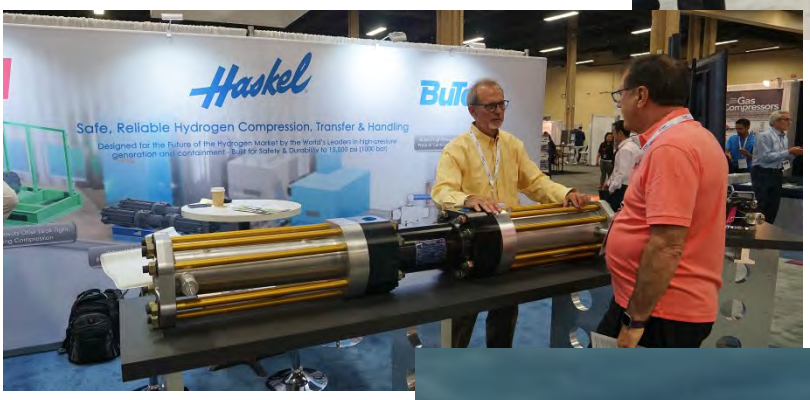
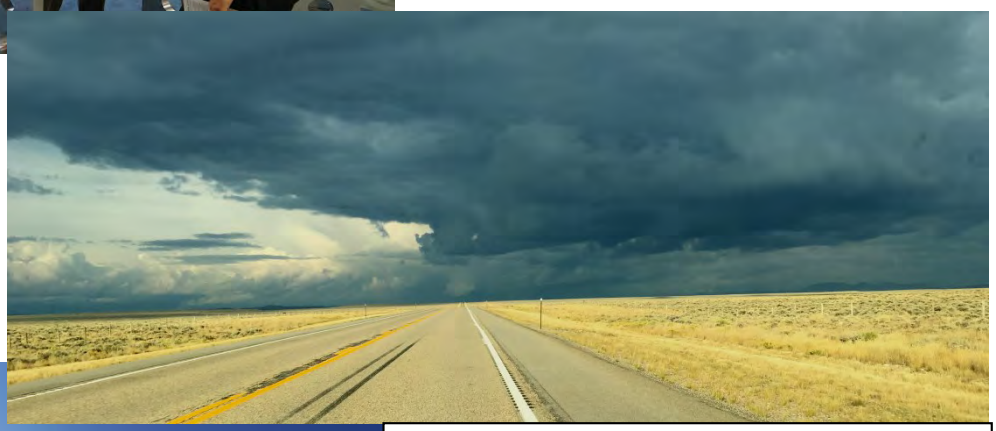
Energy

Solar Hydrogen Gas

US/Canada





The plains of Wyoming as a storm approaches

Gerry Wood MLA September 2017

REASONS FOR THE TRIP

- To attend a solar/hydrogen and fuel cells conference in Las Vegas
- To study gas production in the US and Canada including hydraulic fracturing
- To learn and pass what I learnt on to others

Mandalay Hotel

My trip to Las Vegas will always be clouded by the terrible events that happened there only two weeks after I attended the conference. The conference was held at the Mandalay Convention Centre next door to the Mandalay Hotel from where the gunman opened fire on so many innocent people.

The Las Vegas Strip—the fatal concert was held across the road

Day 1 Friday 8th September

Left Darwin on the early morning flight to Sydney. Then the long flight to Los Angeles and onto Las Vegas arriving on the same day. One day lost!

Day 2 Saturday 9th September—Nevada—Las Vegas

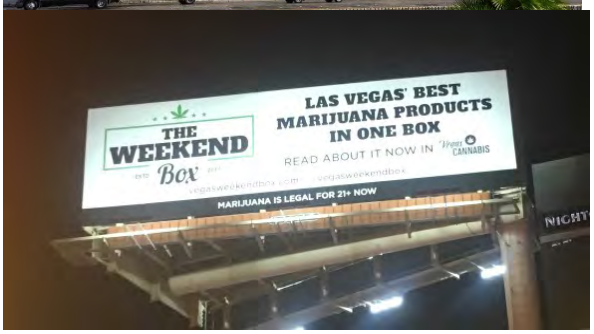
Spent part of the day recovering from jet lag so decided to walk the Las Vegas Boulevard or The Strip as it is locally called. Las Vegas is in the State of Nevada and has a population of over 600,000 people. It is also in the Mojave Desert and that is reflected in the style of many of the gardens around the city. The walk down The Strip is certainly an eye opener and you soon get the feel of the place – money. Extravagant architecture, copies of famous landmarks like the Statue of Liberty, huge billboards, fountains, towers, casinos, and people everywhere. The city is open 24 hours. It attracts people from all over the world and you see that just walking down the street. There are pokies (slots) everywhere including at the airport and you can buy alcohol at your local fast food restaurant. People even walk around the street with coolers on wheels selling alcohol.

One of the highlights for me was travelling up the Stratosphere Tower which is 363 metres high. You can see the whole of Las Vegas while you enjoy a meal at the restaurant. It has other attractions like the thrill rides and the big jump which I didn't try. Perhaps we need something like that at Myilly Point – just a thought.

The other highlight was the beautiful fountains that dance to music during the day and light up at night. That is free and certainly a great attraction – perhaps something else for Myilly Point.

There were plenty of shows each night although the only two from Australia were a Bee Gees tribute band and Manpower!

But Las Vegas is just a big extravagant city obviously built on the gambling industry because who else would build pyramids, Roman statues, the Eiffel Tower, the Trump Tower and much more. The pokies take your money the same as in Darwin so nothing different there. The place was an eye opener but for me, once was enough.



Day 3 Sunday 10th September

This was the first day of the conference with the official name of Solar Power International – Energy Storage International Conference. It is the show piece for the Solar Energies Industries Association and Smart Electric Power Alliance. For the first time at this event Hydrogen + Fuel Cells North America was part of the conference which was what I was mainly interested in. Hydrogen and Fuels Cells are based in Europe and I became interested in hydrogen technology when I saw them at the Hannover Messe (Fair) about 3 years ago.

This conference was huge with over 20,000 people attending and around 700 exhibitors so it is a major event in the United States and attracts people from all over the world. There were a number of workshops on the opening day but they were invite only and quite expensive for non-members which was disappointing especially as it was not cheap to attend the conference. But there was a presentation in the afternoon called Solar101 – a solar fundamentals course -which enabled attendees to learn about the technical and business side as well as regulations and policies around the solar industry and to be better prepared for what would be happening over the following days. All attendees had to say where they were from and why. I think I was the only one from Australia although there was one exhibitor from Australia.

Presenters were Shawn Mummery from Solar Energy Industries Association and Daisy Chung from Smart Electric Power Alliance. With 700 exhibitors there were a lot of things happening.

After that there was the official opening by Julie Hamm, the President and Chief Executive Officer of Smart Electric Power Alliance, and Abigail Ross-Hopper, the President and Chief Executive Officer of Solar Energies Industries Association.

Day 4 Monday 11th September

Caught the shuttle bus early from Holiday Inn to the Mandalay Conference Centre which gave me an opportunity to meet some of the attendees over a 'jelly' donut and coffee at the convention centre. You can even have a beer from Johnny Rockets for breakfast – that's Las Vegas! John was from Massachusetts, Leo from Canada via Jamaica and Alan from Washington State.

The conference started with a general session on Section 201 which I had never heard of until then. It seems two US companies believe that cheap imports are affecting their business and they have applied to stop those imports. Section 201 of the 1974 Trade Act is the United States' "global safeguard" law. One of the companies, US solar company, Suniva, filed a petition in May claiming 'injury' and that case will be heard by the International Trade Commission. President Trump will make the final decision in January. This is the solar industry's

position: *We believe that the imposition of tariffs and price floors for imported CSPV cells and modules would damage the entire solar industry. The proposed tariff could double the price of solar panels in the U.S., crippling demand and costing 88,000 jobs in the industry. As one of the least expensive energy sources in America, solar is a major force in the U.S. economy, spurring billions of dollars in investment each year. This incredible growth will be stopped in its tracks if this petition prevails. GTM has estimated that Suniva's sought after protections would slash new solar projects by two-thirds, or a total of 47 gigawatts by 2022. That's more solar than has ever been built in the U.S.*

So you can see there was a lively discussion about this topic which for visitors to the US seemed to be a very US problem that others weren't overly interested in. Needless to say it was unusual that an American Industry was fighting for cheaper imports over its own locally made industry. What is strange here is that Suniva is a Chinese owned company based in the US. The latest on this case as at Sept 25th: *The US International Trade Commission on Friday voted unanimously in favour of proceeding with the Suniva/ SolarWorld Section 201 trade case, finding Chinese solar imports are "a substantial cause of serious injury to the domestic industry," despite the claims and evidence of virtually the entire US solar industry.*
Watch this space.

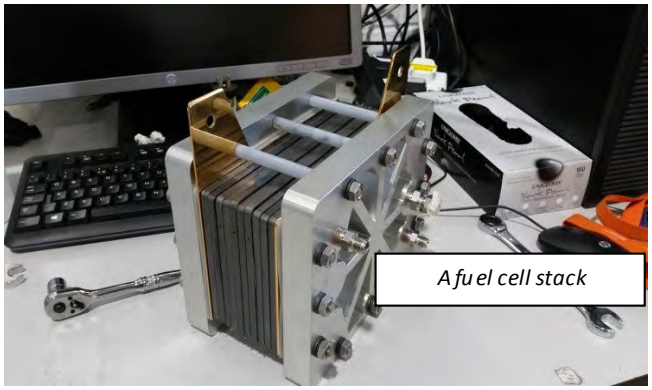
Interestingly in Australia there is only one company making solar panels in Australia, called Tinto Solar. It currently employs 25 people in Adelaide and another 20 nationally, was founded in Adelaide in 2011 and aims at producing high quality solar panels for the upper end of the market. In 2014 it petitioned Australia's Anti-Dumping Commission to investigate claims that the domestic market was being flooded with cheap Chinese PV at prices undercutting domestic sales, or the cost of manufacture. In 2015 Australia's Anti-Dumping Commission, after looking into solar panel imports from China, found that the domestic industry wasn't significantly hurt by the purchases.

After that long discussion the exhibition hall was officially opened which of course was what I was anxious to enter. There were solar and storage exhibits from countries all over the world – some had certainly put a lot of effort into making sure their exhibits attracted potential customers. But I quickly headed off to the hydrogen section where the first talks were about to commence.

Hydrogen workshop

The opening talk was about *How to Connect the Solar Industry and the Hydrogen Industry* which was really interesting considering that much of this conference was about battery storage. This was an opportunity to hear about the production of hydrogen using renewable energy and how hydrogen used in fuel cells is an alternative to battery storage.

A fuel cell is a device that converts chemical potential energy (energy stored in molecular bonds) into electrical energy. A PEM (Proton Exchange Membrane) cell uses hydrogen gas (H_2) and oxygen gas (O_2) as fuel. The products of the reaction in the cell are water, electricity, and heat. This is a big improvement over internal combustion engines, coal burning power plants, and nuclear power plants, all of which produce harmful by-products. Since O_2 is readily available in the atmosphere, we only need to supply the fuel cell with H_2 which can come from an electrolysis process.


A fuel cell stack

One of the great things about fuel cells is that they can store energy from wind and solar when they are producing unused energy and that energy can then be released from the fuel cells when needed. It can also be blended with natural gas to reduce emissions. It can be produced on site and used in trucks, ferries, fork lifts, etc. Shell and other companies are already filling cars especially in Germany. Fuel cells have advantages over batteries – they take up less space and are quickly filled as against the charging time of batteries. To charge a large number of cars at a service station would require a huge upgrade of underground electrical infrastructure. There was some discussion about the SA electricity system and the battery storage the Government and Tesla are installing. It was noted there is a lot of waste in the system and batteries can only store energy for a short time. It was said that hydrogen fuel cells in this case win hands down as they are not capacity limited.

Hydrogen transfer and handling equipment

Hydrogen tank

There were other subjects discussed throughout the day covering such topics as hydrogen high pressure compressors, coatings for fuel cells, fuel cell electric vehides and hydrogen infrastructure, solutions to produce, store and distribute hydrogen, hydrogen storage tanks, pathways to green hydrogen, renewable electrolysis and the Canada hydrogen experience – and that was only day one. Presently petrol is cheaper than hydrogen for cars but that will come down as more hydrogen is produced by renewables. With battery operated electric cars, fuel cells can help keep the battery charged.

Hydrogen fuelling systems

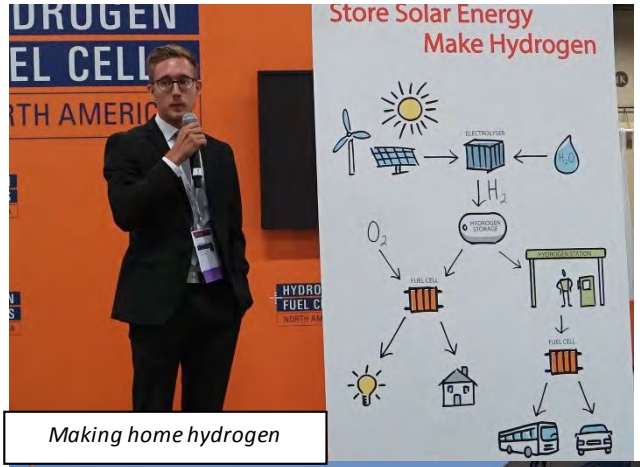
Naturally I could not get to all the talks because there were so many exhibits and talks going in the convention centre, and it was a massive convention centre – my feet knew it.

Day 4 Tuesday September 12th

The day started off with a technical session which I thought I could handle but it was a bit too technical for me. The subject: *How to lengthen the life of a battery!* The general discussion was about the limitations of advancing batteries to be able to store and retain more energy and it wasn't long before the physics and the chemistry got above me. But it was all part of the learning curve seeing what advances are being made in the energy storage market specifically batteries.

Making batteries last longer—storage

Had another 'jelly' donut and coffee with a farmer from Illinois who was putting in some solar panels



Making home hydrogen

on his farm. He said many farmers near him don't want anything to do with solar or wind -they like things as they are! I think he shook his head in disbelief. I also met some young businessmen who ran a solar rooftop business in San Antonio. And it was then off to see what was happening at the Hydrogen exhibition.

There were talks continuing all day at the hydrogen stand including affordable hydrogen infrastructure, storage of solar energy – batteries or hydrogen – hydrogen compression technology, hydrogen refuelling system, electrolysers.

Hydrogen cars

I was able to head out to the carpark at lunch time and drive a hydrogen car and on the wrong side of the road. There were a number of cars for me to try such as the Chev, Honda and Toyota. I tried the Toyota and was able to drive on the wrong side of the road and back to the convention centre without a scratch. Of course the car was as quiet as a mouse because it's run using a hydrogen fuel cell which makes electricity.

An interesting talk in the afternoon was about the recycling of PV cells. In the US over the last 20 years they have been looking at ways to recycle

Batteries or fuel cells or both

Hot water and electricity where it is needed urgently

these cells which will also be a problem in Australia. The Solar industry is developing a recycling programme but there didn't seem to be much detail. The Department of Ecology in Washington State has some legislative requirements for disposal. It seemed the discussion was more about the aluminium and glass recycling but that seemed irrelevant as you would not recycle those products if you were just installing new PV cells. It didn't seem that the industry had a clear pathway as to what to do with the solar cells. A German attendee said that in his country they do have the facilities to recycle them so

perhaps the US industry needs to be talking to them.
That was my last day at the conference and I had to get ready to catch a plane to Denver the next day and then off to Wyoming to look for gas.

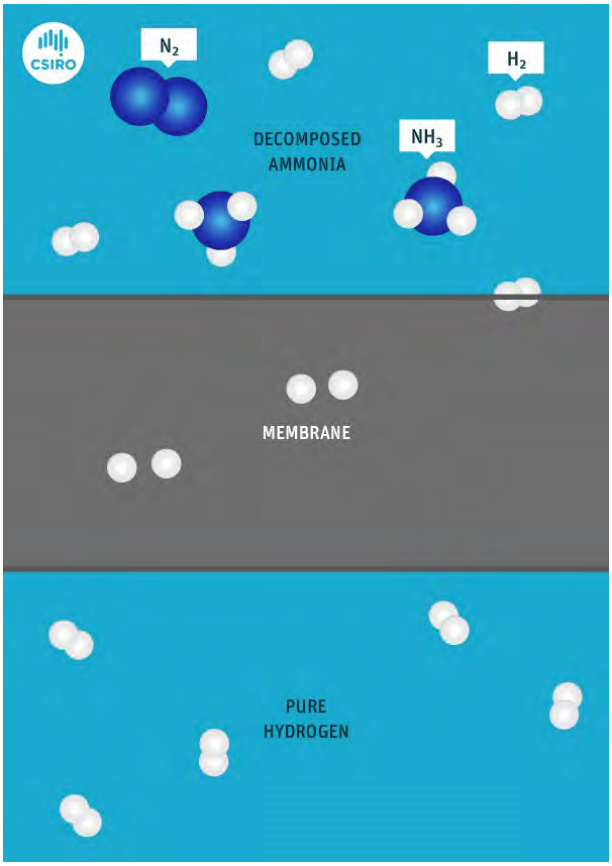
Summary.

I believe the future for transport, especially heavy transport, will be in the use of fuel cells to literally drive that industry. That will lead to the use of fuel cells in cars and not batteries in the long run. Hydrogen is a renewable fuel that when combined with air produces electricity and finishes up as water. Australia has been very slow in developing the technology around the use of hydrogen but a recent announcement by CSIRO and the SA Government looks like we might be getting a move on. The NT is looking for innovative ways of attracting new industries to the Territory and there could be scope to set up a hydrogen plant in the NT. Not so long ago there was talk about using tidal power generated by a plant in the Clarence Strait to produce hydrogen for export but that project seems to have stalled for the time being—might be time to resurrect it.

Below I have attached a number of articles on hydrogen development published in Australia this year to show that there is a future in fuel cells. With the possibility that China is going to phase out petrol and diesel driven vehicles the opportunity to supply hydrogen for export should be looked at by the NT as a potential future industry.

It is interesting that when I was in Las Vegas the emphasis on producing hydrogen was by using electrolysis but in the article below CSIRO is looking at using ammonia as the source of hydrogen and shows that there are ways that may be more efficient in the production of hydrogen than the present processes.

CSIRO research will fill a gap in the global energy technology chain to supply fuel cell vehicles with low-emissions hydrogen sourced from Australia. (March 2017)



The two-year project will build on CSIRO's expertise in separating pure hydrogen from mixed gas streams, in this case converting ammonia to high-purity hydrogen for use in fuel cell vehicles (FCVs).

CSIRO's membrane reactor technology will fill the gap between hydrogen production, distribution and delivery in the form of a modular unit that can be used at, or near, a refuelling station.

The project recently received $1.7 million from the Science and Industry Endowment Fund (SIEF), which will be matched by CSIRO.

The research has also been welcomed by industry and is supported by BOC, Hyundai, Toyota and Renewable Hydrogen Pty Ltd.

Currently, the transportation and storage of hydrogen is complex and relatively expensive, making export commercially challenging.

The membrane will allow hydrogen to be

transported in the form of ammonia (which is already being traded globally), and then reconverted back to hydrogen at the point of use.

The thin metal membrane allows hydrogen to pass, while blocking all other gases.

In the final stages of development, the device is being further refined, ready for commercial deployment.

Recent advances in solar and electrochemical technologies means renewable hydrogen production is expected to become competitive with fossil fuel-based production, providing an opportunity to decarbonise both the energy and transport sectors while creating new export opportunities.

While Australia is a relatively small hydrogen market, the fuel can be distributed to emerging markets in Japan, South Korea and Europe using existing infrastructure.

CSIRO Chief Executive Dr Larry Marshall is excited by the prospect of a growing global market for clean hydrogen, and the potential for a national renewable hydrogen export industry, to benefit Australia.
"This is a watershed moment for energy, and we look forward to applying CSIRO innovation to enable this exciting renewably-sourced fuel and energy storage medium a smoother path to market," Dr Marshall said. "I'm delighted to see strong collaboration and the application of CSIRO know-how to what is a key part of the overall energy mix."

Chair of Renewable Hydrogen, Brett Cooper, believes CSIRO's membrane technology can enable a new, and potentially carbon-free, export industry for Australia that could match the scale of the current LNG industry. "With this technology, we can now deliver our renewable energy to Japan, Korea and across the Asia-Pacific region in liquid form, as renewable ammonia, and efficiently convert it back to pure hydrogen for cars, buses, power generation and industrial processes," Mr Cooper said.

This market didn't exist 10 years ago – now Australia is positioned to be the number one renewable fuel provider in the world's fastest growing region."

