



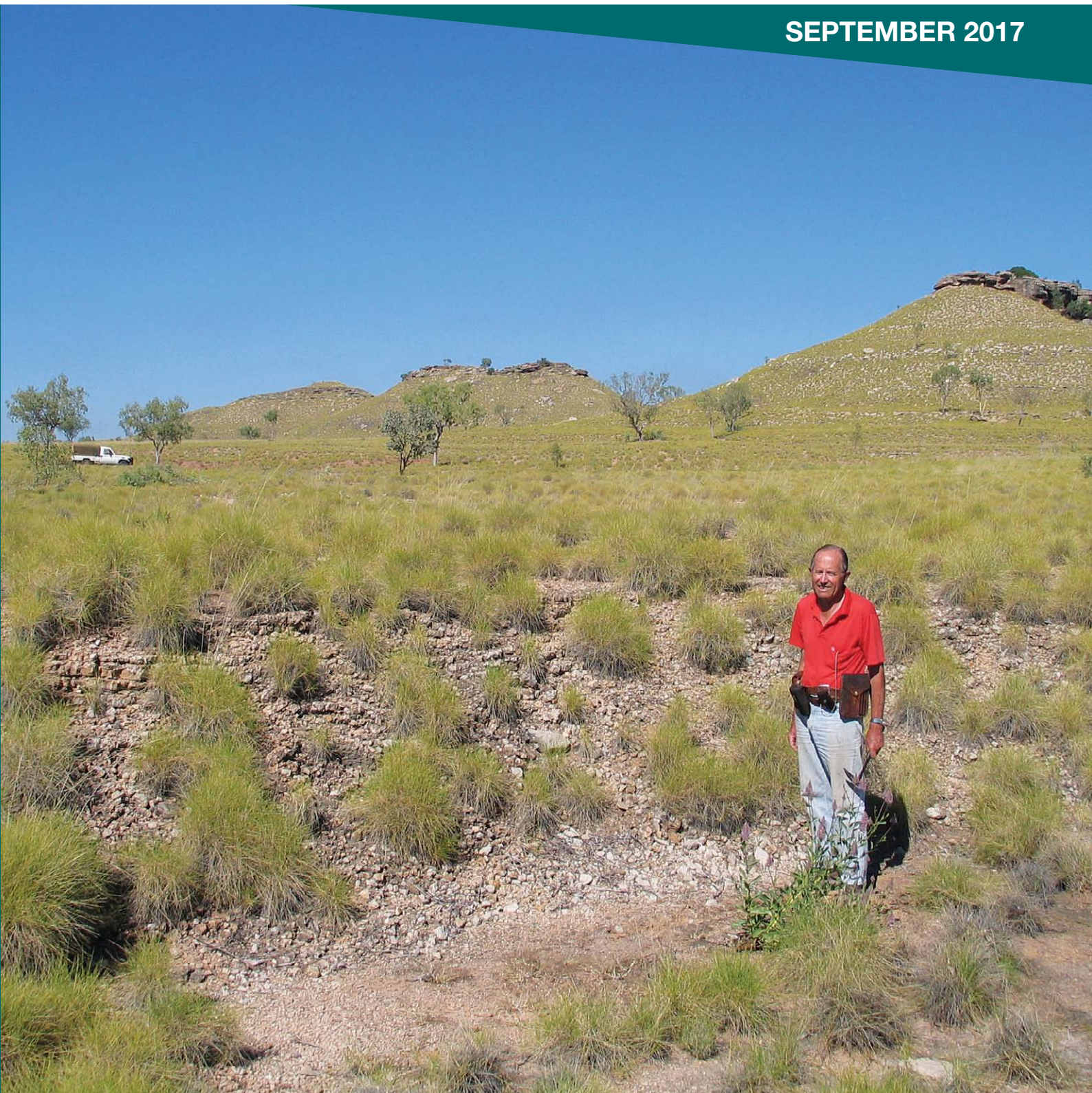
Government of **Western Australia**
Department of Mines, Industry Regulation and Safety

WESTERN AUSTRALIA'S DIGEST OF PETROLEUM EXPLORATION, DEVELOPMENT AND PRODUCTION

PETROLEUM

IN WESTERN AUSTRALIA

SEPTEMBER 2017



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Photo right:
Wheatstone Platform and trunkline became operational in July,
supplying natural gas to the onshore LNG plant at Onslow



Photo © Chevron Australia

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Cover: Phillip Playford, on the Virgin Hills Formation with Mount Pierre (Piker Hills Formation) in the distance, eastern Lennard Shelf, Canning Basin c2003.

