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This water is very different from other coalbed methane waters. It is low salinity. What it has is a peculiar chemistry. It is sodic water. A very high amount of the total dissolved solids in this water is due to sodium. We have almost no calcium and also no magnesium. It’s because of that peculiar water chemistry, and only because of that, that we have a conflict between the use of the water for irrigation and the soil types. Clay-rich soils are probably about the worst kind of soil you can have for that. Nonetheless, this water meets drinking water standards, fit for human conception. And in many cases, the water is superior in quality coming out of the coal seams than it is for shallow water coming out of the Wasatch Formation.

Thank you.

A REVIEW OF CBM DEVELOPMENT IN THE POWDER RIVER AND OTHER WYOMING BASINS

DON LIKWARZ, Director, Wyoming State Oil and Gas Conservation Commission

Thank you very much. I’m glad to be here this morning. We thought it would make more sense if Lance got up first and set the stage. I’ll get into the details. I’m known as “Mr. Facts” because I have all the data. We have a really good web site that’s updated on a daily basis electronically, so some of the data is brand new, and some of it is two or three weeks old. So it won’t agree with some of the information you heard over the last few days. Again, I may be repeating some things, but I’m trying to make sure you come away with some of the key points.

As Lance said, this is totally different than any other large coalbed methane development taking place. It works because the depth of the coals is shallow. It starts at about 200 feet from the surface just west of those strip mines that were shown on some of the information this morning, and it’s moving west at about two to three miles a year. And this is what we call the fairway. Where most of the producing wells are at right now is about 15 miles from the west—from the mines out about 15 miles west—and about 55 miles north to south. So about a 1,500 square mile area. We are now also moving northward to the Sheridan area where there are a couple of pilot projects going on, and then up along the Powder and Little Powder towards the Montana/Wyoming state line.

Most of the drilling, to date, probably averages about 950 feet deep. As a result, using the small truck-mounted
water rigs, it takes about three to six days to drill and complete these wells from start to finish. As we also mentioned earlier, in the state of Wyoming, statutory spacing is 40 acres, but in March of 2001, the Oil and Gas Commission had a rule making where they changed the spacing to 80 acres for one well in the northwest and southwest quarter; and that’s what now applies through the rest of the Powder River Basin. Main targets are very thick, I’m not going to go into detail. They are completed open hole, and they are not stimulated. They don’t need any type of acid treatments or fractures, not with one or two darcies of permeability. So again, it’s different from the San Juan Basin and the Black Warrior Basin in that regard.

We are seeing a few operators now use commingled production, but typically this takes a thicker coal at the bottom, which is completed open-hole, and then they perforate the coals above it. They’re going to have to use more of that technology on the fringes of the basin, because of the thin coal stringers. Initial water rates run between about 400 to 800 barrels of water per day; that’s equal to about 12 to 25 gallons per minute. But as we go west into the deeper coals, like the Big George that Lance pointed out to you, we’re seeing rates of 1,000 to 1,500 barrels of water per day. Gas production typically is from 150 up to 500 thousand cubic feet per day, although we have seen some wells at 1 to 2 million CF per day. The reserves are running about 250 to 500 million cubic feet. They’re not big wells, but because we have so many of them, that makes up for the type of wells that you have down in the San Juan Basin, for example.

Lance showed one slide that said the average life is about seven and a half years. Some of these coals are going to be produced in four years, some are going to go as long as ten, but the average that we have in the EIS and this study came up with seven and a half years. When we first started doing this in March of 1998, we had 300 wells. We didn’t know what a well decline curve looked like because we didn’t have enough data points. Some of those wells had been on production for 10 or 12 years, but they had been drilled unbounded. In some wells, they drained 160 acres. They were, in all cases, limited by the amount of take away capacity for pipelines, so it was limited production. We really didn’t know what a curve should look like.

**POWDER RIVER BASIN CBM**

- Depth to coals 200’–2500’ but most drilling 200’–1200’ to date.
- Takes 3–6 days to drill & complete wells using small water well rigs with diverters.
- 40 acre statutory spacing changed to vertical 80 acre units in NE and SW in 03-01 rulemaking.
- Main target thick coals (50’–150’) completed with under-reamed open holes. Casing set at top of coal. No stimulation required.
- Some operators using commingling with bottom coal completed open hole & 1–2 upper coals perforated.
- Initial produced water rates 400–800 BWPD in Fairway but have seen 1000–1500 BWPD in deeper wells in Basin center. Max. gas rates 150–500 MCFD.
- Reserves of 250–500 MMCF recovered in 4–10 years (avg. 7 years).