Toyota Motor Corporation Australia Ltd Senior Executive Advisor to the Board, Bernie O'Connor, affirmed Toyota's commitment to reducing emissions, and supporting hydrogen FCVs.
"Research into making hydrogen more accessible in the future for fuel and energy storage is key to the success of this technology," Mr O'Connor said. "CSIRO is at the forefront of this research and we will continue to work with them in the future so that we can roll out this technology."

Hyundai Motor Company Australia Manager of Corporate Communications, Scott Nargar ,is also supportive of CSIRO's hydrogen membrane technology advances. "As a global leader in hydrogen-powered passenger vehicles, Hyundai fully supports any initiative which makes hydrogen more practical and easier to distribute," Mr Nargar said. "We applaud CSIRO's expertise in this field and look forward to supporting its endeavours in the future."

In addition to its membrane technology, CSIRO will apply its expertise to all stages of the technology chain (including solar photovoltaics, solar thermal, grid management, water electrolysis, ammonia synthesis, direct ammonia utilisation via combustion and/or fuel cells, as well as hydrogen production).

HYDROGEN

A HYDROGEN ROADMAP FOR SOUTH AUSTRALIA

ACCELERATING SOUTH AUSTRALIA'S TRANSITION TO A CLEAN, SAFE AND SUSTAINABLE HYDROGEN ECONOMY.

On 8 September 2017 the South Australian Government announced A Hydrogen Roadmap for South Australia. The Roadmap sets out clear pathways to capitalise on South Australia's competitive advantages and accelerate the State's transition to a clean, safe and sustainable producer, consumer and exporter of hydrogen.

The Roadmap was developed following close consultation with industry, Ministerial visits to South Korea and Japan and South Australia's Green Hydrogen Study, a comprehensive techno-economic study conducted by Advisian in conjunction with Siemens and Acil Allen.

A call for proposals for hydrogen infrastructure projects under South Australia's $150M Renewable Technology Fund has also been released. Submissions close 23 October 2017.

A call for tenders to supply at least six hydrogen fuel cell buses for use by Adelaide Metro, as well as the supporting hydrogen production and refuelling infrastructure has been released. This is available via the SA Tenders website. Submissions close 9 October 2017.

The Australian Renewable Energy Agency (ARENA) announced in May 2017 that 'exporting renewable energy' in the form of hydrogen, ammonia or embodied in mineral exports, is one of its four new investment priorities.

An interactive hydrogen map has been developed as a tool to assist investors and project developers to identify potentially suitable sites in South Australia to deploy hydrogen infrastructure.

For more information on hydrogen in Australia, visit Hydrogen Mobility Australia and download their fact sheet about hydrogen.

Renewable hydrogen could fuel Australia's next export boom after CSIRO breakthrough

By Rebecca Turner © 2017 ABC Updated 12 May 2017, 12:30pm

Australia's next big export industry could be its sunlight and wind, as game-changing technology makes it easier to transport and deliver their energy as hydrogen.

Industry players are even talking up renewable hydrogen as the next liquefied natural gas (LNG) industry, which could supply hydrogen to power cars, buses, trucks and trains in Japan, South Korea and even Europe. Their plans have been given a boost by a CSIRO-developed metal membrane, which allows the high-purity hydrogen, needed for hydrogen-powered cars, to be separated from ammonia.

What is renewable hydrogen?

Hydrogen is a carrier of energy. Renewable hydrogen is produced by purifying seawater, then separating the hydrogen and oxygen via electrolysis.

The process of separation is powered by solar or wind energy.

The hydrogen becomes a vehicle for storing renewable energy such as solar or wind.

It is converted into transportable forms for export.

CSIRO principal research scientist Michael Dolan said the technology, now being trialled on an industrial scale in Australia, was "the missing link" that allowed hydrogen to be transported and used as an energy source. "One of the great problems with hydrogen is that it's difficult to transport over long distances because it has such a low density," he told ABC News.

"Ammonia is a very nice way of transporting hydrogen from point A to point B — be it from Australia to Japan, for example — because it actually has a higher hydrogen density than liquid hydrogen."

The technology the CSIRO has developed can then be applied at the point of use, converting ammonia back into hydrogen for use in transport fleets.

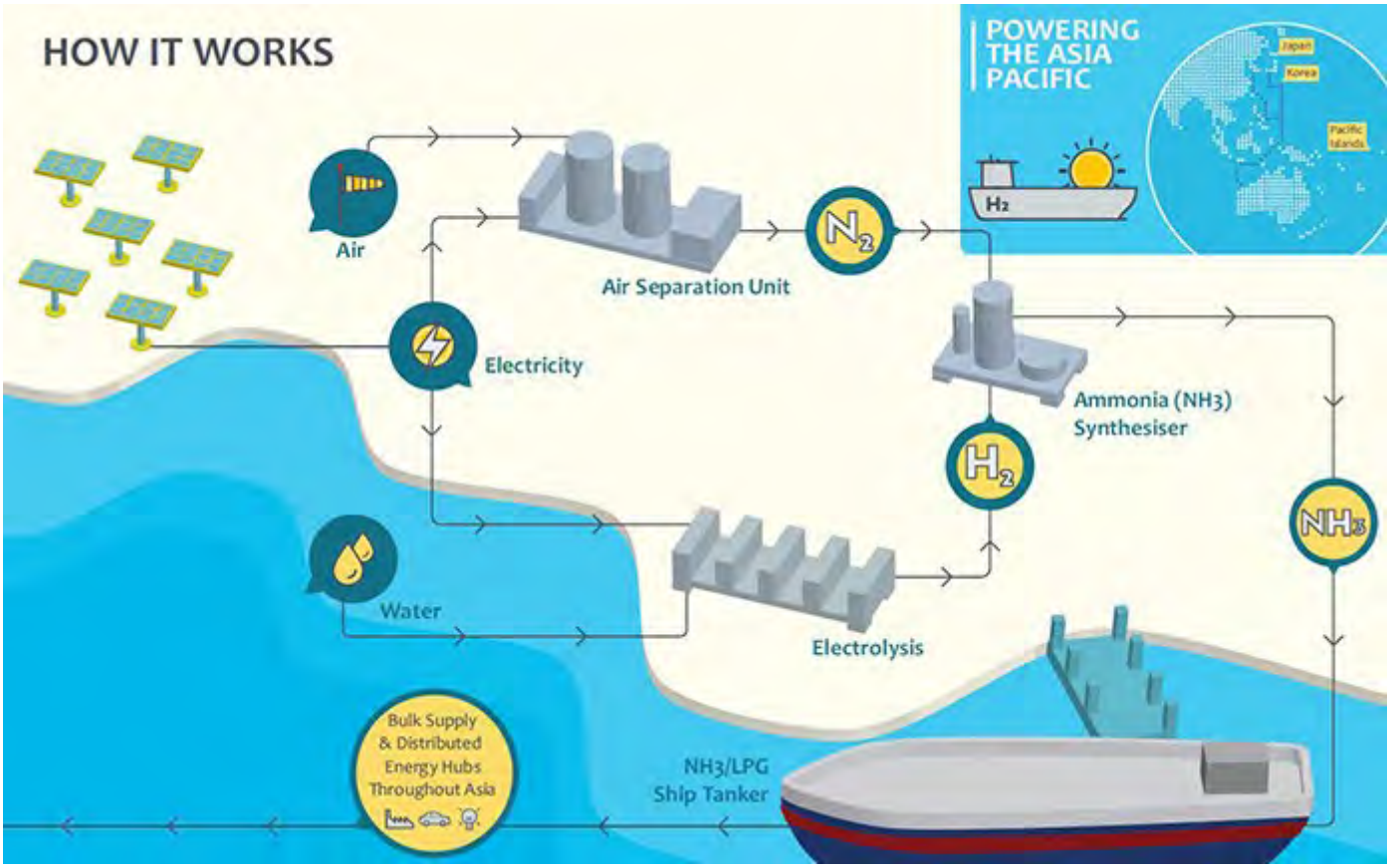
Dr Dolan said the technology had the potential to turn Australia into a renewable energy superpower.

"Hydrogen is the ultimate clean fuel. The only emission arising in the use of hydrogen is water. You can also manufacture hydrogen completely renewably," he said.

While there are only four hydrogen cars in Australia — produced by Hyundai and Toyota — South Korea already has hydrogen-powered taxis on its streets. “There's potentially a very big market for the technology, given these cars are starting to get onto the road in pretty big numbers in Asia and Europe," Dr Dolan said.

In Japan, the 2020 Tokyo Olympics will be a showcase of its dream of becoming a "hydrogen society", as it shifts away from nuclear power after the Fukushima disaster.

While a long way behind these countries, Australian governments are beginning to actively embrace the potential of hydrogen as a clean alternative fuel source — and export industry.



INFOGRAPHIC: How renewable hydrogen is produced. (Supplied: Renewable Hydrogen)

South Australia, for example, is looking to invest in hydrogen projects via a $150 million clean energy fund as it tries to secure its energy supplies.

The ACT Government announced last year it would spend $180 million on hydrogen projects, including a fleet of cars and a refuelling station.

It comes as the Australian Renewable Energy Agency recently made the exporting of renewable energy such as hydrogen one of its top priorities for $800 million of investment.

Companies line up for hydrogen

One of the key players in the hydrogen industry is Andrew Want, the managing director of Renewable Hydrogen — a company involved in projects in New South Wales, South Australia and Western Australia. Describing the industry as bottling and shipping sunlight on an industrial scale, Mr Want said renewable hydrogen was at a similar stage as LNG in the 1970s, when technology allowed natural gas to be liquefied and transported.

"*We genuinely have another LNG industry on our hands, exporting energy," he said.*

Mr Want said a renewable hydrogen export industry was nearing commercial viability, with the CSIRO technology an important development.

CSIRO-DEVELOPED MEMBRANE EXTRACTS HYDROGEN FROM AMMONIA

"What the CSIRO technology is on the cusp of achieving is using renewable ammonia as a very efficient way to transport hydrogen — and that's a game-changer," he said. "It means Korea, Japan, the whole of South-East Asia can now import Australian renewable energy in the form of renewable hydrogen. "Using the CSIRO technology, they can 'crack' the hydrogen back out and run transport vehicles on it, zero carbon."

One company investigating the potential is Norwegian company Yara, which exports ammonia from its production plant in WA's Pilbara. Yara is working towards a trial involving a 2.5MW solar array to power its electrolysis process, with the possibility of eventually fuelling its entire operations using the region's abundant sunlight.

The local Mayor, Peter Long from the City of Karratha, is a champion of the industry in a region well-placed to capitalise on its abundant sunlight, export facilities and gas infrastructure. "It's totally renewable, [could provide] jobs forever and we can actually export the hydrogen gas overseas to Japan," he said.

Tomorrow's "hydrogen society" may still be a dream — but the Pilbara and Australia appear to be well-placed to play a key role.

The Flex House

Below is a house called Flex House which was on display at the Solar Conference. It would be interesting if a similar house could be built in the NT—with appropriate building approvals and a tropical model—especially if it could be built for the price quoted allowing for Australian dollars -the base model ranges in cost from $85,000 to $100,000. The house design by Shelter Dynamics created a lot of interest at the Conference.

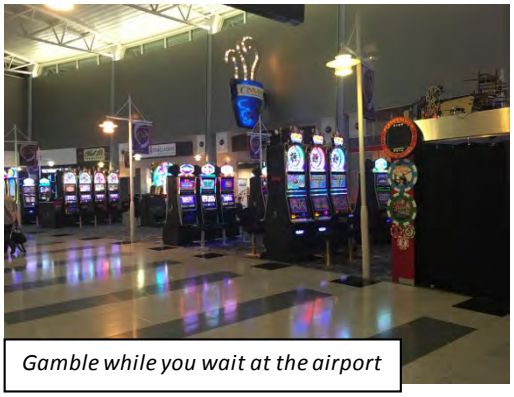
The sales brochure says:

The advanced smart home hub platform streamlines the production, storage, monitoring, and usage of energy to create the ultimate demand-side energy management strategy. It also connects voice-enabled controls with lighting, mechanical, entertainment, water, indoor air quality, irrigation, and other systems.

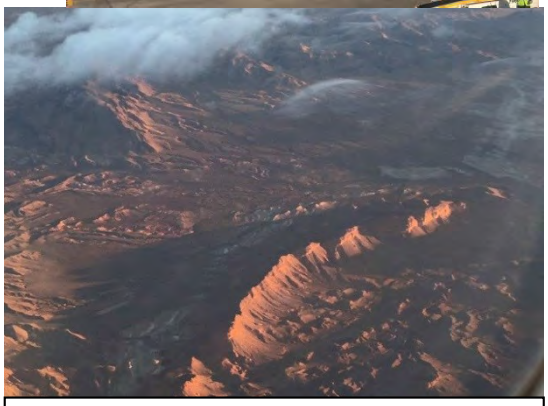
For more information check out https://www.greenbuildermedia.com/vision-house-flex-house

Day 6 Wednesday 13th September

Up at 4am to catch a plane to Denver to start the next phase of my trip. Las Vegas airport is very close to the city – similar to Darwin – so it's only a short taxi ride to get there. Even at 4am you can still play the pokies at the airport. The Frontier plane heads east crossing the Rocky Mountains. Now I know why they are called the Rockies because all you see is bare rocky mountains and it goes on for about 1000 kilometres until you see some farms in the valleys and trees growing on the slopes as you get closer to Denver. Denver is called the Mile High City because it is one mile above sea level.



Gamble while you wait at the airport



Morning over the Rocky Mountains

Because I couldn't get a flight to Cheyenne (Wyoming) I was booked on Greyhound to get me there. In contrast to the airport at Las Vegas, the airport at Denver is way out of town. The taxi fare to the city was $99US. The driver, when he found out where I was going, said he could have driven me to Cheyenne for $180US!

On the bus –logo sign on the right

The Greyhound bus left late. There were some interesting characters on the bus with some old cowboys dressed up, some Latinos and a couple of mums travelling with the kids. The driver was an Afro-American lady who was doing her driver training. Her instructor sat just behind giving the occasional piece of helpful advice. The road to Cheyenne is a four lane highway (Interstate 25). No signs allowed on this highway unless they are approved logo signs—these are signs where the logo of a business is displayed on a sign neatly along with other businesses. Once you get out of the city limits you pass through farming country and small towns along the way. Cheyenne is the Capital City of Wyoming and only a few kilometres across the Colorado border.

Bus stop —Cheyenne

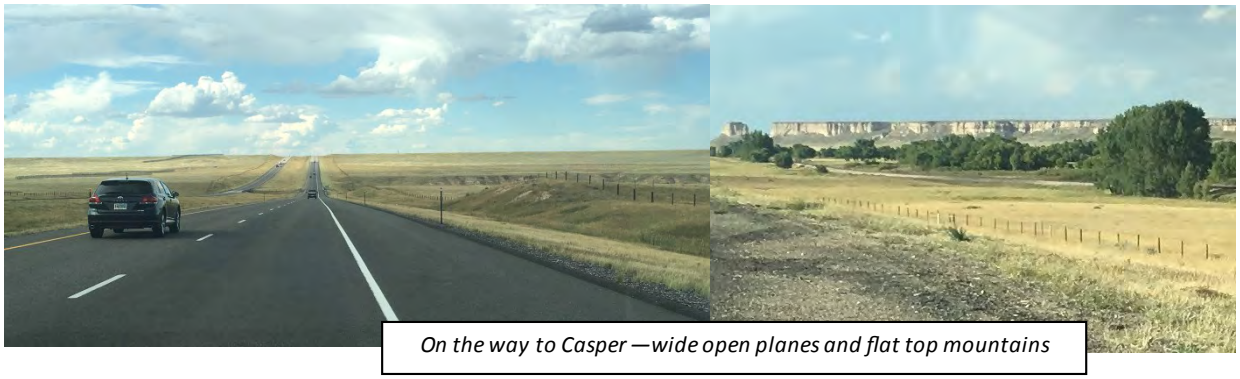
The bus stop at Cheyenne was at a 2 star hotel close to the Cheyenne airport so I got off there. The lady behind the counter at the hotel was getting her hair done but she still kindly pulled out the mobile phone and rang for a taxi– all the time still getting her hair done. About half an hour later TI's Shuttle turned up with a driver who apologised for being a bit late and then put my luggage in the boot (trunk) which looked like it had been used for carting cement –it was just bare metal. The picture (next page) is from TI Shuttle web page and on the right is my driver! But how you look isn't everything and he was a very nice bloke and only charged me $9 to get to the airport – I think it is a flat rate —and I gave him a tip as you do in America. Interesting sign on the window of the taxi ***If you get sick and vomit in this vehicle you will be charged a $175.00 cleaning fee!!***

How TI Shuttle advertises on the web

The vomit warning

The real TI Shuttle

The next part of the trip was far the most nerve wracking as I had booked a car from Avis at the airport to drive to Casper. The idea of driving on the wrong side of the road didn't fill me with much confidence. After getting in the car on the right (but wrong) side a few times, then turning the wipers on instead of the indicators, loading up the navigation, and saying a prayer I headed off, firstly riding over the curb, stopping at a red light not knowing you can turn right anyway and then driving up a dead end road, I eventually got going. I felt I needed a sign on the back – Aussie driver ahead – as a few people gave me a toot. But it wasn't long before I was on the main road to Casper. It's about a 3hr drive to Casper – a bit longer for me. On the way you travel across rolling plains and see the occasional flat top hills the country was similar to country between Newcastle Waters and Tennant Creek. The early morning departure from Las Vegas was catching up and I was starting to get a bit sleepy so I pulled over at a little bar and grill in the middle of somewhere and had a chicken something and chips with white gravy and naturally a Pepsi. The chips were good. Back on the road again but because of late arrival of the bus at Cheyenne I was late getting into Casper and it was dark and I couldn't find the motel and started heading out of town again under the orders of the navigation lady. I rang the motel who gave me clear instructions and found my way there, happy that I was intact after 3 hours on the wrong side of the road - just crashed out for the night.



On the way to Casper —wide open planes and flat top mountains

Casper—230 km north west of Cheyenne ,Natrona County, Wyoming. Population 60,000. Situated on the North Platte River. It's nickname is the Oil City. Regional economy – oil, gas, coal and uranium, cattle, sheep and forage, tourism.

Wyoming. Population 600,000. **Capital:** Cheyenne. State Flower: Indian Paintbrush. Insignia: Bucking Horse.
Origin of name: From the Delaware Indian word, meaning "mountains and valleys alternating"; the same as the Wyoming Valley in Pennsylvania **Land area:** 97,914 sqmiles (253,600 sqkm). When the Wyoming Territory was organized in 1869, Wyoming women became the first in the nation to obtain the right to vote. In 1925 Mrs. Nellie Tayloe Ross became the first woman governor in the United States. Wyoming's towering mountains and vast plains provide spectacular scenery, grazing lands for sheep and cattle, and rich mineral deposits. Wyoming is the leading coal-producing state and a leader in the production of petroleum and natural gas. Wyoming has the world's largest sodium carbonate (natrona) deposits and has the nation's second largest uranium deposits. A leading producer of sheep and wool, Wyoming is also a major producer of beef cattle and hogs. Principal crops include wheat, oats, sugar beets, corn, barley, and alfalfa.

Day 7 Thursday 14th September

New day and off to the Wyoming Oil and Gas Conservation Commission (WOGCC) based in Casper where I had a meeting set for the morning. Got lost driving on the wrong side of the road but eventually arrived about 20 minutes late - not a good start. My meeting was with Mark Watson who is the Supervisor at

Home of he Wyoming Oil and Gas Conservation Commission

WOGCC.

Mark Watson is a graduate of the University of Wyoming with a BS in Petroleum Engineering and the Southern Alberta Institute of Technology with an Associate's Degree in Petroleum Technology. He has worked for the Wyoming Oil and Gas Conservation Commission for 35 years and has been involved in all areas of the Commission's jurisdiction including drilling, completions, production, land owner issues, etc. and is an appointed hearing examiner for all uncontested cases before the WOGCC. He was appointed as the Supervisor (Director) of the agency in April 2014 by the Governor of Wyoming, Matthew Mead. He is now responsible for the day to day operations of the Commission including the management of a staff of over 40 in the regulation of oil and gas exploration and production operations in the State of Wyoming.

Supervisor Mark Watson

I discussed with Mark issues around the gas fields at Pavillion where it was reported there was gas in the water. He said there had been gas in the water for over 40 years but more on that in the section on Pavilion. He noted there are a lot of irrigated crops in the area. I asked him about Jonah field which is covered in wells and which Lock the Gate say is what would happen if fracturing in the NT was approved. He said over 16 years ago there was only direct drilling hence the large number of wells but now there were multiple wells on single pads, reducing the effect on the landscape.