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Minister's message

Bill Johnston
Minister for Mines and Petroleum



Welcome to the latest edition of *Petroleum in WA* (PWA) magazine and my first foreword as Minister for Mines and Petroleum.

Since the State election the McGowan Labor Government has been working hard to meet its commitment to reduce the number of State Government departments from 41 to 25 and establish a public sector Red Tape Taskforce to reduce inefficiencies.

The first of July heralded a new beginning for the newly formed Department of Mines, Industry Regulation and Safety (DMIRS), an amalgamation of the former Department of Mines and Petroleum and parts of the Department of Commerce.

The new department will regulate the mining, building and construction industries and will elevate the focus on worker safety. It will also assume consumer protection responsibilities.

Former Acting Director General of the Department of the Premier and Cabinet David Smith has been appointed to head up the transition

which will develop a new structure to bring together the elements of the two previous departments.

As far as industry is concerned it will be business as usual during this period and a key objective is to ensure a seamless transition that does not interrupt the high standard of service delivery that DMIRS will continue to provide.

The State Government has already given the green light to develop a modernised Work Health and Safety Bill for Western Australia replacing the occupational, health and safety legislation in WA which is 30 years old and out of date.

Based on the national *Work Health and Safety Act*, the Bill will improve consistency with the rest of Australia and provide the primary legislation for workplace safety and health across all Western Australian industries.

Petroleum and major hazard facility industries will continue to operate under a safety case approach.

The State Government's contemporary, single Act approach has been adopted following

collaboration between the former departments of Commerce and Mines and Petroleum.

Consistent with the government's commitment to reduce red tape, the Bill will replace three Acts: *Occupational Safety and Health Act 1984*, *Mines Safety and Inspection Act 1994*; and the *Petroleum and Geothermal Energy Safety Levies Act 2011*.

The government is also progressing a major legislation reform initiative 'Petroleum 2020' to modernise and streamline the State's petroleum and geothermal legislation.

The amalgamation project is another significant step in the department's contribution to the government's commitment to improving the quality of regulatory outcomes.

Petroleum 2020 will amalgamate the three petroleum Acts into one: *Petroleum and Geothermal Energy Resources Act 1967*, *Petroleum Submerged Lands Act 1982* and *Petroleum Pipelines Act 1969*. It will also incorporate the two Registration Fees Acts.

Currently the petroleum Resource Management and Administration Regulations 2015 are under review by the department, and Petroleum 2020 will also look to reduce the number of associated petroleum and geothermal regulations from 10 to three.

In other moves the State Government has already commenced work on the introduction of a strategic five-year release of petroleum exploration areas across the Canning and Perth Basins that will minimise environmental, cultural and land use constraints.

New maps highlight future acreage release areas that will open for competitive bidding rounds for oil and gas explorers from 2018 to 2021. The maps will also advise stakeholders of areas that are not available for 'Special Prospecting Authority with an Acreage Option' applications.

Competitive bidding is encouraged and is DMIRS preferred mechanism for industry to acquire an exploration title for petroleum. Acreage release schedules will be updated at least once a year and when significant amounts of new prospectivity data or acreage becomes available to warrant a review.

Industry is encouraged to nominate specific areas for acreage release, which will be considered the year it is nominated.

This edition also coincides with the annual Petroleum Open Day hosted by DMIRS Petroleum Division and the Geological Survey of Western Australia (GSWA) which will be held at the Hyatt Regency Perth on Friday 15 September 2017.

I will be in attendance and hope to see you there.

Executive Director's message

Jeff Haworth
Executive Director
Petroleum Division



The *Petroleum in Western Australia* magazine (PWA) was first published as a small A5 brochure in 1978 but assumed its current format thirty years ago in 1987, three years after the Petroleum Division was formed.

I was reading the then Director Ian Fraser's comment from that 1987 edition and noted the similarity of his words to my recent comments in PWA in 2016 and 2017. In 1987, he stated, "The fluctuating activities and the volatile crude oil prices in the international petroleum community have created enormous pressures in petroleum exploration and production programmes and on government fiscal and regulatory frameworks".

This sounds familiar to all of us and currently the same environment prevails.

Of further note, were the new projects that started in that time and I quote – "The recent developments of the North Rankin and Harriet fields, together with the proposed developments of Goodwyn, North Herald, South Pepper and Tubridgi...". Alas,

three of those developments are now decommissioned and more are earmarked for closure and decommissioning during the next few years. Decommissioning is now one of the major areas where the department is focussing its attention and resources.