The Powder River Basin environmental impact statement: Not a lot of detail because Richard Zander will be covering this, but it began in June of 2000 with three scoping meetings. We’ve learned from some of the problems that they had in the San Juan Basin, so the Governor asked if we could become a cooperating agency with the BLM on their EISs. They made that offer, we accepted it, and Lance and I have been either lead or co-lead on three EISs so far. That allows us to be part of the interdisciplinary team, which actually selects the various alternatives that are studied. In the case of the Powder River Basin EIS, we went a step further. A number of counties had asked to be a cooperating agency on the EIS, but the BLM said that wasn’t something they were prepared to do at that point. So we helped create a joint powers board and all of the counties affected—Sheridan, Johnson, Campbell, and Converse, plus Carbon County, who’s going to see some activity down in southern Wyoming in Atlantic Rim—got together and became a cooperating agency through us and participated from the start. It’s key to get those local people involved as soon as you can.
• Process began June 2000
• 51,444 CBM/3,200 oil and gas wells
• 12,500 square mile area or 8 million acres. All of Campbell, Sheridan and Johnson Counties & N of Converse County
• 3.6 BCFD maximum production
• Minerals 54% Federal land, 37% Fee and 9% State
• Surface 14% Federal land, 77% Fee and 9% State
• 3rd Qtr. 2002 approval
• Held scoping meetings in 4 cities 6-00
• BLM stopped accepting APD’s 08-11-00 after reaching 5890 cap in Wyodak EIS

The other thing I want to point out, when BLM does one of these NEPA documents, they have to suspend permitting in that area. However, these documents have to look at the effects of wells on all the minerals. The State and fee minerals have to be in there as well so you can look at all air and water impacts. But while the BLM has to shut down permitting, my agency continues to issue permits on the other two minerals. As a result, this creates a situation where Federal minerals are being drained. If you recall some of those pictures from earlier, the individual ownerships are interspersed, so that it is almost a checkerboard. So a lot of the Federal acreage is surrounded on all four sides by State and fee wells. This has created another problem for them. Richard can confirm this, but I understand that this is the largest environmental impact statement that’s been done by the Bureau of Land Management. The Wyadak EIS that was completed in November of ‘99 looked at 5,900 wells.

The study is assuming that we will drill 51,444 wells over about a ten-year period, but we also are looking at 3,200 conventional oil and gas wells on 12,500 square miles or 8 million acres. The area that’s been developed, to date, is probably between 1,500 and 1,800 square miles. Maybe 10 percent of the acreage has been under development. Mineral ownership is 54 percent Federal, but only 14 percent surface. There’s a 40 percent difference there. So the fee or private ownership, while it’s only 37 percent of the minerals, becomes 77 percent of the surface. That 40 percent, I guarantee you, has caused all the difficulties and problems we’ve had to wrestle with.

Maximum production in the EIS is 3 to 6 billion CF per day. In December, we produced a little over 800 million CF per day, so this would be an increase of four and a half times what we had last year. To further put that in perspective, the entire state of Wyoming from all sources of natural gas is 4.5 billion cubic feet per day. We’re anticipating a record of decision some time in 2002.

I’m skipping past some pilots. I was at one point going to go through the seven or eight pilots in southern Wyoming. They will be in the proceedings [see last page].

Drilling permits. So for this year, we’ve issued 1,500, about 40 less than last year. But in the year 2001, 8,865 coalbed methane permits were issued by my organization. That’s 24 every single day of the year and 35 on a workday basis. That was up 40 percent from the year before, which was up 25 percent from the year before. And on March 28th, we issued our 25,000th well permit. I’ll point a couple of other things out here. We’ve issued 25,000 permits, but only 25 percent on Federal acreage, when they should have 54 percent. The first coalbed methane wells were drilled in 1986, but it took some companies a long time to stay with it and figure out how to make it work. Drilling really didn’t pick up until the last part of ‘93. This play has never used any of those gas and oil unconventional reservoir Federal tax credits.
The gas production slide shown here is for the past nine years because we had small amounts, less than one billion CF per year, up through ‘92. Since that time, production has increased at an average rate of 100 percent. Last year, our increase was 67 percent per year. Over the past year, we’ve produced at a rate of about 100 MCF per day per well. The production so far has been 74 and a half percent from fee or private minerals, 17 and a half percent from Federal, and 8 percent from State, accounting for about 15 and a half percent of the total state production.