According to *Kent A. Bowker, Chevron USA Production Company, Houston and John W. Robinson, Snyder Oil Corporation, Denver Jonah field is a shallow, compartmentalized gas accumulation within the larger Green River basin-centred accumulation.*

Mark Watson explained in one line: The Jonah and Pinedale fields consist of unconsolidated lenticular sands. Geology different than in the NT. Lenticular bedding is a sedimentary bedding pattern displaying alternating layers of mud and sand. They are commonly found in high-energy environments. (Wikipedia).

In relation to the land around Pavillion that will be discussed under the heading Pavillion further on.

State of Wyoming Oil and Gas Lease Auction Information

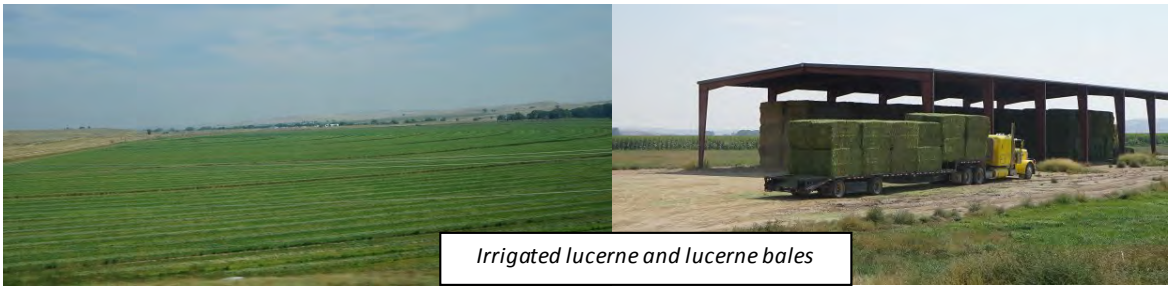
The Office of State Lands and Investments will hold an online oil and gas lease auction, **November 1-8**, hosted through Energy Net. A total of 242 leases will be offered, covering 95,696.54 acres. To view more information and to register to bid, please visit:

Revenue generated by the state trust land oil and gas lease auctions are distributed to support public education, the University of Wyoming, Veteran's Home and other State funded programs.
All leases resulting from winning bids are subject to final approval by the Wyoming Board of Land Commissioners (Board). All approved leases will be issued for a primary term of 5 years and for a rental of $1.00 per acre. A royalty rate of 16 2/3% of the production, or its market value, will be required by the Board. The Board reserves the right to reject any and all bids received and to withdraw any tract from the sale or from leasing at any time.

Mark explained land tenure for minerals in Wyoming. About 60% is owned by the Federal government including Indian land, 30% is private or Fee (as in Fee simple in Australia or freehold title) and the remainder is owned by the State of Wyoming. The state Government can auction off its leases—below is an example of how it is done.

It can get a little more complicated if the owner of the surface land does not own the mineral rights which is how it is in Australia—this is then called a Split Estate. The WOGCC have a fact sheet to explain how it is all done called a Guide to Oil and Gas Operations for Surface Owners.

With that sorted out, I was soon heading out with Drilling Inspector Rick Wass in his very big twin cab Ford 250 to a drilling rig outside of Douglas about a 40 minute drive east of Casper. Much of the countryside is farming with quite a lot of irrigated alfalfa (lucerne). This is baled and sold as feed as I imagine nothing much grows when winter comes to these parts. Also on the way you pass the Dave Johnston Power Plant which is the largest of its kind in the entire Rocky Mountain region, turning steam and coal into electricity at a rate of more than 800,000 kilowatts a day to the Pacific Northwest. This massive operation has at its disposal its own private railroad that transports the coal from the Glenrock strip mine 16 miles to the north.



Irrigated lucerne and lucerne bales

Dave Johnson Coal Fired Power Station

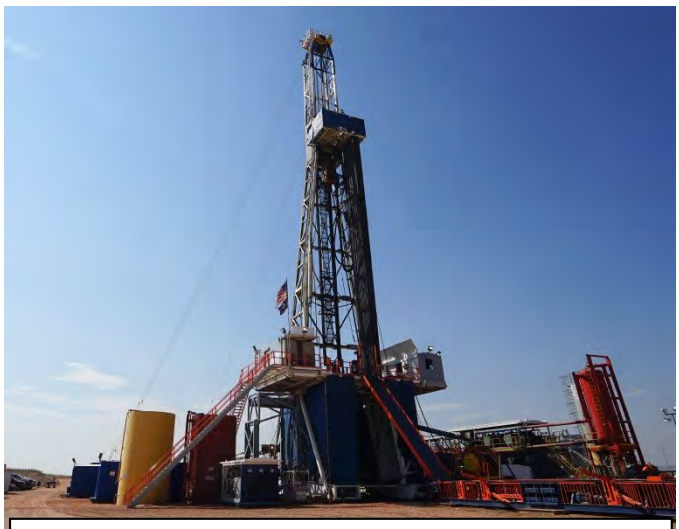
Coal railway

PacifiCorp wind generators—Glenrock, Wyoming.

Just to the north of the coal fired power station is a slightly cleaner form of energy. They are wind turbines but unfortunately because it was a foggy morning it was hard to see them in the distance. Previous days they couldn't be seen because of the smoke from forest fires in Washington State.

So I borrowed a better picture (left) from PacifiCorp—the owners of the turbines- and the following description: *Sixty-six turbines near Glenrock, Wyo., borrow the wind to generate as much as 99 megawatts of energy. Completed in 2008, they stand on land that PacifiCorp retired and reclaimed from surface coal mining operations. We believe this is the first wind facility in the West to recycle land that once provided fossil fuels into one that captures renewable energy.*

We soon arrived at a drilling rig operated by Chesapeake Energy. They are one of the largest operators in this area—the Powder River Basin. Chesapeake employ US wide, about 3200 employees and have a revenue of $7.8USb. The drill rig in Douglas was operating on a well pad that already had one completed well that was in operation. The company, when it has finished the drilling on this spot, intended to move a few metres away and drill again. This land and/or minerals could be owned by someone else just a few metres away. One of the things that is forgotten in the discussion about hydraulic fracturing is that the biggest danger to an aquifer is above the ground from chemicals used in the drilling process. To safeguard the aquifer the chemicals are stored in tanks which sit on a plastic liner or bunker to stop any spills escaping. Drilling muds were al-



Chesapeake drilling rig employing horizontal drilling techniques

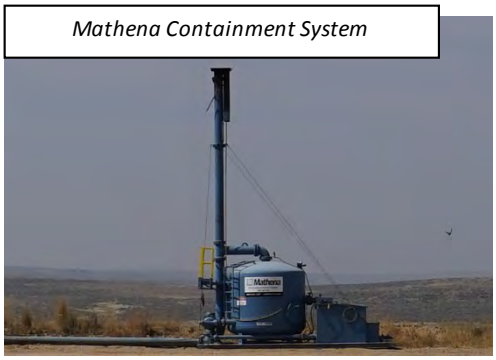
Single well (left) - condensate tanks on the right

Drilling fluids stored in tanks sitting on plastic line bunker

so placed in a large skip bin for removal. This material can be sent to commercial disposal pits where it is either treated with fly ash to solidify it or treated with Eco-sponge which is made up of oil eating bacteria. It can be buried on site but only with an inspection and permit by WOGCC or for landfarming and landspreading which has to be approved by the Department of Environmental Quality or it can be used on roads if approved by both agencies. As well there is a Mathena Containment System which is designed to alleviate environmental concerns while effectively receiving, containing and disposing of waste gas and fluids .

Drilling muds being loaded into skip bin

Mathena Containment System

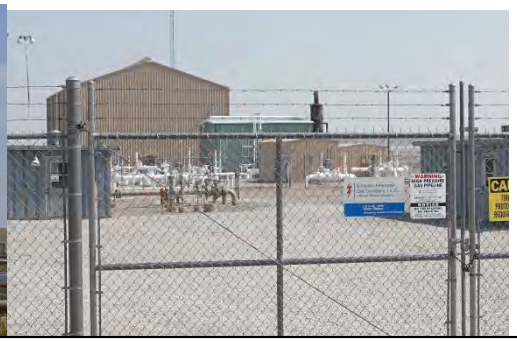


Rick then took me to the control room to see where the drilling operations were monitored. There I met Dustin Hill, Drilling Consultant- and Jackson Klein, Drilling Engineer. Jackson was able to give me a run-down of how the drilling process worked showing the different casings required and the depth for each casing and the cementing process. He also explained how you can have a number of horizontal wells on top of one another calculated on the thickness of the gas-bearing material. Depending on the geology, drilling can be either slowed down or sped up - something that was being discussed when I was there. Of course before drilling can even start there must be an inspector on site such as Rick and you have to go through a lot of permits and design approvals before you can even start. Rick gave me a complete copy of the Rules and Regulations of the Wyoming Oil and Gas Conservation Commission—any drilling company would have to know those rules before they even applied for a permit. These are also available on the WOGCC website. From there we headed back observing some cattle and deer grazing on nearby farms. We also looked at a number of facilities such as high pressure gathering stations and a CO2 extraction plant. It was then back to Casper to thank Mark Watson and Rick for showing me around and making time available to answer questions.

Jackson Klein -Drilling Engineer explaining the fracking process.

Drilling Inspector Rick Wass and his big Ford

Dustin Hill -Drilling Consultant



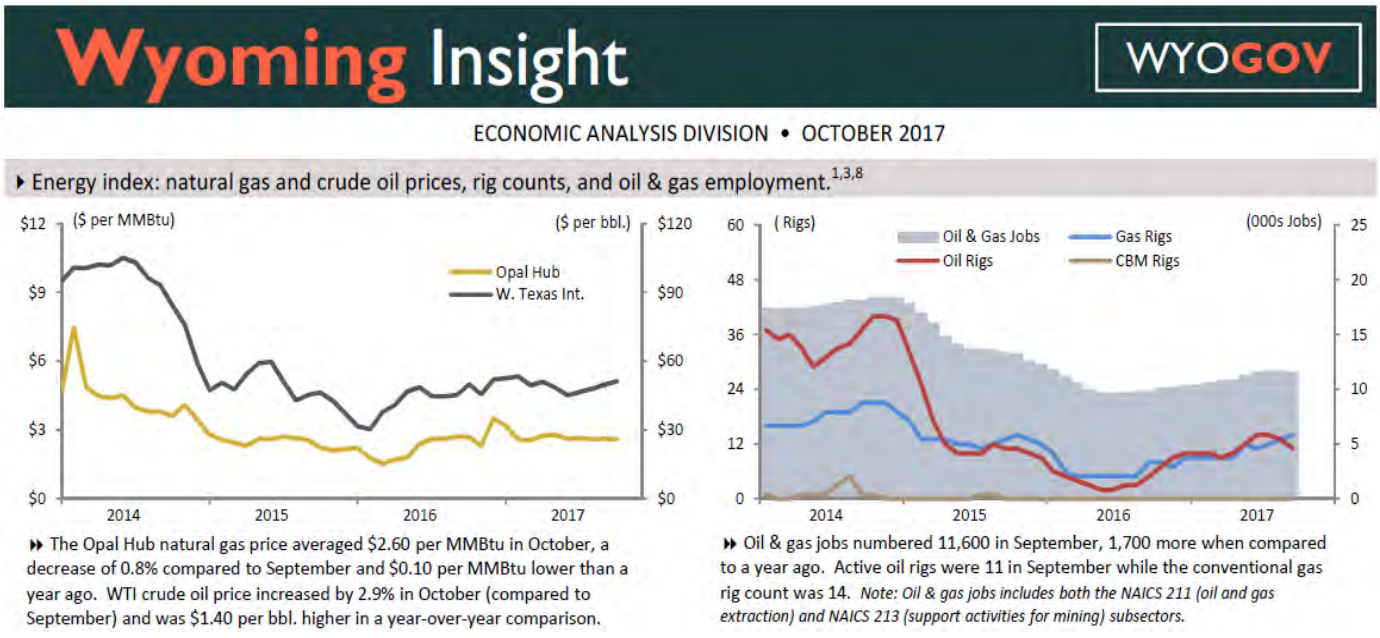
Fort Union Gas Gathering Plant *Buckshot Station Thunder Creek Gas Processing Plant* *Colorado Interstate Gas Company Treating Facility*

Then it was back on the road —next stop Riverton which is 200km west of Casper. My driving was starting to improve by now. Most of the country is flat with some cattle and irrigated pastures along the way. I eventually arrived in Riverton at 4pm and headed for the local print shop for a meeting with the owner Travis Becker. Travis is a commissioner and chair of Fremont County (local) Government. There are four other commissioners working with him. 'Local' Government is divided into county and town. So Riverton also has its own council made up of a Mayor and 6 councillors and a number towns throughout the county may have a council. I wanted to contact Travis as the Fremont County covers the gas fields of Powder River Basin which is close to Riverton. He said over 90% of people support gas and are not afraid of fracking. When asked about Pavillion he said the area was known for its gas pockets which were mobile hence some of the issues there. He also explained the ownership of minerals and how people are paid royalties. He said the gas industry had helped the local economy with jobs. Employment numbers in the oil and gas industry in Wyoming as of October this year are shown below. By this time I was supposed to be heading back to Casper but it was getting late and Casper would mean three hours driving in the night (which I wasn't looking forward to) so I decided to head for Lander and stay the night there. Lander is about half an hour west of Riverton. I had lined up a meeting the next day with Thad Dockery from the local Farm Bureau but I was having trouble with the mobile connection and so I had to use the landline available at the motel. The weather wasn't looking good. One good thing is that Laverton had a good steakhouse so that was worth the change of plans.

Riverton is in Fremont County and its population is over 11,000 people. The economy is mainly mining, oil and gas, and agriculture. It is situated on the Wind River. It is said by the USEPA that the city is in the Wind River Indian Reservation but that is disputed.

Commissioner Travis Becker and his print shop

Riverton main street



Day 8 Friday 15th September

Lander is in Sublette County and has a population around 8000 people. The economy is mainly cattle and traditional agriculture. It also has a strong tourist economy based on fishing, hunting, camping and mountaineering.

Woke up to a cold and raining Lander. I had eventually contacted cattle farmer Thad Dockery who lives on a ranch about 65 km south of Lander on Graham Road. He lives there in his modest house with his wife Andrea and their children.

Thad is the Lander representative on the Farm Bureau.

The Wyoming Farm Bureau Federation is the state's largest organization of farmers and ranchers with over 2,600 farmer/rancher member families. Their voices are combined with over 10,000 associate member families who support agriculture and private property rights and are committed to protecting Wyoming's farms and ranches. Our members live in all 23 Wyoming counties. The American Farm Bureau Federation has close to six million member families.

Down on the ranch—Graham Road

From the *Wyoming Stock Roundup:* The ranch ran a commercial Hereford cow-calf operation until Andrea and Thad joined the operation 10 years ago. Thad had a commercial Black Angus herd, and the ranch operation changed to run Black Angus bulls on the two-year-old heifers. Thad and Andrea see the future of agriculture strengthening as more people become involved. "We need to get more ag-friendly people in public office to make a difference," states Thad. We're members of the Wyoming Stock Growers Association (WSGA), Farm Bureau, and R-CALF," their friend Cindy says.

Thad's home

Thad and his dog

Andrea adds, "We all can't leave for conventions at the same time, so Mom and Dad go to the WSGA conventions, and Thad and I go to the Farm Bureau conventions. Thad is president of Fremont County Farm Bureau, and I'm the secretary. Thad is on the Fremont County Predator Board, and served as president of the Fremont County Cattlemen for two years. Mom and I are members of the Lander Valley CattleWomen and Fremont County CattleWomen, and I serve on the board for Wyoming Ag in the Classroom and on their education committee. We're also involved in the local church at Jeffrey City, and Thad and I are foster parents to two children."

Thad says farmers out his way were about 50:50 when it came to fracking partly because they didn't understand it or were more interested in raising cattle. They wanted to know what chemicals were being used. He said agriculture is the backbone of the economy of Wyoming and gas just helps make Wyoming more prosperous. Thad said when people first looked at fracking they did have concerns but now they have looked at it they are not concerned. He felt that the gas issues revolved around ideology and ignorance. I didn't get the impression that fracking was a big issue- more about cattle.

Said my goodbyes to Thad (left him to his paperwork) and headed back towards Lander, then turned off

The South Pass

to Pinedale. The weather was not great as I drove through the South Pass on Highway 28 which takes you across the southern edge of the Wind River Mountains. This is also the continental divide of the US just like our Great Dividing Range. The South Pass is a National historic landmark of the Oregon Trail. It was travelled by thousand of westward emigrants during the mid-19th century. It was slow driving as low cloud covered the mountains but once on the other side the weather improved. From then on there were the beautiful wide open plains which went on for miles until you got closer to Pinedale where irrigated pastures and pivot irrigators start to dot the country. The main reason for coming to Pinedale was to learn about the Jonah Field. John Fenton and the Lock the Gate people had shown me a picture of Jonah Field when they came to visit me in Parliament House over a year ago. They were concerned that the NT would look like Jonah Field if the NT started fracking.

Pinedale is a small city in the Upper Green River Valley in the Sublette County and surrounded by three mountain ranges. Its population is just over 2000. The economy is oil and gas and tourism. Pinedale is on the way to Yellowstone National Park.

Pinedale—main street

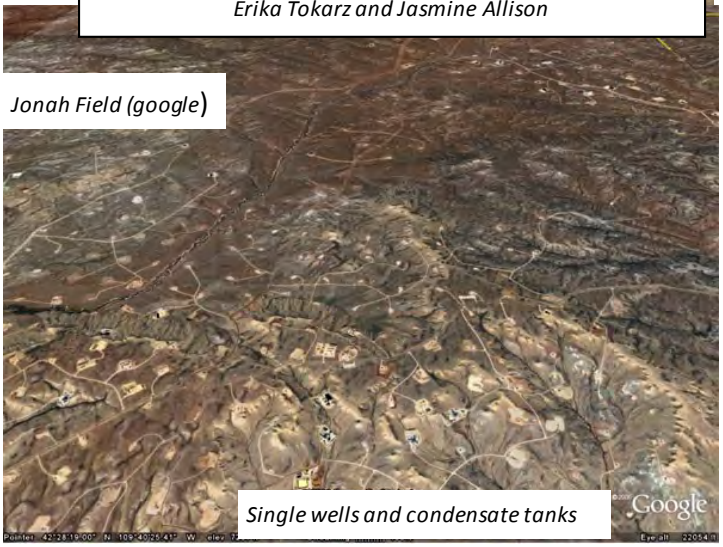
I was hoping to meet the Commissioner of the County but he was away in Washington. My next hope was to meet Mary Lankford, the Sublette County Clerk, but as I had arrived a bit later than expected I was told she had literally gone fishing. It appears this was nearly the last chance to go fishing before the winter set in so I missed her. So instead I headed down to see Erika Tokarz at Ultra Petroleum. Erika was recommended by Mark Watson from Wyoming Oil and Gas Conservation Commission. She is the senior regulatory and environmental representative for the company. Erika introduced me to Jasmine Allison, Senior Permitting Analyst. Ultra has a number of wells in the Jonah Field and Erika and Jasmine gave me an introductory lesson about the geology of the region, gas drilling techniques and methane discharge monitoring.

Erika Tokarz and Jasmine Allison

The Pinedale Anticline from the air, 2009. (Ultra/Shell/QEP photo)

The Pinedale Anticline and Jonah Field cover 0.36% of the total area of Wyoming

Jonah Field (google)



Single wells and condensate tanks

The Pinedale Anticline Natural Gas Field is located in the Upper Green River Basin of west-central Wyoming, south of Pinedale. The Anticline's 198,000 acres of rolling sagebrush is 80 percent federally owned. The area has one of the richest concentrations of natural gas in the United States, currently estimated at more than 25 trillion cubic feet.

The Jonah Natural Gas Field is located in the Upper Green River Basin of west-central Wyoming, south of Pinedale. Jonah's 30,000 acres of rolling sagebrush is 94 percent federally owned. The area also has one of the richest concentrations of natural gas in the United States, currently estimated at more than 14 trillion cubic feet.

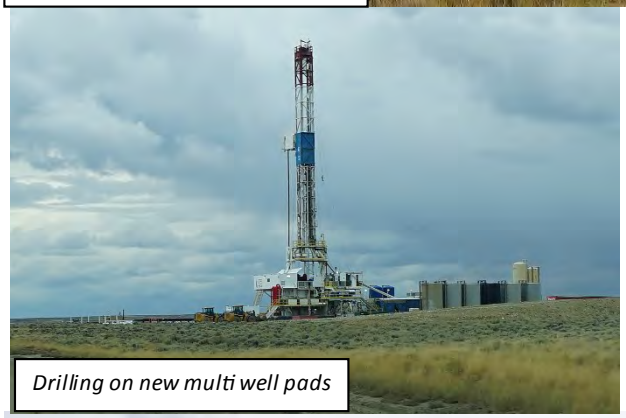
After the introduction they took me out to the Jonah Field on the way discussing the history of the Jonah Fields, the geology and land ownership. Most of the land is controlled by the Federal Government.