This issue of PWA sees the Western Australian petroleum industry facing challenges and opportunities, some of which are lifelong and some that are new. For the Petroleum Division, we are now part of the larger, regulatory focussed Department of Mines, Industry Regulation and Safety (DMIRS), which was formed with the merger of the previous Department of Mines and Petroleum and parts of the Department of Commerce. However, our focus is unchanged with regard to the petroleum industry and our aim for responsible exploration and development of Western Australia's petroleum resources.

We also find ourselves operating under a new government whose policy direction and priorities, while similar to previous

governments, have some noted differences that DMIRS and the Petroleum Division are required to implement.

The public debate on hydraulic fracture stimulation (fracking) and the community sentiments on this subject continue despite the State Government's stated policy, which is a permanent ban on fracking in the South West, Perth and Peel regions and a moratorium over the rest of mainland WA while a scientific inquiry is undertaken.

Issues on the East coast around gas supply, energy security and electricity prices have had an effect on the whole country and the Federal Government's response to these issues again has implications for the Western Australian petroleum industry.

Chief Scientist Dr Alan Finkel's report "Blueprint for the Future: Independent Review into the Future Security of the National Electricity Market" released in June 2017 has also raised issues that impact the development of sustainable and reliable energy for the nation.

How the industry addresses these issues will be a test of its resilience and ability to maintain its social licence to operate, as well as determining the future of the onshore industry in Western Australia.

Western Australia's domestic gas market is certainly not in the same situation as the eastern States, and while we currently have a gas glut,

we cannot remain complacent as it is predicted that we could face gas shortages in 2020–2022 onwards.

So, in conclusion I, today, will use the same rallying call as Ian Fraser did thirty years ago which is, "Encouraging exploration and development is vitally important to Western Australia".

On a final note, I wish to acknowledge the passing of Dr Phillip Playford on 12 July. He will be remembered for his significant work in geology and shipwrecks, as well as aboriginal culture and will be missed.



Dr Phil Playford at the 'balancing rock' in Nullara Limestone south of Limestone Spring in the Napier Range, Canning Basin

Director's message

Denis Wills

Director Petroleum Operations
Petroleum Division



My first article for this publication back in September 2015 touched upon the subject of compliance. In this September 2017 edition of *Petroleum in Western Australia* (PWA) I will again talk to the subject of compliance and also to acreage release (better described as obtaining a petroleum exploration permit in WA). The third theme within this article will be decommissioning, probably the more contentious subject.

Compliance may have a different meaning depending on circumstances. I recently came across this nicely worded view of the concept of compliance by the US Army – "Compliance can be defined in many ways. The meaning of the concept is directly dependent upon the discipline and the context in which it is used. Lacking a gold standard for its measurement, a clear definition for the concept of compliance in nursing and other health-related professions should be explored".

Although it was referring to compliance within a health system, some might suggest this view of compliance as being

ill-defined equally applies within the resource industry. To dispel any misunderstanding of what compliance means – what the gold standard is to a regulator – it is worth considering the definition used by the Institute: Governance-Risk-Compliance is "... the process by which organisations identify and meet their strategic obligations whether arising in law, standards, codes or from stakeholder expectations".

For a petroleum title holder this means compliance with the legislation, regulations and associated guidelines, policies and explanatory notes. It means complying with conditions on an exploration title, complying with the environment plan, safety case/safety management system, well management plan and field management plan.

I see this as a two-way street with compliance also required from the regulator; compliance with legislation and regulations and compliance monitoring of petroleum activities.

The question might be asked, how important is compliance to an

organisation compared to other functions? For the department it is absolutely important. So important that within the Petroleum Division a standalone compliance unit has been formed.

This unit, which will report directly to my position, will be proactive in monitoring compliance across petroleum activities and advising senior management within Petroleum where there is an imminent risk of non-compliance.

As a final reflection on compliance I am always reminded of a quote from a well-respected safety professional – Dr Trevor Kletz, "There's an old saying that if you think safety is expensive, try an accident". To translate this into the compliance environment, maybe it would read – "If you think compliance is expensive, try non-compliance".

An acreage release took place at APPEA in May this year, with a closing date of 1 February 2018. The acreage release working group within the department has commenced planning for the next acreage release at APPEA in 2018. Such planning involves assessing

potential release areas against a number of criteria, including prospectivity, environmental considerations, heritage, land access and land use. Once possible release areas have been identified, there is a process of engagement with key stakeholders to get their feedback before finalising the acreage release areas.