Water rates: similar to gas slide. Although it hasn’t been increasing quite as rapidly as the gas, about 81 percent per year, but last year it only went up 36 percent. What we’re seeing in the Powder River Basin, water production generally drops 50 percent within 12 to 18 months of initial production.

We have partial dewatering of the coals, and the gas starts coming in at excellent rates, again, due to the excellent permeabilities. Then last year the 515 million barrels per year was an increase to about 1.4 million barrels of water per day, but it’s been on decline since April, and it had an increase of only 36 percent from the prior year. Gas production was twice that rate. That’s about 182 acre feet a day, 92 cubic feet per second, and about six and a half gallons a minute. A typical hose in the backyard is 25 gallons a minute, and the rate in December was down to 5.2 gallons per minute. So it’s dropping off very rapidly. Even though we’re adding wells on production, the base is so big that the water rate is declining.

I have one more slide, on coalbed methane water issues. I want to make a couple points there. It’s complicated in Wyoming because not one agency has all of the responsibility for the water production. You first have to get a permit from the State Engineer to give you an allocation to use that water. So every coalbed methane well has to have a State Engineer’s permit. Every water well drilled by the individual landowners is supposed to have a permit too, but we found out that generally wasn’t the case. Then, if you’re going to discharge that water, unless it goes directly into a reservoir, you have to have a discharge permit from the Department of Environmental Quality. You also have to come to me, in some cases, if you’re not going to reinject in the shallow zones and the BLM gets involved. There’s a lot of coordination, that’s why we formed the Governor’s CBM Work Group in January of 1999. We then got together with the Bureau of Land Management, all the county commissioners, conservation districts, and some of the royalty owners. We next got the agricultural groups involved, and they used some coordinated resource management plans. You get all the state holders involved and
try to come up with some agreements on how to handle the water. We then started studying individual drainages with all the operator’s development plans, rather than one company in isolation.

There are some areas where you can’t get a discharge permit right now. As a result, the Oil and Gas Commission has permitted 38 large pits. They’re one to five acres in size. We also have been bonding the pits to ensure they’ll be closed without us having to do that for them. 25 of them are in the Sheridan and northern Campbell areas, because there are no discharge permits in the area, these are on the Powder River, and four of them are down in Carbon County.

Reinjection: I keep hearing that; let’s use reinjection. You don’t want to do that under the class two program that I was delegated under the EPA, because you’re going to take what’s good quality water—and I agree with Lance—especially in the areas close to the mines where you’re going into the Belle Fourche River, that’s excellent water. A lot of the people have been using the same water from the same coals for drinking water and

CBM WATER ISSUES

• Involves 3 state agencies and BLM so coordination required. Mostly good quality water in Fairway.
• WOGCC permitted and bonded 38 large pits (1–5 acres): 25 in Sheridan, 3 in Johnson, 6 in Campbell, and 4 in Carbon. Where DEQ not issuing NPDES Permits.
• Re-inject split with DEQ. WOGCC only issued 24 permits as CBM water has to go into zone with poorer water quality (5–10,000 PPMTDS).
• Water well agreements offered to landowners. Permit all water wells and do baseline survey.
certainly for livestock water. If you do it through me, the disposal zone has to be at five to 10,000 parts per million. You will not be able to use it for anything. I maintain that this valuable water resource would be ruined.

Most of the reinjection has been done under DEQ, under their class five program. Since the water is going into similar water quality reservoirs. But I can tell you of the 18 of them they’ve tried, only one has worked, and that’s the one going into the city of Gilette’s water supply. The shallow aquifers will take only a small amount of water before pressuring up, and we won’t allow anybody to fracture out of zone where they have those aquifers, so they have not worked in the Powder River Basin.