Jonah Field—one of the richest gas fields in the US.

Single wells and condensate tanks

There are certainly a lot of wells drilled – most of them single vertical wells although not all –as you can see from the picture (previous page). When I first saw the aerial photos of Jonah Field I was not impressed and mentioned to Erika and Jasmine that those photos were used by the media in the Northern Territory to claim that the Territory would look like that if we also went down the path of fracking. The Jonah field was looked at in the 1970s and 1980s but it seemed uncommercial to develop until the 1990s when new techniques such as fracking were developed. Single hole drilling with only 4ha spacing was also common.

That is one reason you see a spider web effect – a multitude of single well heads—and the second is the condensate tanks at each well head. These well heads are connected by a road so a tanker can collect the condensate or a type of light oil.



Drilling on new multi well pads

Ultra Central Gathering Facility

Picking up the condensate

Condensate can be used to make both fuel and plastic. The main thing is to stabilize it by removing unnecessary admixtures. Any condensate is obtained after the transition of a gaseous substance into a liquid state due to a drop in pressure or temperature. There are not only gas fields but also gas condensate fields in the subsurface. When pressure and temperature decrease as a result of drilling a well, gas condensate – a mixture of liquid hydrocarbonsseparated from gas – is formed.

There have been positives and negatives from the Jonah Field and here is an extract from an article by the Wyoming State Historical Society:

The Jonah Field and Pinedale Anticline: A natural-gas success story

Impacts brought on from drilling in the Jonah Field and Pinedale Anticline were not always welcomed in the small Wyoming communities surrounding the area, notably Boulder, Pinedale, Big Piney, Marbleton, and La Barge, and the bigger towns of Rock Springs and Green River. The boom strained community housing, schools, and such services as law enforcement and health care.

A 2005 study of Pinedale residents conducted by sociologists from the University of Wyoming found that the newcomers brought many new "social impacts," and that longtime residents found it "increasingly commonplace not to recognize someone while going to the bank or buying groceries." Services were harder to get. A quick stop in the store was no longer quick, with long lines at the checkout. It took a longer wait to see a local doctor. For the first time, it was hard to find a parking spot. Perhaps most noticeable was how difficult it became to cross Pine Street, Highway 191, Pinedale's main drag, with the constant traffic of heavily loaded semi trucks.

Concerns were raised, too, about the industry's impact on wildlife, particularly sage grouse, pygmy rabbits, pronghorn antelope, and mule deer. The Sublette mule deer herd, one of the biggest in the state, winters on the Mesa – the northern portion of the Pinedale Anticline. To protect the deer, the BLM (Bureau of Land Management) restricted drilling during critical winter months until 2008, when a new plan was developed that allows for year-round drilling if the herd population can be maintained. Mule deer numbers have declined significantly, though. A 2010 BLM report shows a decline in 60 percent in deer populations from 2001 to 2009, based on annual estimates. The report blames energy development disturbance. On the Mesa, deer have also lost nearly 2,000 acres of habitat over the past decade, with the majority, 85 percent, of the habitat loss attributed to well pads and the rest to road construction.

Deer on the Jonah Field

Measures have been taken to try to reduce impacts to wildlife and the environment in the Pinedale Anticline. Gas companies are coordinating their drilling efforts into designated areas for year-round development. These Development Areas (DAs) allow the companies to concentrate their activities and timing in specified areas leaving large blocks of contiguous habitat undisturbed and available to big game and their migration corridors and sage grouse habitat. In an effort to reduce the amount of area disturbed, companies have been clustering their wells onto a single pad and then using directional drilling from the pad, resulting in fewer pads and roads needed for drilling activity. By 2010, this method had allowed 100 fewer needed well pads in the Pinedale Anticline Project Area and 70 percent fewer roads to fully develop the field, leading to less habitat disturbance.

Sublette County citizens are concerned about the increased water and air pollution connected with the development. Long-time residents noticed a decline in year-round air quality starting in 2000. Air pollution is now a way of life. The situation became dire in 2008 when the Wyoming Department of Environmental Quality began issuing "Ozone Alerts." Ground-level ozone results from chemical reactions between oxides of nitrogen and volatile

organic compounds in the presence of sunlight. Ozone levels get too high when too many engines, from all sources, are pumping dangerous emissions into the atmosphere that are then "cooked" by the sun, often when there is a snow cover to intensify the sunlight. High ozone levels can be particularly dangerous to people with compromised immune systems and respiratory problems. Air quality monitoring is now required, with ongoing steps taking place to alleviate the potentially dangerous situation, though "Ozone Alerts" continue.

At the same time, positive impacts from the successful drilling in the Jonah Field and Pinedale Anticline were immediate and far reaching. Millions of tax dollars have been collected as a result of the natural gas production in Sublette County, which have been used for improved infrastructure and community resources. Thousands of jobs have been created for local residents and for those willing to relocate to the area. Industry has also been very generous in volunteering time and donating money to organizations that serve the community. Industry operators have also worked with the Wyoming Game and Fish Department to implement innovative technologies and operational practices that lessen the effect of natural gas operations on the environment.

Jonah Field. The pipelines in the picture are temporary surface lines that are used for completion (frac) operations. They transport water to the pad for frac operations and then transport water away from the pad for treatment. They move around the field with the completions crews. Ultra uses 100% recycled water for completion operations.

Natural gas production continues in 2011, and so too, do many of the problems that came with it. Population growth has slowed somewhat since 2008, however, and the newcomers continue to be served reasonably well by private-sector housing and other services. At the same time, increased tax revenues have allowed local governments to be proactive in building infrastructure, and industry is working to alleviate the problems brought on by the drilling activity. Pipelines, for example, are being built to carry out the condensate now carried by large, dust-raising semi trucks. The BLM and Wyoming Game and Fish monitor the area, and face continued challenges.

Since 2010, additional natural gas fields in Wyoming and throughout the West have been located and development plans are underway. Citizens from Sublette County have been invited to these areas to discuss ways those communities can learn from Pinedale. These could be valuable lessons.

As said in the report things are changing on the Jonah Field as Erika and Jasmine showed me. Now many companies are drilling from a single pad where there will be multiple well heads at that pad so that there will not be the same visual impact of the area. Ultra has pads that range in size from 1 to 58 wells. On average, they have 12 to 25 wells per pad. Ultra currently has 69 producing wells in the Jonah field. They are currently not drilling there, but there is the potential for roughly 400 wells on their acreage. Ultra is actively drilling on the Pinedale Anticline and they have 2,000+ producing wells. As well all the condensate will be collected from tanks at a single pad, again reducing the need to drive all over the landscape to collect the condensate. I asked about the fracking process. They don't release the names of the chemicals used but they can only use what is approved by WOGCC who are the regulators.

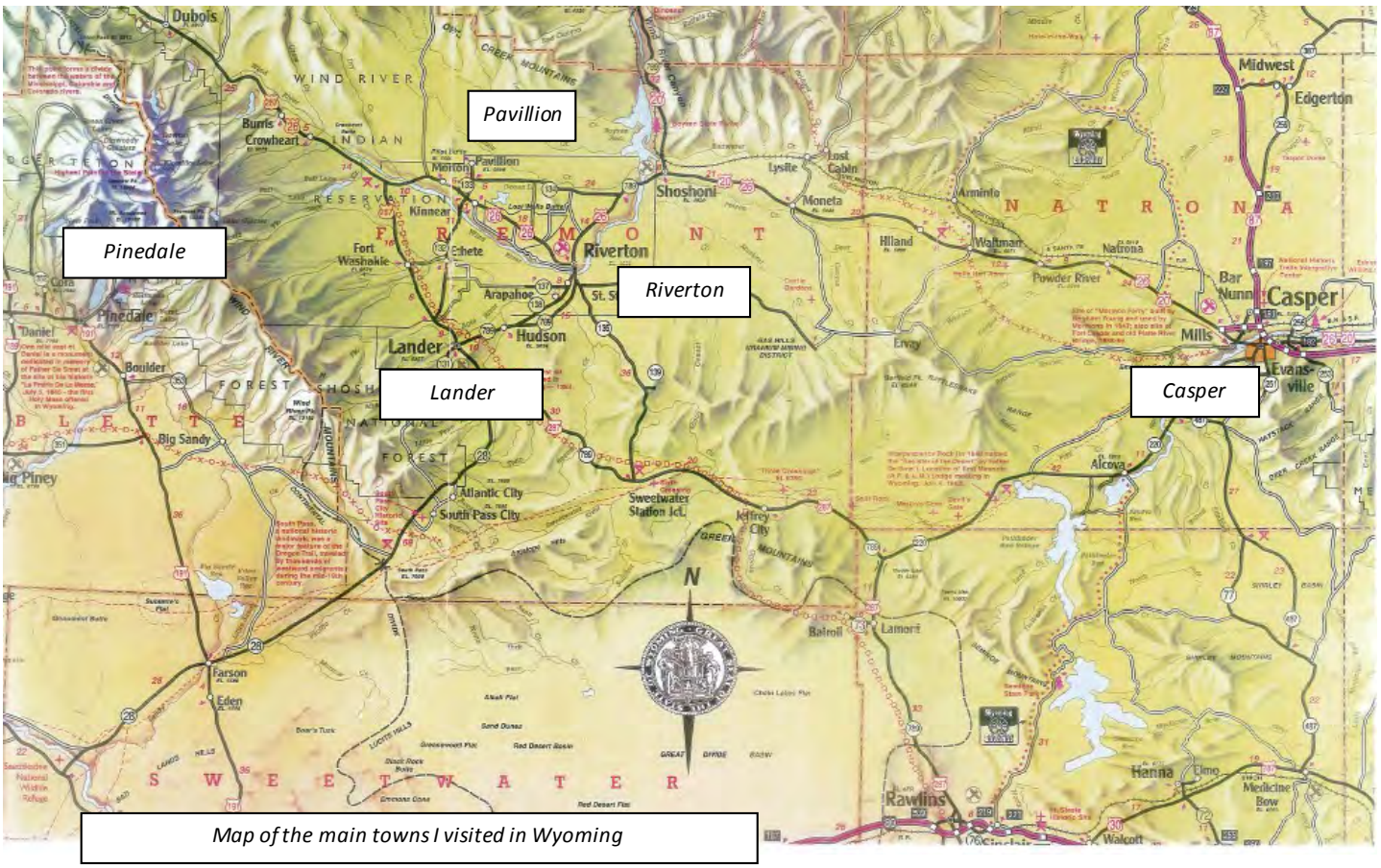
Multi wells and condensate tanks all on one pad—Ultra Petroleum

I asked what happens to the fracking fluid that remains down the hole and they said it remains there under pressure and cannot move.

I was seeing a very different geology, land and mineral ownership scenario as well as regulatory processes here than in Australia. As an example gas extraction proposed in the NT would not have condensate as it is dry gas.

It was getting late into the afternoon and I headed head back to Casper that evening (273 miles) as I had to catch a plane in the morning. Unfortunately I had to cancel my trip again to see Lois Meeks at Pavillion so I rang him to apologise. Heading back along Highway 191 I noticed a headstone on the side of the road and stopped to have look. It commemorated the Oregon Trail where the early pioneers passed. You can just see the trail on the right of the photo. Eventually I got back to Casper at about 10.30pm, tired and hoping for a good night's sleep but with the plane leaving at 4.30 in the morning that wasn't going to happen.

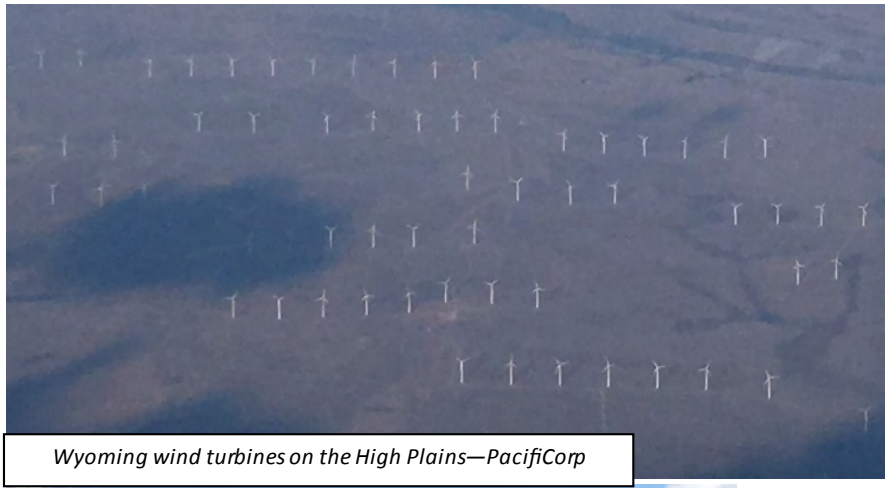
On a different topic, when travelling by road I noticed a couple of things. Firstly the price of fuel, especially relevant in the NT today. In Pinedale I had to fill up with fuel -$2.97/gal which converts to $0.98c/l which in Australian dollars is about $1.29/l. Everywhere you pay for your fuel with your credit card before you fill up which saves you time and as you don't have to go inside which saves you buying the overpriced drinks in the shop!



Map of the main towns I visited in Wyoming

Day 9 Saturday 16th September

Up early to catch a 4.30 plane from Casper to Denver. Lucky to have caught the plane as the motel staff forgot to set my early morning call so thankfully I had my alarm on my phone. I took my Avis car to the airport but unlike other airports Avis weren't allowed space there so I had to head back to their office on the main highway to drop off the car. Thankfully there a was bus waiting to take me back to the airport. I was starting to wonder if I would catch my plane now at 3.30 on a cold and damp morning. Anyway there wasn't anything to worry about . The driver at the Avis office made me a coffee, as you do anywhere you go in Wyoming, and then told me he was a Korean veteran. He was a friendly bloke and very interesting to talk to especially about his time in Korea. Interestingly he said that during the Korean War the one army that the Chinese were scared of were the Australians not the Americans! The weather was cold and drizzly a bit like a winter's day in Melbourne as the plane took off for Denver.



Wyoming wind turbines on the High Plains—PacifiCorp

It was interesting to see wind farms in southern Wyoming because even though Wyoming is reliant on fossil fuel for its power generation it also has a considerable number of wind turbines. Wyoming is 15th in the US for wind generation.

Farmland from Colorado to Ohio

From Denver I flew to Dayton, Ohio. To get there you fly over Colorado, Kansas, Missouri, Illinois, Indiana and Ohio. This is a very productive faming region and there are miles and miles of farms all across these states. It obviously is a very productive part of the US from an agricultural point of view.

Marysville

I landed in Dayton Ohio to be met by Judi and David Green. People may remember Judi and her daughter Paden who came to the NT about 10 years ago for a commemorative cricket match on Anzac Day at the Strauss Cricket Ground. Judi is the niece of Capt Al Strauss and Paden the grandniece. Capt Strauss was an American Army Airforce Pilot who was shot down and killed over Darwin Harbour by the Japanese in April 1942. So naturally it was great to catch up with Judi and Dave. They drove me to their home outside of Marysville which is about an hour's drive from Dayton. They were kindly putting me up at their place for a few days while I looked at the gas industry in Ohio. It was good to have a place to rest especially as I had a head cold that appeared to be getting worse. That evening I had a barbecue dinner with the family at their Blues Creek Road home as the sun went down across nearby fields of corn and hay.

The Green House on Blues Creek Road

Day 10 Sunday 17th September

Thankfully this was a rest day which I needed to try and shake off my Wyoming cough. But it gave me time to put my feet up, read a book and check my itinerary for the next few days.

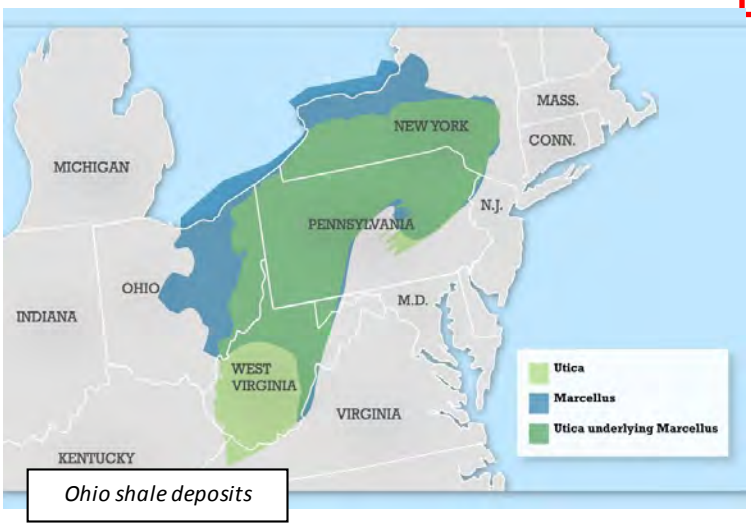
Day 11 Monday 18th September

After a good night's sleep interrupted by a cough or two I was off to Akron in north eastern Ohio, courtesy of Judi and Dave's taxi service. Needless to say you see a lot of corn on the way. At Akron I was met by Mr Mike Chadsey who is the Director of Public Relations with the Ohio Oil and Gas Association (OOGA). Mike had organised a trip through eastern Ohio. This area is part of the Marcellus Oil and Utica Fields

My first appointment was with Becky Clutter, a local landowner and board member of the National Association of Royalty Landowners (NARO). We met up at the local Bob Evans Restaurant. Mike explained that OOGA does educational outreach to explain about the gas industry in Ohio. This is the catalyst for a working relationship between the industry and the community. NARO is one part of the community that OOGA works with. Becky explained to me about royalties and how it relates to farms in Ohio. If a company wishes to take gas from your land they may have to pay $12,000 per acre as a disturbance fee, 12% of production sales, compensation for the well pad, plus road access and revegetation. Because the company uses County roads there has to also be a RUMA – a road use management agreement. Where companies wanted to store pipelines some people were able to receive rent for storing pipes on their land. The gas may belong to the Federal Government who have auctioned it off to the highest bidder who then has to negotiate with the owner of the land. The owner of the land can be either Federal, fee (private) or State. Becky said that gas had helped many poor people out of their financial mess and many jobs had been created from the gas industry in Ohio.

Akron is a city in Summit County Ohio. The population is nearly 200,000. Once famous for being the centre of tyre manufacturing but since the 1990's the companies have all gone. It now boasts industries based around Polymer Valley.

The Marcellus shale play runs through northern Appalachia, primarily in Pennsylvania, West Virginia, New York, and Ohio. It is one of the richest gas fields in North America. It is estimated to hold as much as 500 trillion cubic feet of natural gas, about 50 tcf of which is recoverable using current technology.



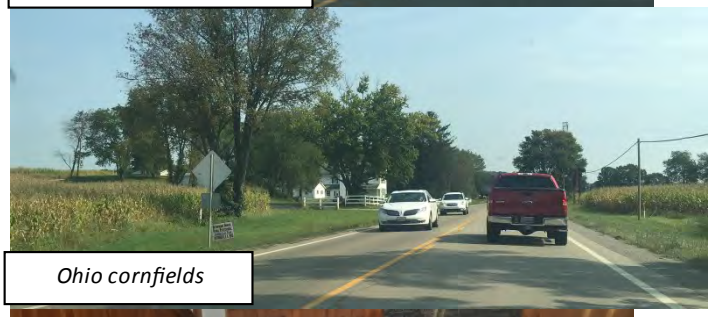
Ohio shale deposits

We said goodbye to Becky and headed south through the rolling hills of the country in contrast to other parts of Ohio which are flat. Our next stop was Carrollton where I met Amy Rutledge, Director of the Carroll County Chamber of Commerce and Visitor's Bureau. We had a lunch meeting at Donna's Deli in the heart of town.

She told me that gas along with oil and coal had been extracted from this region for over 100 years and that there had been little or no backlash to the industry. She said her land had been looked after for 5 generations and she wasn't going to let it be messed up if she thought the process would damage the land

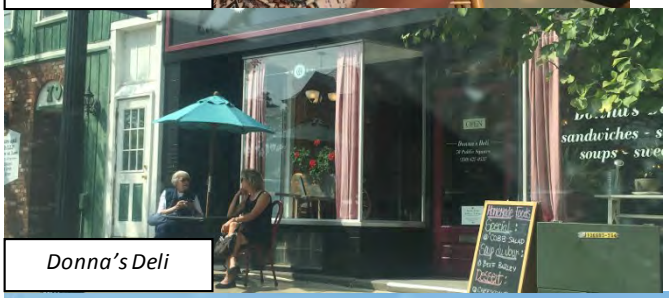

Becky and I

Carroll County, Ohio

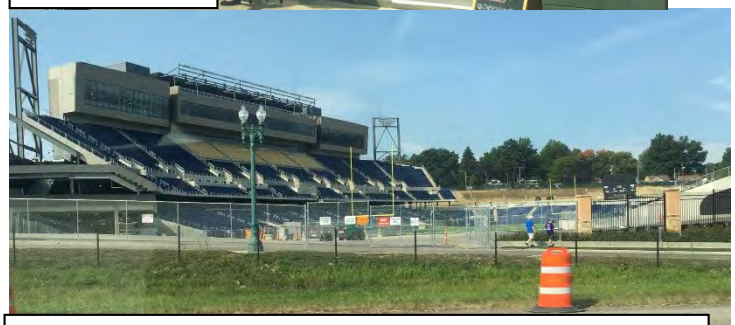


Ohio cornfields

Amy Rutledge



Donna's Deli



Original home of American football

Oil—a train full

and water.

