "Does Bakken Horizontal Drilling Imply a Huge Oil-Resource Base in Fractured Shales?" in GEOLOGICAL STUDIES RELEVANT TO HORIZONTAL DRILLING: EXAMPLES FROM WESTERN NORTH AMERICA (Rocky Mtn. Assoc. of Geols., Denver: 1992) 199-214.

- Price is a senior research geologist at the USGS, Denver. He is a well-known, independent, controversial and daring thinker who has no fear of challenging accepted wisdom. Two previous challenges to accepted wisdom, which are now accepted paradigms, are:
  - \* ability of oil to migrate from source rocks to reservoir rocks in gas-phase solution;
  - \* non-local generation of oil, in the deeper parts of petroleum basins ("oil kitchens"), with extensive vertical and horizontal migration, to shallower reservoir rocks.
- Price's professional recognition includes several awards by the AAPG and regional geological associations and editorship of the Journal of Petroleum Geology in 1992.
- LeFever is a more conservative thinker in her state's government who is responsible for stimulating resource utilization.
- Price and LeFever have studied this resource for years.

2. Estimated size of North Dakota's Bakken shale resource

Focusing solely on North Dakota Williston Basin's Bakken shales, Price & LeFever estimate at least 100-150 billion barrels in place -- perhaps as much as 250 billion barrels.

- This in-place resource is omitted from all current resource base estimates -- just as coal-bed methane used to be omitted as a gas resource until a couple of years ago.
- If this North Dakota oil resource could be proven with a 20% recovery factor, we would add 20-30 billion barrels or more to -- and so double -- DOE/EIA's current estimate of 25 billion barrels of proven, remaining, recoverable crude oil for all of the United States combined (including Alaska)!
- DOE/EIA estimated that North Dakota's year-end 1991 proven, remaining recoverable crude oil was 232 million barrels -- perhaps 0.1% of the Price-LeFever in-place resource base.

### 3. Nature of North Dakota's Bakken shale crude oil resource

This in-place resource is a desirable commodity, readily marketable as soon as it can be commercially produced. It will displace oil imports, and thus could favorably and significantly impact the U.S.A. balance of payments.

- This 40-45° API gravity crude oil is an extremely desirable refinery feedstock.
- It will flow up the well bore. (This is not a synthetic fuel to be made by heating the shales. Past geologic heat flows have already made the oil.)
- It is found at depths up to 10-11,000 feet.
- Because it is not waxy, it is easily producible. It is mobile, and some has been produced already (but not in great quantities, only about 5 million barrels) despite the operators' use of technologies that reflect serious misunderstanding of and are inappropriate for the resource.
- The resource base exists in regionally interconnected fractured networks which should be highly amenable to sustained recovery using appropriate secondary oil recovery techniques -- which the DoE is already examining in a program seeking to exploit a part of some 76 billion barrels of the in-place conventional oil resource base.
- A significant portion of Bakken oil possibly could be produced -- but well drilling, completion, stimulation and production techniques, including pressure maintenance, have to be tailored to the non-conventional characteristics of the resource.
- Industry has spent roughly half a billion dollars on a horizontal drilling program in the Bakken shales without finding an effective, economical approach. These efforts concentrated on non-optimum portions of the Williston Basin and used drilling, completion, stimulation and production techniques quite inapplicable to the characteristics of this resource base.

### 4. What DoE should do

The issue which DoE needs to resolve is whether technology is already available -- or can be readily developed -- to enable commercial recovery of such in-place oil resources.

- Like coal-bed methane, the correct techniques may turn out to be quite simple, yet seem radically innovative at first.
- These North Dakota wells will only cost hundreds of thousands of dollars each. Recoverable reserves may be 1-5 million barrels per well or more. However much remains to be tested and demonstrated.
- There is an enormous job-generating potential associated with this resource base at generally-low environmental costs or

risks.

- There are extraordinary strategic stakes.
- Profound and responsible curiosity should impel DoE now.
- Affirmative findings might reverse the U.S.A.'s decline as a crude oil producer within a very few years.
- Even before significant production is achieved, just proving up a significant new petroleum province will be strategically important (as was North Sea, for example).

#### 5. Implications beyond North Dakota

The potentials go well beyond North Dakota. Turning to what is known of the organic-rich source rocks and petroleum geochemistry of other basins, Price & LeFever speculate that in-place oil resources on the order of tens to hundreds of trillions of barrels may exist in the lower 48 contiguous states.

- If you assume ultimately proving up 10 trillion barrels in place with a 10% recovery factor, you would be considering one trillion barrels of recoverable oil.
- Current crude oil reserve estimates are 260 billion barrels for Saudi Arabia and close to one trillion barrels for the world as a whole.

#### 6. Why this resource has been overlooked

The Bakken shale of North Dakota is, conveniently, one of the best known and most studied organic-rich source rocks in the world. Price and LeFever's extraordinary estimates reflect the following principal factors:

- Contrary to industry beliefs through the 1980s (formerly shared by Price), almost none of the oil in place in the North Dakota Bakken shales ever migrated from the shale ("primary migration") and none of the shallower conventional production in North Dakota has come from the Bakken shales.
- The Bakken shales contain much more oil than previously estimated. Past analyses of Bakken rock samples were misleading because most of the oil escaped into the drilling fluids as rock chips moved up the well bore and pressures dropped.

Petroleum geology deals in issues of great uncertainty and is still a developing field. Petroleum geochemistry is an even less exact science at this time. It often takes a long time for new ideas to get real attention and to take hold.

#### 7. Conclusion

DoE can go far to accelerate evaluation and development of this resource by judicious, timely, efficient and persistent interest and a relatively modest level of effort.