In areas where we have the higher SARs, higher TDS, there wasn’t conventional oil and gas. So it’s going to be a problem. They’re going to have to come up with some type of treatment—maybe chemicals or more pits through me, but it’s going to cost more. The costs that we see are usually double what you saw yesterday in the information that was presented. We are doing some injection down in southern Wyoming because they’re not going to be able to use surface discharge there. Anything that drains into the Colorado River or the Green River is restricted among the various states and also Mexico. So that water is going to have to be reinjected or put into pits that are permitted through my agency. We have water well agreements issued to the land owners. This is a BLM requirement. We strongly urge every operator, some two or three person outfits, independents, and a couple of majors to do this. We’ve asked them to give that water well agreement to everybody. What it says is if a coalbed methane well is drilled within a half mile of your well, affects your well, and water drops off, the operator has to either repair it or replace it.

Data on other pilot projects:

**WASHAKIE BASIN CBM**
- Atlantic Rim EIS for 3880 Wells in W. Carbon Cty began 8–01. BLM allowing 200 wells to be drld on 9 pods during 2 yr period.
- 4 coals 5–20 ft. thick at 300–3000 ft. depth. 5–15 days drlg & compl. Most wells cased & perfed & will frac if req’d. Mixture of 40 & 80 acre spacing
- 130 APD’s issued, 24 prod. & 2 inj. wells drld & 1 Prod using submersible pumps.
- Est. 100–1800 BWPD/well with 380–1300 TDS & 3–47 SAR into off channel reservoirs or reinj. into Deep Creek & Cherokee Sands at 4100–4500 ft.
- 46 well Pipeline Pilot in E. Sweetwater Cty Prod 3–5 Almond & Lance coals at 2500–2900 ft. 40 acre spacing.
- 20 APD’s issued, 10 wells drld & 5 prod. 10–625 MCFD, 15–65 BWPD, & 20–175 BCPD using rod pumps. SDS not perfed but coals fraced.
- 2 Inj. wells drld to Fox Hills at 1500 ft.
- Rock Ridge Pilot (Greasewood Wash) in Sweetwater Cty began with 3 wells on 160 acre spacing in 4th Qtr ’97. 6 wells on 40 acre spacing added late ’00.
- Prod. 10–90 MCFD (15% CO2) & 150–500 BWPD from 5–7, thin (7–10 ft.), low “K” R.S. coals at 3800–4500 Ft. using PCP’s. Also prod. 4 BOPD.
- 3000–4000 TDS water reinj. into 1 Ericson well at 5500 ft. & 1 Nugget well at 10,500 ft. Gas being vented.

**HANNA BASIN CBM**
- 9 wells drld at Hanna Draw Pilot in Carbon Cty at the same location as Metfuel’s 3 well pilot in ’90. EA ROD due for 16 more wells.
- 3 coals 20–50 ft. thick at 3400–4500 ft. 15 day wells using conventional rigs. Unstimulated, cased hole comp. With PCP’s.
- Prod. 1–2 MCFD & 50–1350 BWPD/well. Gas vented. 2400 TDS water into 2 WOGCC off channel pits & 1 SEO pond.
- Seminole Road Pilot in Carbon Cty. Will have 18 CBM wells on 160 acre spacing from Almond and Allen Ridge coals.
- Conventional rigs drilled 6000 ft. wells in 15–18 days. Unstimulated, cased hole comp. with rod pumps.
- 6 wells on Prod. 4th Qtr.’01 making 300–600 BWPD with 1300–2000 TDS & 25 SAR discharging into ephemeral stream draining into Seminole Reservoir .

**GREEN RIVER BASIN CBM**
- Blake Hollow Pilot in Uinta Cty has 4 Prod in Evanston coal at 2500–3000 ft. on 80 acre spacing.
- Using PCPs to produce 3–17 MCFD & 135–255 BWPD. Gas being vented.
- Reinj. _________ water into Frontier at 6700 ft.
- 1st. Qtr. ’02 Riley Ridge Pilot in Sublette Cty has 5 spot on 108 acre spacing. Took 10–15 days to drill & compl. 2500–3500 ft. wells into thin Mv coal.
- Est. Prod. 200 MCFD/well using Rod pumps.
- Est. 2–500 BWPD/well with 2000–3200 TDS & low SAR will be reinj. into Mv at 4100 ft.