She also emphasised the huge economic benefits highlighting that since 2010 when shale production had commenced, unemployment had gone from 13.9% to 4%. People were being paid for gas on their land. She said she used to employ three people, now it is six. In the town there were seven businesses closing but they are all open now. There was one hotel and now there are three. There has been a lot of indirect employment with gas companies requiring pad builders and land clearing and preparation for pipelines.

In relation to the aquifers she mentioned that wells were drilled down to about 4000ft with the aquifer at around 400 to 500 ft. Some wells are developed quite close to houses which can cause a disturbance.

A new mid-stream power station (Bechtel) is being constructed which will produce 900 Mgw of electricity using gas.

After meeting with Becky it was off to meet the Editor of the *Daily Jefferson* the local newspaper in the Cambridge region. We had a general discussion about gas. I was reminded by Ray Booth, the executive Editor, that the Ohio Department of Natural resources requires every new well to obtain a permit, and when drilling to be inspected by a physical witness. If the company does the wrong thing then it can get the State Attorney General to make you do the right thing.

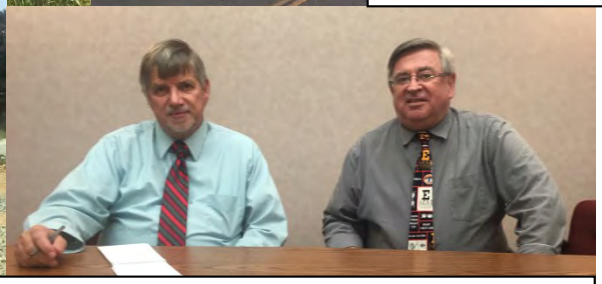
Carrollton is a small town in Carroll County south of Akron. Its population is about 3400. Carroll County's economy is based on agriculture corn, soybean, wheat, beef, dairy, sheep, bees, Christmas trees! and gas from Utica Shale.

From there Mike took me to one of the local gas companies to meet Amanda Finn from Ascent Resources. Ascent Resources is a oil and gas company which has a 300,000 net acre stake in oil and gas production in the Appalachian Basin. The company has overseen the drilling of

Oil well on farm near Cambridge

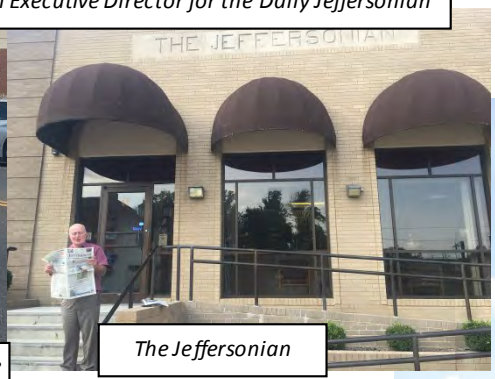
Rolling hills –eastern Ohio

Pipeline construction



John Lowe and Ray Booth Executive Director for the Daily Jeffersonian

Mike Chadsey Ohio Oil and Gas Association—main street Cambridge



The Jeffersonian

thousands of horizontal wells across the U.S. including over 800 wells in the Utica and Marcellus fields and more than 30 rigs in various unconventional plays. We discussed how, in Ohio, as in other parts of the US, private land owners can own the gas along with the Federal and State Governments. I was able to inspect a whiteboard showing a list of owners and the wells on their properties—it showed me how involved it can be.

Cambridge is a city in Guernsey County in eastern Ohio. The population of the city is around 11,500. Economy—livestock, poultry, grains, milk, hogs and pigs, forage, silage, soybean, corn, oil, gas, tourism.

After that I thanked Mike for his assistance and re-joined my hosts Judi and Dave for the drive back to Marysville.

Day 12 Tuesday 19th September

Originally the plans for today were to visit the Ohio Department of Natural Resources but they were only able to see me on Wednesday morning which meant some travel arrangements had to be changed. But that was okay, there was a large agricultural fair, similar to our field days, just outside of Marysville on the Tuesday so that was an opportunity to see the latest in Ohio agriculture. But before we departed we noticed there were some men unpacking some equipment from vehicles just across the road from the Green's house. This was a company called Haverfield who were setting up a base there. Their job was to replace spacers on the high voltage power lines that crossed nearby fields and they were starting that morning, well they

Haverfield waiting for the sky to clear

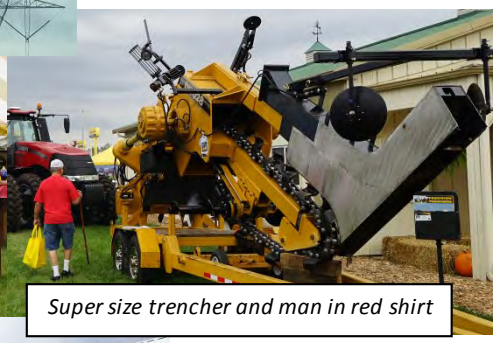
New replacement spacers

HV Powerlines and spacers

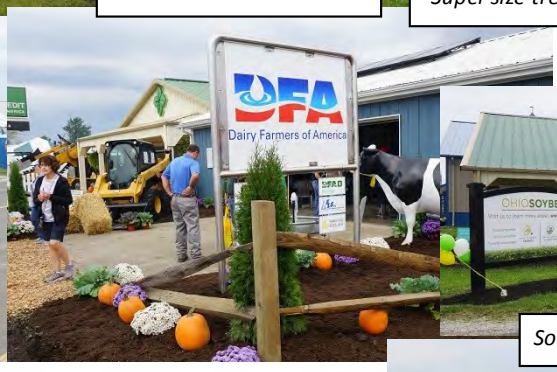
hoped to but the weather forecast was not looking good. As this job involves men hanging out of helicopters attaching spacers to the wires, then the weather has to be good.

Crop harvester and man in red shirt

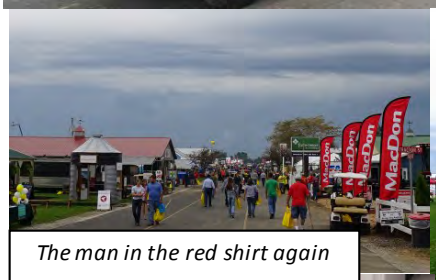
Pork burgers for lunch



Super size trencher and man in red shirt

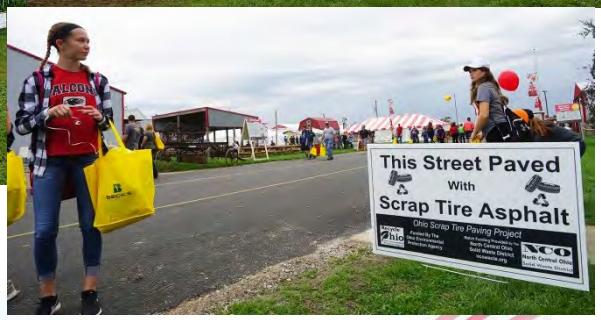


Soybeans above and trials below



The man in the red shirt again

Row fertilizer for tall crops



Old style

Stump grinder for Bobcat

Police patrol and mobile phone!

In the meantime we headed off to the fair and already there were hundreds of cars parked and large crowds in attendance. The day is actually called the Farm Science Review and is regarded as one of the biggest farm days in the US. The event is sponsored by The Ohio State University's College of Food, Agricultural, and Environmental Sciences. According to the brochure there were 640 exhibitors and 120,000 people likely to attend and even though the weather was not looking the best there were still plenty of people including many young people from colleges around Ohio. Just looking at the exhibits and the effort some companies put in to show off their products shows the importance of the agricultural sector

in Ohio and other parts of the US. When you travel through Ohio and see the amount of soybean and corn that is grown you can see why companies are anxious to be seen at such fairs. Unfortunately the weather closed in and although we waited for it to clear, it just got colder and wetter, so we headed home. The bad weather had also meant that Haverfield who were hoping to fly their helicopters above the power lines had gone home for the day in the hope tomorrow would be fine. So Dave took me for a tour around Marysville showing me the small farm where he and his family grew up. The house was still the same and soybeans were still growing in the fields nearby.

Original home

Soybean

Last night with the Green family

This was my last day with the family so Dave got the barbecue all fired up and all the Greens came round for dinner that night to say goodbye. Sitting around the table, saying grace together before the meal, enjoying beautiful food and talking to one another without the TV on which is something I don't experience too often meant it was a special evening.

Day 13 Wednesday 20th September

Judi and Dave Green took me to Columbus, the capital of Ohio.

There I met Chief Richard J Simmers and Assistant Chief, Scott R. Kell at Ohio Department of Natural Resources (DNR). The first discussion was around the gas at Pavillion, Wyoming. I asked about the gas there. They said Pavillion had a shallow reservoir with poor quality confining between gas and the aquifer. The geological conditions should not have allowed wells to be drilled. They said this was under federal control.

They told me there are 65,000 wells drilled in Ohio. The drilling of a well was compared to building a house. Wells were inspected at all stages of production. This is critical when casing is being installed. Pressure testing is done before any hydraulic fracturing is permitted.

A conductor casing protects groundwater and in case that fails a second surface casing is installed to protect fresh water. The bottom is then mapped. The casing is installed 50 ft below fresh water.

They went on to say there is annual monitoring of wells. If anything is wrong with the casing and cementing that well is either shut down or remedial action is required. There was one case where a company, Hess, drilled a well costing $12m and it cost $11m to rehabilitate.

With regard to well construction and pad construction, Ohio has the most comprehensive rules in the US. Ohio has the best seismic monitoring in the US with extremely good emergency notification. They also do

Staff at Ohio DNR Chief Simmers (2nd r) and Scott Kell Assistant Chief (2nd l)

radiological monitoring. They monitor the fracking process which along with waste water injection can cause seismic issues if not monitored. They monitor seismic down to 0.5. If, stimulated event occurs at 1.5, they warn the company that if they reach 2 then they have to modify their process before they can continue. If they get to 2.5 they are shut down. Ohio citizens are able to ring Ohio Department of Natural Resources anytime at if any earth movements are felt.

Modified Mercalli Scale		Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibrations like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at night some awaken; dishes, windows, doors disturbed; standing autos rock noticeably	3
		3.5

Shaking generated by fans jumping up and down at Ohio Stadium during the OSU vs. Michigan game Nov. 26 was measured by seismometers under the stadium. The Fan-Quakes Magnitude Scale reached a record high of 5.79 during the winning touchdown (image courtesy of Mike Brudzinski).

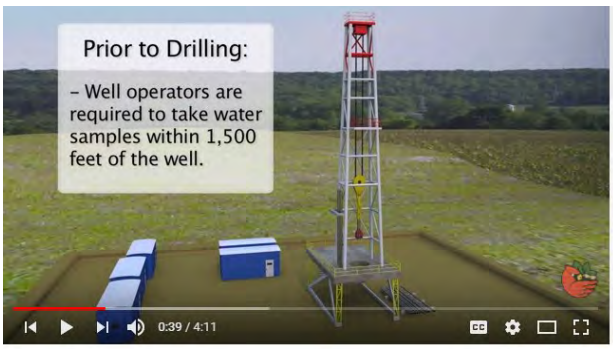
In Ohio they have seismic recording devices around the state. If the public ring in with a complaint the ODNR check if any drilling company is in the area. If there is, then monitoring devices are placed in the area and if the drilling activity is the cause of the problem then the requirements mentioned earlier come into play.

I raised the issue of earthquakes in Oklahoma and how it is used as an example of the dangers of fracking.

They explained that Oklahoma did not have the same controls as Ohio did over drilling or monitoring for seismic changes until about 5 years ago which is why they had problems. Ohio DNR can monitor within a couple of hundred metres of where the fault is. That means you can identify the actual well. Using a seismic station connected to solar cells then by mobile connection to phone tower, the computers can plot the epi- centre.

Ohio has about 16,000 horizontally fractured wells and there have been no problems. The use of this technology means there is less effect on the landscape as only one pad is required for several wells. Previously most wells were vertical wells and so a lot more wells dotted the landscape.

DNR charges the gas companies for the permits required for the development of each well. This is done through 40 different fees and charges which feeds $50m into the state which also helps fund ODNR.



Any release of gas has to be reported. Citizen complaints are looked at and followed up.

The Ohio DNR has total control over the drilling process with each step of the process being inspected by Ohio DNR inspectors.

There is a groundwater protection council which gets very involved in hydraulic fracturing with the main concern naturally, water.

They mentioned Pavillion again, citing poor well construction and poor reporting 50 years ago.

In relation to chemicals used, gas and oil companies cannot use any chemicals not on the Ohio DNR list.

They said the fracking chemicals aren't the problem, surface pollution from chemicals above ground is.

They also mentioned there is an environmental fund - the EDF.

Hydraulic Fracturing Video
ODNR's Scott Kell describes the hydraulic fracturing process and regulatory oversight

In Ohio the Federal Government can give approval for a company to drill but the Ohio DNR sets the rules and a well can't be constructed unless DNR approves the engineered plans. So if the well proposed is in a sensitive area like a water catchment, then a company may not bother to go ahead as the conditions to allow them to develop the well may be so costly because of the stringent conditions required by the Ohio DNR.

The OHIO DNR has a very good website where there are many fact sheets, audio and video. Below is a list of materials available on www.dnr.ohio.gov.

Here's an example of what you would find on the fact sheets.

Will my well water be harmed? *Each application to drill is examined on an individual basis by trained staff at the Division of Oil & Gas to determine the deepest source of underground drinking water. A casing plan is then designed to protect the aquifers that may be affected. Steel casing is installed in the well and cemented under the supervision of Division of Oil & Gas inspectors.*

I spent nearly three hours with the staff that day which enabled me to get a great insight into what they do and a belief that the people working in the department are people who live by the motto of the department. (right)

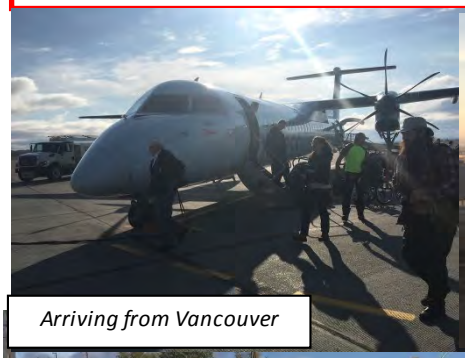
It was therefore disappointing to find out that security had to be increased at DNR because of threats to staff by some people who didn't support fracking.

When the interview had finished I was picked up by Judi and Dave, stopped at Crackle Berries for lunch and headed for the airport at Dayton. It was a beautiful day but unfortunately there wasn't enough time to go back to the agricultural fair. Said my farewells, back through airport security again and then back to Denver connecting with a flight to Vancouver, staying overnight and then on to Fort St John in British Columbia, Canada.

Day 14 Thursday 21st September

Up early again to catch the 6am flight from Vancouver to Fort St. John. As you fly north you pass over the mountains which had some early snow on them—this was the beginning of fall or autumn. The route to Fort St John follows a large river with farms along the way. Arrive at Fort St. John at 9.50am. Check in for my rental car, expecting a mid range vehicle but instead end up with a Ford 150 which is the type of vehicle most people seem to drive in this part of the world—certainly a bit bigger than my Ford Ranger. Check out my navigation equipment and head for the hotel on 100 Ave. Fort St John has kept its road naming system pretty simple—roads going east/west are avenues and if you live north of 100 Ave (the main street) then your avenue number will be above 100. If south of 100 Ave you will be below 100. If your road runs north/south the road will be a street and the street number will depend on which side of 100 St you live on. It can get a bit more interesting when you get to 109A St! You don't need a place names committee.

Fort St John is a small city of about 18,000 people and is situated on the Peace River. It was established in 1794. It is part of the Peace River Regional District. Although it is regarded as the oil and gas capital of British Columbia it also has an economy which includes forestry, agriculture and tourism.



Arriving from Vancouver

Fort St John

The city is spread out with only a few tall buildings. Breakfast/dinner was a Dominoes pizza as I needed something to warm me as the weather was on the cold side which didn't help with my persistent cough.

My Avis rental 'car'

100 Avenue Fort St John

By now I had got my bearings and was ready to meet people from the British Columbia Oil and Gas Commission (BCOGC) down on 100Ave. They are like the people at our Department of Mines and Energy and the Environment Protection Agency. I drove down to the headquarters and was met by Phil Rygg, Director of Public and Corporate Relations. Fort St John is situated on one of the biggest gas fields in Canada, called the Montney Field.

Phil Rygg outside BC Oil and Gas Commision

Ken Paulson

Ken Paulson, P.Eng, Executive Vice President and Chief Operating Officer for BC Oil and Gas Commission (BCOGC) was kind enough to speak to me via teleconference from Victoria (BC) where he is based. Ken has over 30 years of experience in the oil and gas sector including more than 15 years in regulatory roles for Canada and the Province of British Columbia. Prior to Ken's current position, he

was the Commission's Chief Engineer.

Ken said BC Oil and Gas had done a scientific review re fracking as nearly all gas today comes from hydraulic fracturing. The Commission is funded from industry fees. It established its mission values about 6 years ago. It also developed First Nation principles -UNDRIP. The Government can still make a decision over development even if opposed. He said mineral rights rest with the Crown except along railway lines where railway owners were given land and mineral rights along those corridors.

Gas is taken out of the Montney Field which is 30% of total production in British Columbia. The Montney gas field is easily accessible to the rest of North America. It produces not only gas but also some oil which gives added value to the field. BCOGC does not allow leaks of methane and pipes and mechanical connections are all checked using ultraviolet light equipment. If detected, companies have to fix the problem. Some of the First Nations are involved in gas development. BCOGC keeps a list of all chemicals used in fracking and has done so since 2012.

Ken recommended the website called FracFocus to get a good understanding of the chemicals used in the industry amongst many other things. He said academia gets overlooked in this discussion. He says they have good data on seismic issues. Companies, when drilling, cannot effect seismic readings any more than occurs naturally. If it registers above 4 then the well is shut down and management of the well has to change its practices, for instance by reducing pump rates. Ken also sent me an excellent presentation about the BC Oil and Gas Commission.

Charles Porter

My second interview, also by teleconference, was with Charles Porter, Vice President, Strategic Engagement. In addition to his other roles, Charles is a lawyer with the company with a focus on Aboriginal Law. He is a negotiator. He was once an Assistant Deputy Minister for Negotiations with the BC Ministry of Aboriginal Relations and Reconciliation. Charles gave me the big picture view of the history of BC. He says all provincial First Nations people have a belief that they have been here forever. However, recent research seems to indicate ancient origins in multiple waves coming from Siberia originally which may contribute to the great diversity of First Nations in British Columbia today. He said they have many cultural similarities with Australian Aborigines. They hold strong connections with the land and strongly held views that they are stewards of the land for future generations. He said negotiations can get quite emotional as the conversation often revolves around a clash between strongly held values and economic development. This sometimes makes the job of the regulator, including finding middle ground, a challenge.

He said the earliest history of contact in this region was more positive, highlighted by the sensitive and respectful treatment of First Nations by Captain Cook and other early British explorers. As contact increased, pragmatic business partnerships between Europeans and First Nations formed around the fur trade. However, the fur trade and European settlement began irreversible changes for the Aboriginal people. There was an instant change to the pre-contact sustenance and trading economy with the trading of furs. Sadly, along with contact, came economic disruption which was compounded by diseases like smallpox, flu, etc. with mass illness and mortality.

The first Governor of the united colony of British Columbia, Sir James Douglas, had been a Hudson's Bay Company trader and understood the need for trading partnerships and peaceful relations

between First Nations and settlers. He took steps to obtain funding and medical assistance for First Nations affected by disease and economic upheaval.

Prior to British Columbia joining Canada, Sir James Douglas followed a pattern of negotiating land acquisition treaties to clear the way for European settlement on Vancouver Island. He intended to negotiate treaties throughout what is now British Columbia but could not raise the funds to do so and he stopped after negotiating 14 treaties on Vancouver Island.

In 1871 British Columbia joined Canada and expected that Canada would negotiate treaties throughout the rest of British Columbia as had occurred throughout most of the rest of Canada. However, this did not occur and longstanding grievances and land claims of First Nations were not resolved, and many remain unresolved to this day. The only treaty settled in BC for more than a century was Treaty No.8 in 1899 which covers lands in several provinces and territories and which covers part of North-eastern BC. This is the area where most oil and gas development in British Columbia occurs.

Honourable David Laird explaining terms of Treaty #8, Fort Vermilion, Wikipedia

In the late 19th century, Canada began a formal policy of assimilation which compounded the effects of economic turmoil and disease which had so badly disrupted First Nations communities and culture. First Nations were barred from speaking their language, were barred from legally challenging assimilation measures, were forced onto small land reserves and had their children removed and sent to residential schools. The extensive assimilation efforts continued for almost a century under the control of the government of Canada and created lasting harms. In an attempt to begin to provide redress for past harms, the government of Canada created a Truth and Reconciliation Commission to look at what happened in the past and to record both positive, and the overwhelmingly negative aspects of Canada's assimilation policies.

Most of British Columbia's First Nations do not have treaties in place, but steps have been taken to try to resolve land claims. Starting in 1973, the Supreme Court of Canada found that that Aboriginal rights and title had not been extinguished and a series of other findings which began to change the balance in favour of First Nations. In response, governments initiated modern treaty negotiations which continue in many parts of British Columbia. In recent years, the key term which has originated in court judgments, but which is more widely used in the political landscape of British Columbia, is the term "reconciliation" which has both its layperson's meaning as well as being a legal term which refers to finding a way for two sets of laws (the First Nations and Canadian) to co-exist.

In addition to court cases, in 1982 Canada patriated the Canadian Constitution and modified it to include a Charter of Rights and Freedoms and special rights for Canada's Aboriginal peoples.
As a result of court decisions and the new constitutional rights, a conversation started about how to engage or consult with Aboriginal people to talk about their constitutional rights and the impacts on those rights of lands and resource decisions by Crown agencies.

The complexity around consultation on First Nations rights is complicated by the number and diversity of communities. In British Columbia there are about 30 ethnolinguistic groups and 203 Indian Act bands. In many cases there are additional political structures such as tribal councils. A number of

communities are moving back to traditional decision making processes which may pre-date contact. Sometimes negotiations or consultations on agency decisions can be quite complex and may be influenced by separate negotiations going on between the First Nations and proponents (oil and gas companies) which are not transparent to provincial regulators.

Negotiations are often positive if initiated early by regulators and/or proponents and if there is time for First Nations to work through the proposed project and obtain an understanding of potential issues and benefits. The companies are able to work with communities and work on key issues of concern to the community such as stream crossings on salmon streams, or protecting caribou trails, or protecting an historical trail.

On the other hand, sometimes there are very strongly held viewpoints on some types or projects where the conversation does not go well. For example, there may be opposition to a pipeline, etc. which leads to a decision by the community not to participate in negotiations with the proponent or consultation with the government agency. However, in Canada, the law has evolved to place a duty on First Nations to participate in Crown consultations and where they do not, the Crown is entitled to proceed with making a decision.

Where consultation occurs and it is determined that rights may be impacted by a Crown decision, then a duty known as "accommodation" arises, a term which covers avoidance, mitigation, compensation, additional monitoring programs or other Crown measures. With respect to proponents, the First Nation is not obligated to participate in negotiations. The practice which has evolved is that even if the community is not interested, the company will tell them what they intend to do and if possible address all impacts. Sometimes that helps, sometimes there is no response.

There are no Federal funds provided to assist First Nations with either consultation or project-specific negotiations. As a result, the BC Oil and Gas Commission will provide both ongoing and short term (sometimes project-specific) capacity funding to provide First Nations with the means to fully participate in the consultation and decision-making process. Companies will often also help with their own form of capacity funding but it is directed towards the companies' own engagements with the community rather than in support of the Crown consultations to avoid perceptions of influence. The previous Federal Government was taking steps to audit First Nations finances but that practice may not be carried on in the future. Some communities have great concerns with trust in their leadership around these types of agreements, sometimes driven by issues of wealth distribution in the communities.

Private land ownership in British Columbia is based on the Torrens system and British Columbia has a land title system similar to our land title system. That means there is private or fee simple land and Crown land. Crown land becomes fee simple land through the mechanism of a Crown grant. Historically, those grants were broader but in more recent times have only included surface rights. Sub-surface rights are held by the British Columbia Government except for radioactive materials which is controlled by the Federal government.

In terms of oil and gas development, Charles said that a gas or oil company would first have to get

an exploration permit and develop an understanding of whether or not a subsurface resource exists. If they find a resource they wish to develop, they go to the BC Government and request that the Government auction the subsurface resource. A public auction is held and anybody can bid, but usually the company exploring wins the auction. These auctions are known as "land sales" and are run by the BC Government, not the Oil and Gas Commission. After winning an auction, the company obtains subsurface tenure. Subsequent oil and gas activities, such as road building, drilling etc.is managed by the BC Oil and Gas Commission which must issue a range of different authorizations relating to the proposed activity. In some cases, the tenure is issued in an area where the First Nations has concerns about development, complicating the decision making process of the Oil and Gas Commission.

The next member of BC Oil and Gas I spoke to was Sean Curry. Sean is the Executive Director of Resource Development and Environment at BC Oil and Gas.
Sean spoke about the disposal of waste water.
In BC there are opportunities for the deep disposal of waste water between impermeable geological layers. These layers are very common at about 800 to 900 metres down to 2 kilometres. The waste water is injected well below the aquifer and the pressure is measured in the process. This process is highly regulated and if pressure exceeds an allowable range then BC Oil and Gas shut it down.

Sean Curry

Waste depends on how much comes back fracked. It can be a considerable amount of water. All the water used for fracking is 37% freshwater and the rest recycled water. Note: In the case of Pavillion the methane is very shallow and mixes with potable water.

Sean emphasised that the number one thing in the process was to focus on the casing and the cementing.

In British Columbia you need tenure to drill a well and the BC Government makes that decision. There is no drilling in drinking aquifers. If you are applying to drill you need to be aware of all the issues such as those relating to Aboriginal people, the environment, etc. You have to bid for your right to drill and that may only be between certain depths. When applying for permission to build a well pad you have to focus on water rights and air quality. There are water regulations to protect the ground water – volumes of water are monitored, flow back volumes are monitored.

Below is a summary of what is required by the Water Licence Application Manual;
Water is a Crown resource. The Water Sustainability Act vests "the water at any time in a stream" and the "percolation and flow of groundwater" to the Crown. The use of water from a stream or groundwater for oil and gas or related activity requires a water use approval or a water licence from the BC Oil and Gas Commission (Commission) through the Water Sustainability Act. Commission staff are designated as Regional Water Managers and Assistant Regional Water Managers by the Deputy Minister of the Ministry of Forests, Lands and Natural Resource Operations, with the authority to administer the Water Sustainability Act for water licensing for the oil and gas sector. Mandatory licensing and approvals enable the Commission to monitor and track water consumption and withdrawal locations, thereby bettering sustainable water management. The primary objective for water licensing is that of efficient and equitable access to Crown water resources to support sound development of the oil and gas sector, in a manner ensuring environmental protection and public safety, and not impairing First Nations and public rights, or existing water rights.

When water comes back it is held in produced water ponds. Produced means: *Water flowing or is extracted to the surface from a natural gas or oil well, including water injected into the formation, and including any chemicals added during the production/treatment process. This includes flow-back fluids from well completion and stimulation operations. This also includes any fresh water not used for domestic purposes.* These ponds are designed to the specifications of the Management of Saline Fluids for Hydraulic Fracturing Guideline. This covers a whole range of issues from siting, design, to monitoring etc.

If a company is drilling multi wells then the water is held in pits so that it can be recycled and if it can't be used anymore it can be trucked away to be injected.

Some companies have too much water and are using a process called crystallisation distillation. From that about 80% will become distilled water and the rest will be a mixture of brine distillate, brine and salt. The fresh water has to be treated and pass the drinking water test before it can be put back into a river – this is all monitored. The disposal of brine is still an issue, but this distillation process significantly reduces the amount of brine. The salt produced is used in swimming pools and on roads to help melt the snow. The use of produced water has raised some political interest because the use of disposal wells is limited by capacity and that is why there has been some focus on distillation processes.

When a site is decommissioned there needs to be an assessment to make sure there has been no contamination, so soil is sent offsite for testing. Contamination from a storage dam can be caused by sabotage (which does happen) and seepage. Groundwater monitoring is required around the ponds. Companies need to be aware that if not done properly it might cost $1m to build the well but $10m to clean it up.

Sean said there is an extensive network on stream flows throughout British Columbia. BC Oil and Gas use Geographic Information Systems (GIS) to calculate long term stream flows which are calibrated month by month and at any time of the year 85% of the total must flow. Water licences cover both surface and underground water. There are high flows when the snow is melting in May, June and July. Because the flows can drop too low, pumping is not permitted so companies can harvest water in times of heavy flow. Pump testing is done to make sure ground water is being replenished.

Phil Rygg took me outside to show me the BCOGC Air quality truck . Here I met Reg Marquardt who is the Environmental Response Specialist for BCOGC.

The official name of the vehicle is RAM – Roaming Air Monitor. It is a specially designed van housing the necessary air monitoring equipment. It serves as a quick response unit for emergencies and complaints from the community. However, it can also be used for other air monitoring deployments when not in emergency service. The Commission Roaming Air Monitor (RAM) is designed and purpose-built as a quick response mobile air quality monitoring unit. It is built on a Mercedes Benz Sprinter cargo van chassis, the only factory-delivered one ton vehicle that has 4-wheel drive and extended roof height required to house the necessary monitoring equipment. RAM strengths:

Reg Marquardt and his $500,000 worth of RAM

- Instantaneous deployment
- Monitoring equipment can be powered by vehicle alternators, custom internal battery capacity, and/or connection to a 120 volt external power source
- Allows the Commission to investigate complaints and respond to emergencies quickly and easily and access virtually any location that has road access

What can a RAM Measure?

RAM is designed to measure the following air pollutants and atmospheric conditions:

Air Pollutants:

- Hydrogen Sulfide (H_2S) Sulfur Dioxide (SO_2) Total Hydrocarbons Canister Sampler – to enable sample collection for subsequent VOC analysis Particulate sampler – using a Three Wavelength Nephelometer
- Low volume particulates

Atmospheric Conditions: temperature, humidity, wind speed and direction.

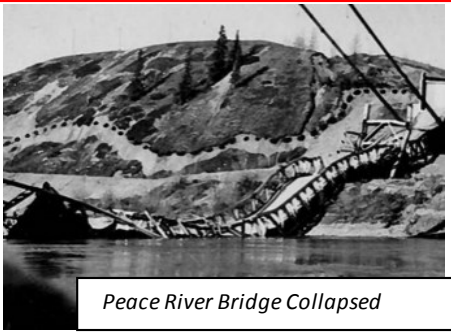
One of these units costs about $500,000.

BCOGC has eight monitoring sites and the RAM. BCOGC actively participates in the Northeast Air Quality Monitoring Project which measure air pollutants, including concentrations of sulphur dioxide and total reduced sulphur, commonly associated with oil and gas development. Air quality in the region is monitored in order to make informed decisions about public health, pollution management and the protection of sensitive ecosystems.

It was a very informative afternoon so I said goodbye to Phil and Reg. Phil gave me some directions as to where I would see some drilling rigs and so headed south along the Alaska Highway, stopped at a little town called Taylor about 10km from Fort St John and popped into the visitor information centre to get some directions. The information centre was in a small park, built in a log cabin style and the lady behind the counter was friendly and a wealth of information. She said she sees a good number of Australians pass by and there were some Australian names and addresses in the visitor book the day I was there. I continued south across the Peace River Bridge. The Peace River Bridge at Taylor is the longest one on the highway. Opened in 1960, it is 649 meters (2,130 feet) long. The original suspension bridge, which opened on

Taylor Visitor Centre

Taylor is a small town of just over 1,500 people. It is part of the Peace River Regional District. The district is a farming area mainly of cattle and grain. In Taylor is the Enbridge Gas Processing Plant which processes 0.81 billion cubic feet of natural gas per day.



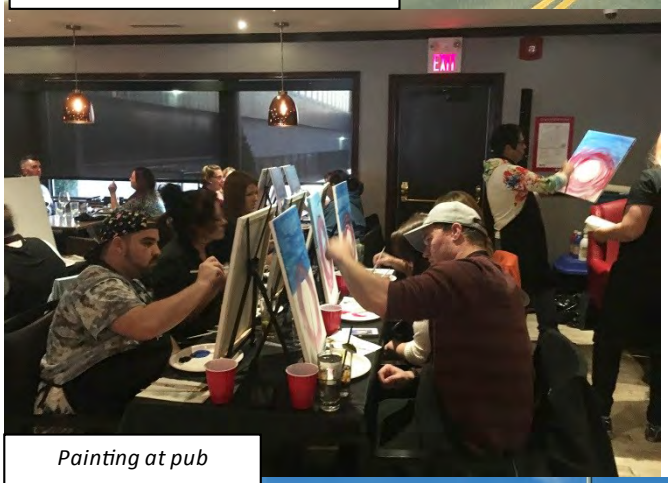
Peace River Bridge Collapsed

The replacement bridge

Drilling rigs on a farm on Braden Road

August 30, 1943, collapsed on October 16, 1957. No one was killed.

Safely across the bridge I headed down the highway turning off at Braden Road which takes you through farming land. There was drilling activity but unfortunately I hadn't organised a visit on-site so I couldn't get close to any rigs. It was interesting to see that this road was getting a major upgrade and as the Alaska Highway News reported *continued construction on Braden Road is being funded through B.C. Oil and Gas Rural Road Improvement Program, which funds road infrastructure projects throughout the Northeast.* Getting dark so headed back to Fort St John and negotiated the afternoon traffic and successfully found my hotel.



Painting at pub

I decided to have dinner at the hotel's restaurant . There was an interesting gathering of people there—artists—all learning how to paint. There was a master painter who gave out the instructions to about 20 would-be painters. It seems that it is a regular event at the restaurant and when the painting is finished they all enjoy a good meal. I don't know how that would go on at the Howard Springs Tavern on Wednesday nights—life drawing!

The Alaskan Highway through Fort St John

Day 15 Friday 22 September

Still coughing but up early to get ready for a visit to the Mayor of Fort St John, Lori Ackerman. Lori is

The Mayor of Fort St John Lori Ackerman presented me with a local beanie

Fort St John Council City Hall

obviously very passionate about her city so it was great to hear what she had to say. She mentioned how this region first developed as part of the fur trade. Now it produces highly nutritional food in the short growing season they have, and in fact this region produces 90% of BC's grain crop. Other significant industries include livestock, bees and honey, forestry – and there are two mills in the area – a brewery and of course oil and gas. Lori said that the region has very high environmental standards when it comes to gas.

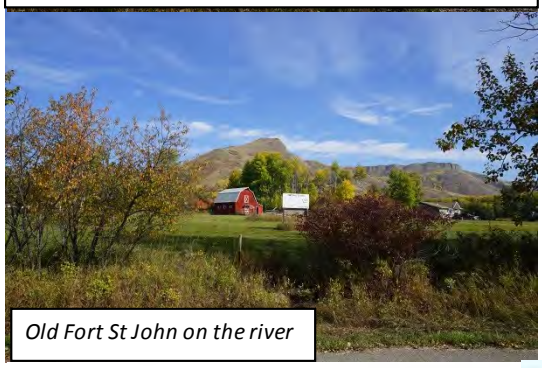
She mentioned that the geoscientists will tell you there is a lot of naturally occurring gas in the region. They are always looking to marry other industries with the gas industry but she also supports responsible and sustainable industries. She said we need to manage these industries carefully so they are viable and to take these opportunities for future generations including the First Nations.

Lori also explained one of the big issues around the city at the moment that she was heavily involved in. There is a proposal to build a third dam on the Peace River for hydroelectricity. It is called Site C. She said a survey conducted said that 20% were for it, 20% against and the other 60% were too busy to worry. She then looked at the Council's community plan to see how it would be affected and how it would be impacted by the dam. She said she spoke to as many people as she could—at the playground and coffee shop, wherever. She spoke to non-Government organisations, police, health, businesses and out of all that she won a Consultation Award. She was able to pull together the community measures agreed on. There was to be stringent rules, the company could build a camp but the locals would operate it, and there needed to be a child development centre and other facilities.

View of the foggy Peace River from the lookout

I gave Lori a copy of 'Outback' as a gift and she gave me a Fort St John beanie and mittens. We said our goodbyes and I headed off to the chemist for some flu tablets.

As the afternoon was free, I headed down the Old Fort Road to the Peace River lookout. It was a bit foggy but still a great view. From there I headed down Highway 29 which follows the Peace River. It was along here I made sense of what Mayor Ackerman was talking about when she referred to Site C. It was along this stretch of the river that a new dam is proposed. Here and there it was obvious that the idea is not to everyone's liking with some signs along the way objecting to the proposal. The scenery along this road is beautiful with the big river, mountains in the background and rolling hills with cattle grazing or crops growing. I eventually got into the small town called Hudson's Hope. It is a pretty little town on the banks of the Peace River. I was able to catch up on the local politics of the area by once again dropping into the visitor centre which was just as neat and tidy and inviting as the one in Taylor. I had a cup of tea, a good



Old Fort St John on the river

Hudson Hope Visitor Centre and multi faith church (saves money)

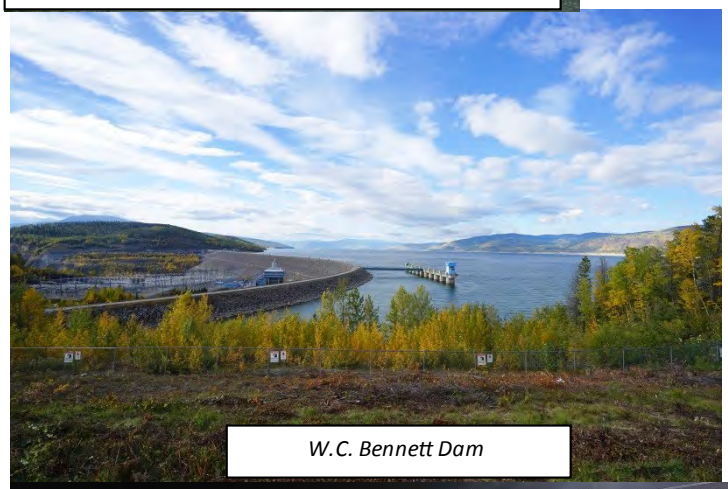
BC Hydro's Site C Clean Energy Project will be a third dam and hydroelectric generating station on the Peace River in northeast B.C. It will provide 1,100 megawatts (MW) of capacity, and produce about 5,100 gigawatt hours (GWh) of electricity each year — enough energy to power the equivalent of about 450,000 homes per year in B.C.

The dam being constructed at Site C.

Road to the W.C. Bennett Dam—Autumn colours

chat and was given directions on how to get to the main dam further upstream.

So after going up a road that lead me nowhere but did give me beautiful views of the dam, I eventually made it to the dam wall. The lake is called the Williston Lake and the dam is the W.C. Bennett Dam. It is the seventh biggest dam in the world and along with a smaller dam downstream called the Peace Canyon Dam, they produce 29% of BCs electricity.



W.C. Bennett Dam

According to the BC Hydro site, the Site C project received environmental approvals from the Federal and Provincial governments in October 2014, then got the green light from the Province of BC in December, 2014. Construction of the project started in summer 2015 and is anticipated to be completed in 2024. Doubts have now risen as to whether the project will be completed because of a $10b blowout!

Headed back to Fort St John and had dinner at the restaurant—no painters tonight—but a wedding reception meant dinner was late.

Avis big rentals

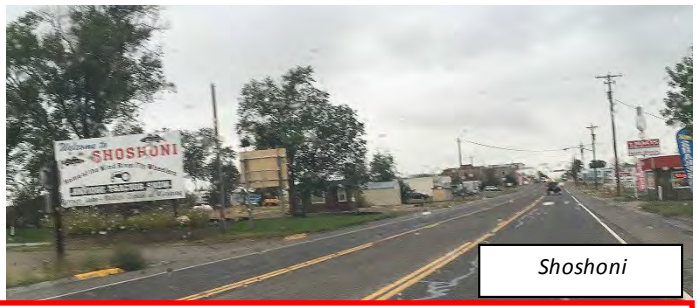
Day 16 Saturday 23rd September

Next morning up early at 4 to catch the flight back to Vancouver. It was a fresh 2.3 degrees C. I dropped my Ford150 off at Avis lined up with the rest of them – it seemed the only type of vehide Avis had available. I had decided to make the effort to see Louis Meeks in Wyoming. Louis was one of those residents on a farm outside the town of Pavillion who said he had gas in his water and has been fighting for many years over this issue. I tried to visit him the week before but ran out of time, so instead of heading back to Los Angeles and then home I decided to deviate and head back to Wyoming. So from Vancouver, I headed for Denver - a bumpy ride as you approach the airport. From there I picked up a normal vehide and remarkably found my way onto the main highway from the airport and then on to Cheyenne where I stayed overnight – a wet and cold night. I had arranged to meet not only Louis the next day but also a John Hazlewood. I rang John that night and he said there were forecasts of snow so that could mean I may not be able to get through, but I was to give him a ring the next morning. I also rang Mike Farizius, a member of the Wyoming Forage Association, whose name I got from Scott Keith of the Wyoming Business Council and involved in the forage/hay

Heading for Cheyenne

Here's comes some fossil fuel—coal train

industry. Mike lives around Riverton, but unfortunately I couldn't fit him into my schedule. He is a long time top alfalfa (lucerne) farmer who crops about 900 acres of hay a year. I was told he knew a bit about the gas issue at Pavillion and he said to me, " I don't think it's hurting a damn thing. The problem was there when my grandpa was there 50 years ago. He never drank the water. He went to the local gas station to get his drinking water". He said there was always gas coming out of the ground and he doesn't understand why anyone would buy the land. He said the country had lakes, springs, swampy grounds and the springs bring up shitty water. He believes people were trying the gas companies on. He said you head up to Yellowstone park and you'll find natural springs with warm gassy water, so there was another view.



Shoshoni

Shoshoni is another small town of about 650 people in Fremont County on Highway 20. It is named after the Indian Shoshone tribe.

Day 17th Sunday 24th September

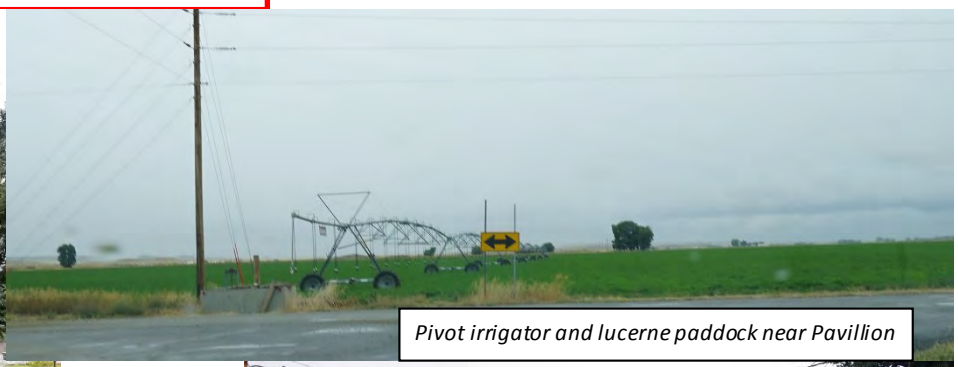
The next morning I rang John Hazlewood and he advised me on the best route to Pavillion as one road had warnings that had shown up on the Roads website. So after fuelling up I headed off to Casper, firstly on the wrong road, but eventually the right one. It was foggy, overcast and cold – autumn was coming. On the way you pass through a number of small towns like Powder River and Shoshoni, typical of the region.

Welcome to Pavillion

Pavillion is another small town of 231 people in Fremont County and located inside the Wind River Indian Reservation. Complaints about gas in the water originated 5 miles east of the town.

I eventually reached Pavillion. Pavillion is definitely a 'blink' town as somebody told me. It has a population of about 231, a church or two, a store or two, some houses and a school serving the area. Pavillion is in a farming area and you see a lot of crops under pivot irrigation. I think I even saw some sheep, which is not something I had seen before on this trip. The land is generally flat or undulating. You see gas wells here and there.


Pavillion United Methodist Church

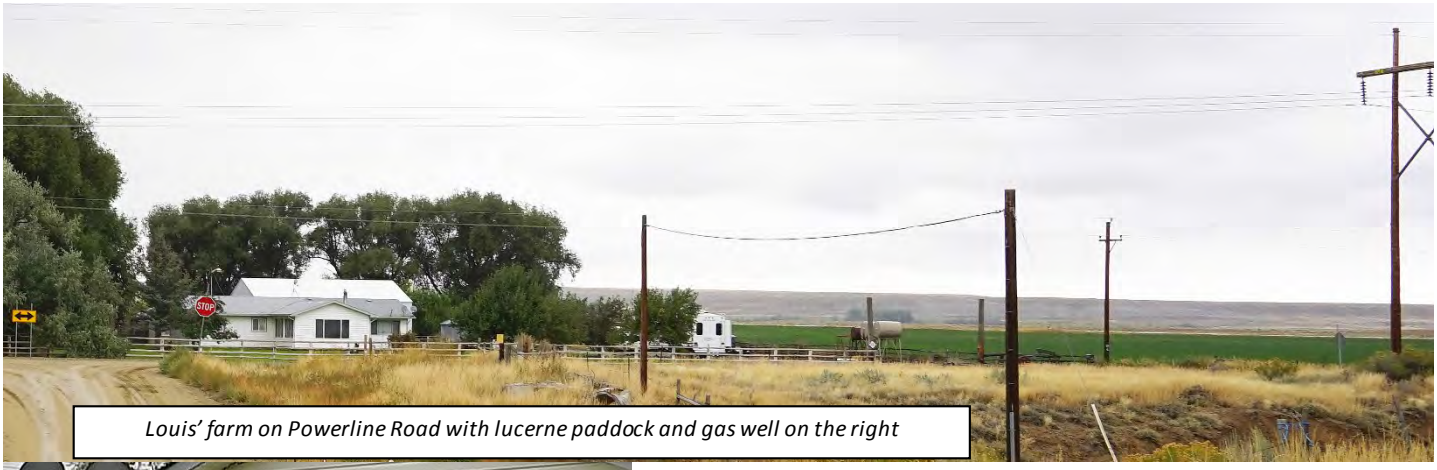

Pivot irrigator and lucerne paddock near Pavillion


Main Street Pavillion

I knew Louis Meeks lived on Powerline Road but I

In Australian dollars Pinedale fuel is $0.96 per litre!

had no idea where that was, so I started looking for locals luckily it was Sunday, so I stopped a musician leaving the local United Methodist Church who said he didn't know where Powerline Road was as he was only a visitor. So as the service was over he took me around the back where some of the congregation were having some nice morning tea. I was introduced to everyone and Bruce and his wife offered to show me the way, which was very kind of them.



Louis' farm on Powerline Road with lucerne paddock and gas well on the right

The water well that Louis said was affected by poor gas well construction

So after a while travelling on sealed and dirt roads, we got there. I thanked Bruce and drove onto Louis' property and knocked on the door. I was greeted by the dog first, but Louis popped hid head out and invited me in. I met his wife Donna who made me a nice cup of coffee. Louis explained about good wells and bad wells with good water down to about 210 feet. He said gas was a long way off in 1976 when he first came to this property. He said the problem started when Encada (the gas company) drilled a gas well too close to his house (540ft). This was in 2008. He said it wasn't the fracking that caused the problem it was poor well construction. The cement around the well was bad. He also blamed a lack of proper oversight, mentioning the orphaning of wells. The Federal (US) Environmental Protection Agency (EPA) drilled two monitoring wells since this happened and I attached the name of the report in the back - INVESTIGATION GROUND-WATER CONTAMINATION NEAR PAVILLION, WYOMING—WORKGROUP MEETING NOVEMBER 30, 2011 US EPA. Mr Meeks had tried to sue the company but it seemed to go backward with the lawyer he hired. He also believed that the

EnCana gas well in the lucerne field that Louis Meeks said caused the problem

Louis Meeks and his gassy water

well Encada drilled was too close to other wells as that increased their flow rates after the other well was fracked. Louis didn't say he was against gas, but he is definitely against poor well construction and lack of oversight. He took me out to the laundry to show me the water from his well. Water from the tap was clear and when he poured it into a bottle I could smell something a bit rubbery, but having a blocked nose from the flu didn't help me get a good whiff! In the photo attached it might look like the water has a colour but that is the colour of his hand behind the bottle. You get a better indication from the colour of the water pouring from the tap into the laundry trough.

EnCana gas facility, Pavillion

I did mention that I had originally come to Pavillion to find a Mr John Fenton. Mister Fenton had come to Australia last year courtesy of Lock the Gate and I met them all at Parliament House last year. He was portrayed as a rancher from Wyoming by the Lock the Gate and the ABC. When I mentioned Mr Fenton's name he quickly said that he was the one that raised the concerns about gas in the water, nor Mr Fenton. He said he was one of those who started the lobby group the Powder River Resource Council but it had been take over by Mr Fenton. Louis said as for being a farmer, Mr Fenton owns no land and he works for his father in law as a hired hand.

That certainly was a big surprise hearing that and I started to wonder about Lock the Gate and the ABC reports – had they questioned any off this.

Anyway it was time to go I thanked Louis and Donna for giving me their Sunday time. They must be sick of visitors. Before leaving I took some photos of his water well and the gas well that he said had caused all the problems.

My next stop was back at Riverton where I had been given the name, John Hazlewood, by Scott Keith , who I mentioned earlier. John and his wife Joyce live outside of the town on a small farm where they keep a few horses. They overlook the Wind River and in the far distance across the Wind River

Jim and Joyce outside their home at Riverton

Feeding time

Indian Reservation you can see the Wind River Mountains. I was very grateful that they could see me on a Sunday afternoon. Before we sat down for a chat John showed me his barn where he kept his hay for the horses and he proceeded to cart some hay out into the yard. He didn't need to say anything before the horses were already on the way.

Looking across to the Wind River Indian Reservation and the Wind River Mountains.

Joyce made us, a nice cup of Lipton's tea, would you believe not coffee, before we sat down for a chat about drilling? I thought I was drinking an Australian tea, I since found out Lipton's was founded by a Scotsman who set up a company in New Jersey and Lipton is now owned by the big multi-national Unilever who also own Bushells and Lan Choo. So much for my history of tea companies.

John is the US Sales and Marketing Manager of a company called Bri-Chem Supply Corp. based in Riverton. He supplies drilling fluid chemicals and additives such as emulsifiers and wetting agents to drilling companies some of those in Australia. He acknowledged that in the past drilling companies were without any conscience and so there were leaks in pipelines, spills and accidents but he also acknowledged that over the last 20 years there had been big changes.

One thing that I got from talking to John was that there has been a lot of publicity about fracking chemicals but drilling had always used chemicals, and for some reason those who have concerns about fracking seem to ignore the fact that other chemicals have been used for years in the NT as part of the normal drilling process.

It was getting late and I had to get back to Casper that evening. I thanked them for their hospitality but before I did, they said "You're staying for dinner", much to my surprise. It just shows the hospitality of many people in America, especially rural America. I had never met these people before and they didn't know me from a bar of soap and they invited me into their house for dinner. I must admit I enjoyed the nice home cooked meal after all the snacks and fast food I had been living on. It was a nice way to end my trip in the US. I drove back to Casper that night on Highway 26 which I had got to know fairly well by now. I had been an interesting Sunday and I had plenty to think about.

Day 19 25th September

The next morning, I drove from Casper to the Denver airport which was a challenge with all the traffic but amazingly got there with the hire car unscathed. From there it was a flight to Los Angeles and then the midnight flight back to Brisbane. Thankfully, getting through Customs was very quick which can be a worry if you are trying to get a connecting flight. So then onto Darwin in time for lunch and still coughing and glad to be home on the **27th September?** Casper to Darwin in one day—hard to believe.

REPORTS

PAVILLION, WYOMING AREA DOMESTIC WATER WELLS FINAL REPORT AND PALATABILITY Nov 2016 Wyoming Department of Environmental Quality

PAVILLION GROUNDWATER REPORT FACT SHEET NOVEMBER 7, 2016 Wyoming Department of Environmental Quality

PAVILLION FIELD WELL INTEGRITY REVIEW Wyoming Oil and Gas Conservation Commission 2014

INVESTIGATION GROUND-WATER CONTAMINATION NEAR PAVILLION, WYOMING—Workgroup Meeting November 30, 2011 US EPA

Answers to questions I asked of the Wyoming Oil and Gas Conservation Commissioner

(these questions do not relate necessarily to the NT because of different land tenure but they help give some understanding of the gas industry in the US, specifically Wyoming)

If the Federal Government owns the gas how is the person who owns the land compensated?

The surface owner who does not own minerals is compensated through a damage agreement that calls for an initial payment and sometimes includes yearly payments for the life of the well. These are private agreements and we do not get involved with them.

Is the gas auctioned to the highest bidder?

Yes, the leases are auctioned to the highest bidder.

If the gas is on fee (private freehold) land does the owner negotiate for a company to extract the gas and how does the owner normally get paid - -a % of the gas?

If the oil and gas is located on private minerals, the original owner retains a royalty (usually 12 - 15%) and is paid on the monthly sales volume.

If the State owns the gas do they auction it?

The State uses an auction for its minerals.

Do they receive only what is received from the auction or do they take a % of income from the gas sold?

Both, they receive the initial high bid for the lease and also receive a royalty if oil or gas is discovered and produced.

Are there rules as to where the State must spend the money earnt from the sale of its gas?

Proceeds from mineral production on state minerals are used to fund the education system in the state.

Is the WOGCC funded totally by fees and charges applied to the oil and gas companies or is it the Government that sets the fees and charges and uses some of that revenue to pay for the cost of running WOGCC?

The WOGCC is funded by a conservation tax on oil and gas production (.005 mils or $5 for every $10,000 in oil and gas sold) as well as fees for drilling and for hearings.

Does the WOGCC control and monitor every application for a well regardless of whose land it is on?

The WOGCC requires a drilling permit for all wells in the state (federal, state and private minerals).

If not are the regulations for well construction and decommissioning the same regardless of who is the regulatory body?

The WOGCC and the Bureau of Land Management (federal agency) have very similar rules for well construction and decommissioning.

What in layman's terms would the geology of the Jonah and Pavillion gas fields be described as – I am trying to compare that with the geology of the Northern Territory ?

I have provided a link to the final Pavillion report in question 8 and part of the report discusses the geology of the Pavillion field. The Jonah and Pinedale fields consist of unconsolidated lenticular sands.

Is condensate and oil normally part of the by-products of gas production in these areas?

Condensate (light oil) is not normally produced with the gas in the Pavillion field but is common in the Pinedale and Jonah fields.

What would be the average depths of well in these areas – I note that the 2011 EPA report on Pavillion says some wells were drilled at 372m bgs while domestic wells were drilled to 245m bgs and surface casing did not extend below the maximum depth of domestic wells – if was the case, is that a possible reason for issues related to domestic well water quality in this area – the depths sounds very shallow with little gap between the aquifer and the gas?

The Wind River formation occurs from the surface down to approx 3,500 ft and the Ft Union occurs from 3,500 ft to 5,500 ft. There are no impervious formations between the two to prevent gas from migrating to the surface. There are reports of gas at shallow depths from the earliest wells drilled in the '40's.

Is there a minimum distance between a domestic well and a gas well?

The minimum distance from a water well to a gas well is 350 ft. Some water wells are closer, but they were drilled after the gas wells were drilled.

Is there a minimum distance between a condensate storage tank and a house?

The minimum distance from a well location to a house is 500 ft. Some houses are closer but were built after the gas well was drilled.

I visited Mr Louis Meeks at Pavillion who is the Gasland movie – he says fracking was not the issue but poor well construction. Does that sound reasonable and was he right? Are you able to say what year the issues arose in Pavillion as there appears to have been gas production in the 60s, 70s and 80s before production increased rapidly in the 2000s? Who would have been responsible at that time for making sure the wells were constructed properly and whether the land was suitable for extracting gas in the first place? Mr Meeks says the regulatory bodies aren't checking well construction and said this also applies to the decommissioning of wells.

There is ongoing litigation with some of the landowners and Encana so I cannot comment on this question.

You may not be able to answer this question, but Mr Meeks says that Mr John Fenton, who is a resident of Pavillion and brought to Australia as part of an anti-fracking campaign, and described as a Wyoming rancher, does not own any land and in fact is a hired hand for his father in law. Do you know if that is true?

I've heard the same stories regarding Mr. Fenton but I cannot verify them. Mr. Meeks lives in Pavillion so I would assume he is right.

Is there any report on Pavillion you can recommend for reading?

Here is a link to a summary http://deq.wyoming.gov/media/attachments/Water%20Quality/Pavillion%20Investigation/Investigation%20Final%20Report/03_Fact-Sheet-for-the-Pavillion-Wyoming-Area-Domestic-Water-Wells-Final-%20Report.pdf and here is a link to the final report http://deq.wyoming.gov/wqd/pavillion-investigation/resources/investigation-final-report/.

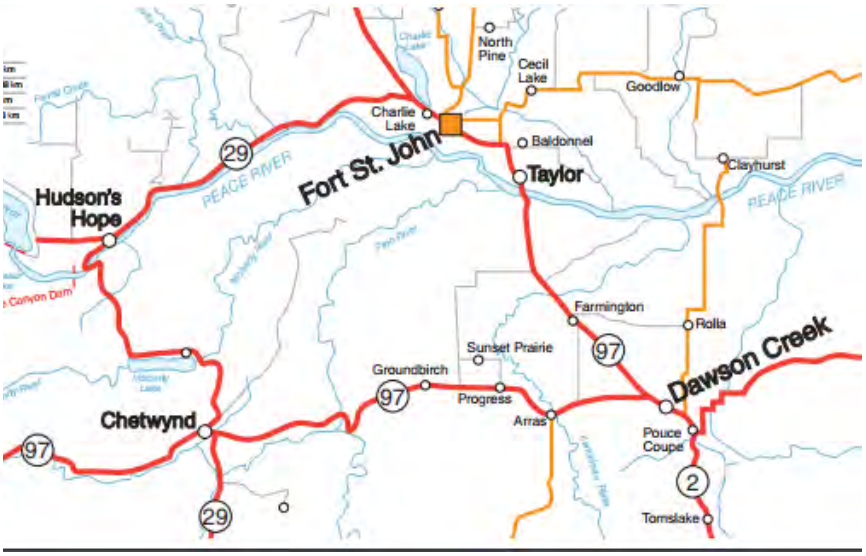
You mentioned in relation to Jonah Field that when the field is eventually closed down it will be returned to its natural state. What do you expect the life of the field to be?

The life of the Jonah field could be anywhere from 25 to 35 years depending on gas prices which affect the economic life of the field.

Mr Louis Meeks from Pavillion believes that the gas in his water was caused by poor well construction and poor regulatory enforcement. Who was or is responsible for regulation and inspection of wells around the area around Pavillion and do you think Mr Meeks is right or is it not that simple?

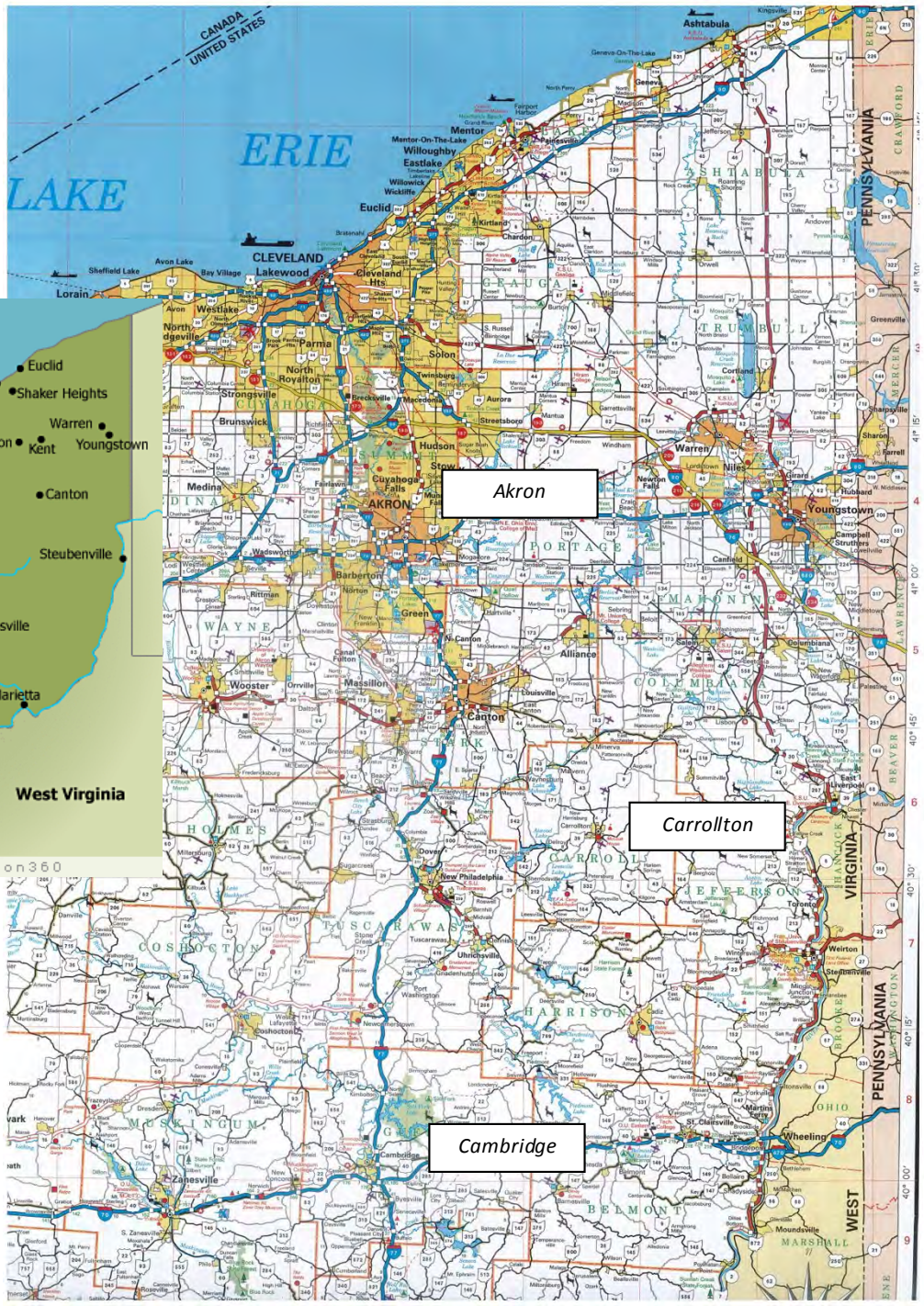
The water analysis shows the presence of bacteria and the Dept of Environmental Quality is doing further testing to determine the cause of the bacteria. As far as what Mr. Meeks says, they are his opinions. The well construction comment relates to the best practices at the time the wells were drilled. All regulations have been strengthened over time as technology changes. For instance, the depth of the surface casing run in wells drilled in the 50's should have been set deeper but they were done according to the rules at the time. So yes, it's not that simple. As far as jurisdiction in the Pavillion field, half the wells fall under the BIA (Bureau of Indian Affairs), which is a federal agency, and the remaining lands fall under the Wyoming Oil and Gas Commission jurisdiction because they are located on private lands.


BRITISH COLUMBIA
Dease Lake
Fort Nelson
Fort St. John
Prince Rupert
Terrace
Smithers
Sandspit
Prince George
Quesnel
Williams Lake
Port Hardy
Kamloops
Revelstoke
Whistler
Campbell River
Kelowna
Vancouver
Penticton
Cranbrook
Tofino
Nanaimo
Creston
Grand Forks
Victoria

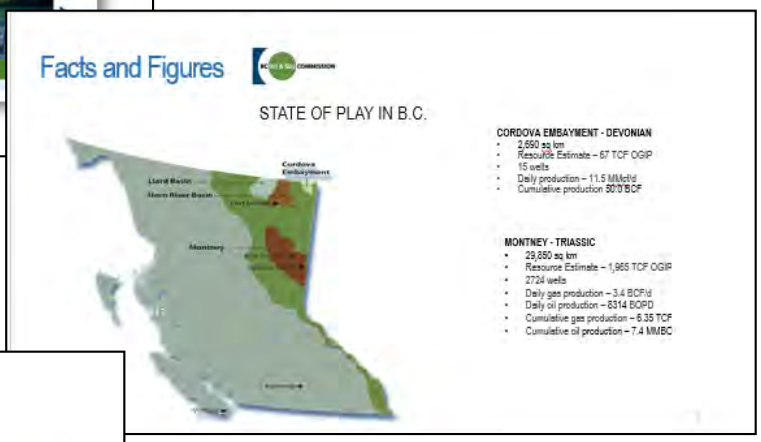

North Pine
Cecil Lake
Goodlow
Charlie Lake
Fort St. John
Baldonnel
Taylor
Clayhurst
Hudson's Hope
29
PEACE RIVER
Farmington
Rolla
Sunset Prairie
97
Groundbirch
Progress
Dawson Creek
Chetwynd
Arras
Pouce Coupe
2
Tomslake

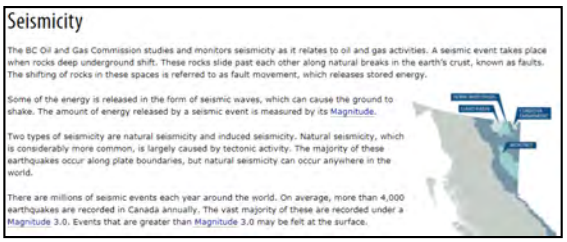
OHIO

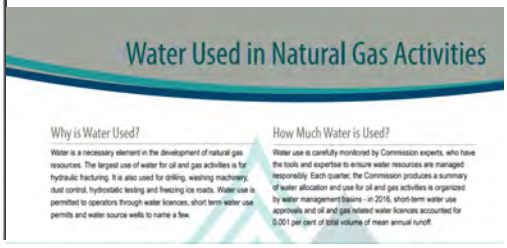

Michigan
Toledo
Cleveland
Euclid
Sandusky
Parma
Shaker Heights
Warren
Akron
Kent
Youngstown
Findlay
Mansfield
Canton
Marion
Ohio
Steubenville
Springfield
Columbus
Newark
Zanesville
Fairborn
Dayton
Xenia
Lancaster
Middletown
Marietta
Chillicothe
Norwood
Cincinnati
Portsmouth
West Virginia
Kentucky
Ohio Map – ©2006 Destination360


CANADA
UNITED STATES
LAKE ERIE
CLEVELAND
Akron
AKRON
Carrollton
Cambridge
Columbus
PENNSYLVANIA
VIRGINIA
WEST VIRGINIA

Education—British Columbia







Education—Ohio

BEST MANAGEMENT PRACTICES FOR OIL AND GAS WELL SITE CONSTRUCTION

Ohio Oil & Gas Well Locator

Launch the Oil and Gas Well Locator

The Ohio Oil & Gas Well Locator is an interactive map that allows users to search for oil and gas wells and related information in the state of Ohio.

Permitting

Permitting represents one of the most fundamental regulatory activities to be conducted by the Division of Oil & Gas Resources Management (DOGRM). Geologists perform a complete and thorough review of every permit application to drill and plug wells for oil and gas in Ohio. Detailed examinations verify that wells are designed to minimize environmental impacts, that proper environmental safeguards are in place, and that all legal requirements are met. **Oil and gas well permits** are regulated under provisions of Chapter 1509 of the Ohio Revised Code and rules established in Chapter 1501:9 of the Ohio Administrative Code. It is mandated by the Ohio Revised Code to complete oil & gas permit reviews within twenty-one (21) days or thirty days (30) in an urbanized area.

Ohio Oil & Gas Well Database

Search the Oil & Gas Well Database

The Division has revised several of its online search tools related to the oil and gas well database and features expanded search capabilities.

This online search is linked directly to the Risk Based Data Management System (RBDMS) database, therefore a search always yields the most current well information. Access nearly 275,000 Ohio oil and gas well records including completion, permit and production information.

Oil & Gas Inspector

⊖ How do I contact the oil & gas inspector for my county?

How do I contact the oil and gas inspector for my county?

Every county has an assigned inspector and each inspector is connected with a Division of Oil and Gas regional office.

1st Quarter 2017 Horizontal Shale Production
01/01/17 – 03/31/17
(updated 6-7-17)

2nd Quarter 2017 Horizontal Shale Production
04/01/17 – 07/31/17
(updated 9-1-17)

Passed in Sub. H.B. 59, and effective Sept. 29, 2013, operators of horizontal oil and gas wells in Ohio were required to submit production data quarterly instead of annually. Companies must submit the data to ODNR 45 days after the end of the quarter. The increased reporting provides ODNR, the industry and the public with more accurate and timely information regarding Ohio's oil and gas industry.

Urbanized Drilling

⊕ What is urbanized drilling?

⊖ Are permitting and drilling rules different for urbanized areas?

Are the rules and requirements different in urbanized areas for permitting and drilling wells?

Yes, urbanized rules went into effect August 11, 2005. Anyone permitting and drilling in an urban area must be familiar with these rules as the requirements are more stringent.

Wyoming Oil and Gas Conservation Commission
Supervisor's Report to Commission – Mark Watson
October 2017

APDs:
There were 236 APDs approved during the month of September 2017. That number is down from 1314 that were approved in August 2017.

The number of APDs received in September 2017 was 905 which was an increase from 883 the previous month.

RIG COUNT:
According to Baker Hughes' Rig Count Summary Report ending September 29, 2017 the rig count was 25. *The rig count last year at this time was 13.*

BONDS:
The end of September 2017 bond report is as follows:

Total Bond Amount $181,385,331 Idle well bonds $123,624,376

FLARE:
The volume of approved flared gas for July 2017 from 5 wells was 57,700 MCF total.

However, the actual flared volume of gas for the same time period was 19,231 MCF total; which is approximately 33% of the approved volume.

There are currently six oil wells flaring in excess of the 60 MCFD limit, in accordance with WOGCC Rule Chapter 3, Section 39(b); that requires Supervisor or Commission approval.

ORPHAN WELL UPDATE:
In September 2017, 44 wells were removed from the Orphan Well Plugging list (YTD Total 346).

Remaining under contract to plug are 14 wells in the Arvada - 2016 package and 15 wells in the Sweetwater - 2017 (IGS) package, both of which are in progress.

The Kuhn Ranch - 2017 package (188 wells) is to be put out for bid this month. Twenty-nine wells were removed from the Kuhn Ranch area due to Marathon agreeing to plug these wells (these wells are included in the 44 wells removed for the month).

Fourteen Petcon Associates wells (Docket 697-2017) and 1 Antelope Resources well (Docket 1681-2017) were added to the orphan well list in September, bringing the total count of wells to be plugged or converted to water wells to 3,654.

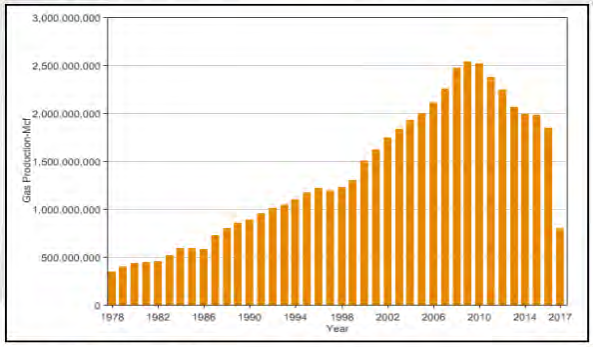
Liens searches have begun for Enpro LLC (Docket 357-2017) and Armada Operating (Docket 922-2017).

- Rules and Regulations
- Chapter 1: Authority and Definitions
- Chapter 2: General Rules
- Chapter 3: Operational Rules, Drilling Rules
- **Chapter 4: Environmental Rules, Including Underground Injection Control Program Rules for Enhanced Recovery and Disposal Projects**
- Chapter 5: Rules of Practice and Procedure Before the Wyoming Oil and Gas Conservation Commission

Our Mission

The Wyoming Oil and Gas Conservation Commission is committed to regulating oil and gas activities in a manner that ensures responsible development and management of Wyoming's oil and gas resources and provides appropriate environmental stewardship for Wyoming citizens.

Production



Annual Gas Production
(2017 partial through July)

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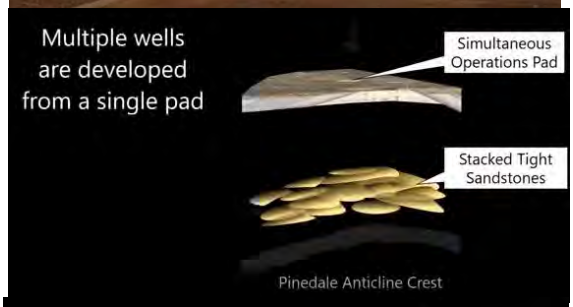
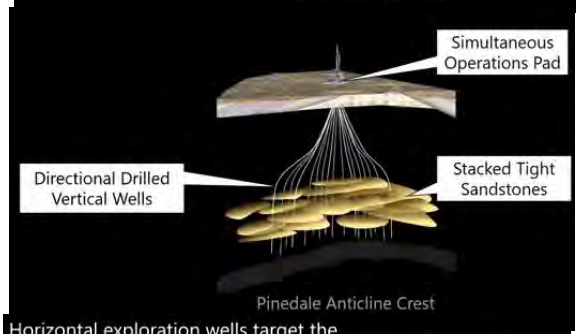
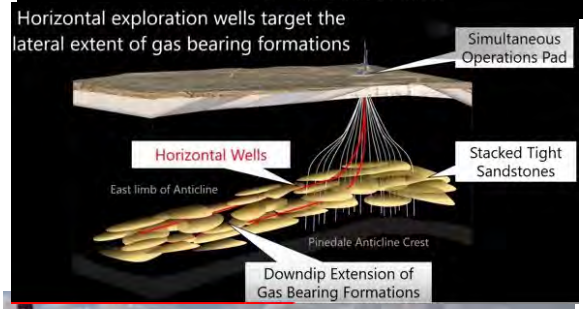
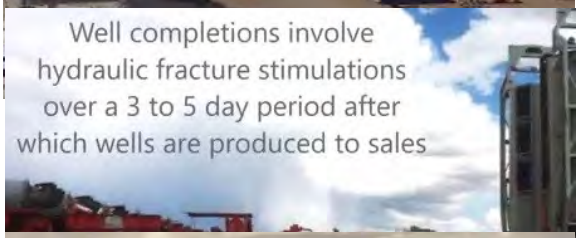








Summary

This report covers a number of issues (solar/hydrogen/gas), all relevant to the Northern Territory.

We have an abundance of sunlight, especially in the Tennant Creek region of the NT, and we have the possibility of tidal energy in the north. These two forms of renewable energy, one reliable and the other not as reliable, could be part of an industry that produces an energy source that is both renewable, reliable and clean — hydrogen.

South Australia is already taking the lead and the NT should be talking to the CSIRO about whether there are possibilities for the Territory to use its natural energy sources to set itself up also as a potential producer of hydrogen both for domestic and international customers.

The second part of this report deals with gas as this is an important issue especially in light of the current hydraulic fracturing inquiry. I know the issue is a concern for some people in my electorate as I see signs opposing the use of fracking, and therefore they may not agree with my views. But at least I hope it helps the discussion by giving a different point of view.

I travelled to Wyoming and Ohio in the US, and British Columbia in Canada. These three states all have been producing gas for many years and over the last 17 or so years have drilled horizontal wells that are hydraulic fractured. In fact 275,000 wells were drilled and likely hydraulically fractured between 2000 and 2013. (Data from DrillingInfo (2014))

So I went to these places where this had been happening for some time to get a feel for the issues and the benefits of the gas industry there.

My conclusion is

- Hydraulic fracturing is not the issue — hydraulic fracturing is an industrial process used for many years in North America to release gas trapped below the ground.
- The issue is about well-integrity — that is, a well must be built to the highest standards and to make sure that happens an independent, reliable, inspection and regulatory process must be in place.
- The issue is also about having a thorough knowledge of the geology of a prospective gas field to make sure it is suitable for development and from there, determine how it will be developed. There is no doubt, for instance, that some issues have arisen in the US where drilling has occurred in areas where there is shallow gas and shallow aquifers. This may not relate to the NT but it is just an example of where fracking gets blamed for everything when something else was the cause.
- Even though the North American experience may not be the same as ours we can learn from them and do it better. For instance, in Wyoming and Ohio there are two regulatory bodies, sometimes overlapping, and four owners of minerals with the possibility of different surface owners. In the NT we have one owner of minerals and one regulatory agency — the Government - so we should be able to do it better.
- There needs to be a strong, independent, well-funded and well-resourced body enforcing the standards required and funded by the industry, including things like water use and reuse, air quality, rehabilitation, the natural environment, social impacts, etc. We can certainly learn from the Wyoming Oil and Gas Conservation Commission, the Wyoming Department of Environmental Quality, the Ohio Department of Natural Resources — Oil and Gas Division and the British Columbia Oil and Gas Commission. The people I met in Wyoming, Ohio and British Columbia who oversee and regulate the industry are all strongly dedicated to making sure there is continual improvement in the industry and that protection of the environment is a key objective of what they do. As Scott Kell, Assistant Chief from Ohio Department of Natural Resources, said, " If I believed half of what the anti-fracking people said was true, I would change sides."

Naturally we have to be very careful with any mining process and we need to make sure thorough environmental studies are done first. But I feel that we are seeing activists taking over the agenda and not being questioned about

their motives or who finances them. They don't want a gas industry, even one that is developed to the highest standards, but simply oppose gas production in Australia. To achieve that end the use of fear and sometimes people who have only heard one viewpoint is a great weapon to achieve that outcome. That's not to say there aren't people with genuine concerns and it's good to have people questioning what is happening. With the knowledge we have locally and from what we can learn from overseas, I believe we can lead the way in gas production and protecting the environment at the same time, instead of taking a view which is non-negotiable and no matter what, the answer is always no.

The Northern Territory's economy is very much dependent on mining and it has been for years. Some of that history is good, some not so good. We also have diminishing Federal receipts through the GST and that has occurred this year. Our GST revenue is not guaranteed and it can be changed by the Federal Parliament. To offset those financial losses our economy needs to grow, and gas is one way — but not the only way — that the economy can grow. Talking to people in my travels it was clear that the gas industry has helped the economies of local communities, especially job creation, whether in the development stage, production phase or through service industries. If gas does come to the Territory then we need to make sure that other sectors benefit, such as the pastoral industry, tourism, Aboriginal people, housing, etc., so that there are long term benefits well past the life of the gas industry.

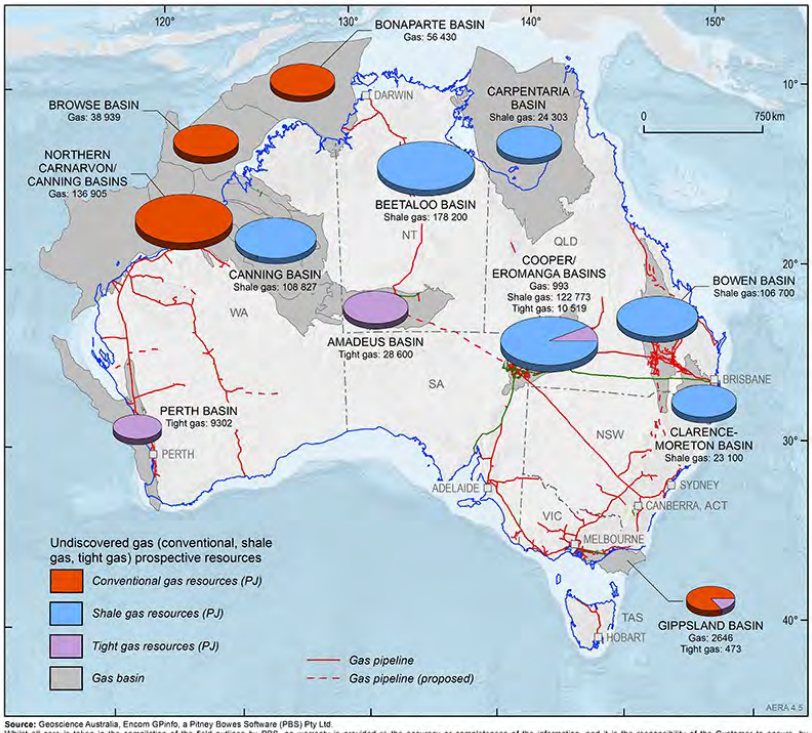
Gas will be needed for some time yet for heating, cooking and industrial uses in Australia and overseas. As it appears we are not willing to go down the nuclear path, gas is one way to switch from coal to a cleaner form of energy. In Ohio, where I visited, at least six gas-fired power stations are being built as coal-fired stations are being phased out.

Renewables have their place, but do not fill all our energy needs. Hopefully hydrogen will fill the gap, but that is still some way off.

The Territory needs to be careful but also needs to be dynamic and not be afraid of development. We need development - sensible and sustainable development - and not be afraid to do things.

I have looked at how the gas industry operates in parts of North America. I didn't see any yellow anti-fracking signs. The industry continues to grow in North America. I know there have been problems, but did that bring the industry to a halt? Technologies are always changing, there is improved scrutiny, and the benefits help local economies. We can sit on our hands and live in hope, or we can do something.

On balance, if done right, I believe gas production will be safe and bring benefits to the people of the Northern Territory.



Source: Geoscience Australia, Encom GPinfo, a Pitney Bowes Software (PBS) Pty Ltd.
Whilst all care is taken in the compilation of the field outlines by PBS, no warranty is provided re the accuracy or completeness of the information, and it is the responsibility of the Customer to ensure, by independent means, that those parts of the information used by it are correct before any reliance is placed on them. Accurate at July 2015.

W.A.C. Bennett Hydro Dam—Peace River, British Columbia, Canada