This year also saw the department release a five-year acreage release strategic plan, which outlines our proposed schedule of areas to be considered for release in future. I refer you to the Minister's message in this publication for more detail on this topic, as well as the current schedule outlined on pages 16-18.

It also saw an explanatory note issued: 'Obtaining petroleum exploration titles in Western Australia'. This explanatory note is aimed at ensuring clarity (transparency) and consistency in regards to how the department assesses applications for petroleum exploration permits and special prospecting authorities. In addition, the guideline 'WA Petroleum Guideline – Criteria for Assessment', covering award of exploration permits and drilling reservations and transfer applications to become a registered holder of a petroleum title was updated, again to improve transparency and understanding.

At a more strategic level, it is the intent of the Petroleum Division to issue additional guidelines and explanatory notes over this financial year to enhance consistency in regulating the industry and also to provide a better understanding within the industry on the department's expectations and application of the legislation and regulations. This should provide industry with more certainty in regards to the regulatory framework.

In talking about new guidelines, the main focus of the industry will no doubt be on the Decommissioning Guideline being developed.

Taking my lead from the Executive Director Petroleum, I had a look

at past issues of Petroleum in Western Australia. Bingo – in the September 1996 publication there was an article by the Director General (Ken Perry) of the then WA Department of Minerals and Energy, on the topic "Urgent attention needed to abandonment strategies". I was hoping for a 1994 year article so it would have an Orwellian twist against 1984.

In 1994 decommissioning was seen as walking up the garden path to knock on the regulator's and the petroleum industry's front door. The Director General was being forward thinking in seeing that this was a subject that needed to be addressed. Today decommissioning is banging on the door.

I am going to take the easy path here and quote from that article as the comments made then remain valid today; comments made 23 years ago and at a time when decommissioning was seen as something in the far distant future.

What was recognised in that article was "the major challenge (decommissioning challenge) is to put in place a set of criteria which are acceptable both to the industry and the needs of the wider community. These criteria must consider the risks to safety and human life, the environmental consequences of the abandonment and any residual structure, engineering feasibility and costs, impediments to navigation and fishing etc."

Again what was seen as a particular challenge 23 years ago was the issue of liability – "Of particular interest to government will be the question of future liability for incidents or accidents arising from installation or pipeline remnants".

Decommissioning of petroleum facilities and pipelines will need to be addressed on a case-by-case basis against a set of criteria principles. In any such assessment of a decommissioning strategy

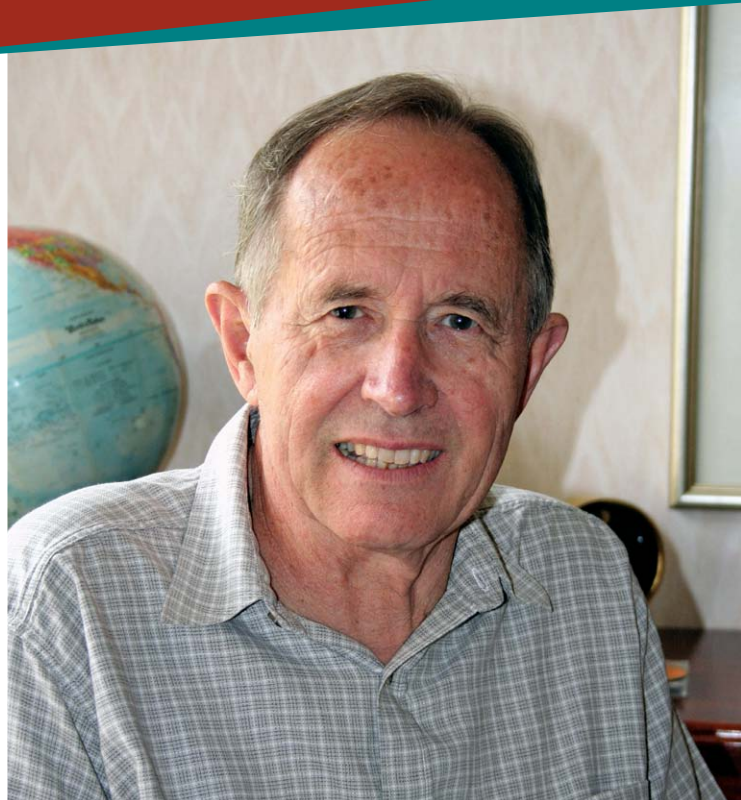
it gets down to what each party considers as acceptable risk – the concept of 'as low as reasonable practicable' (ALARP) applies.

In this discussion on decommissioning there are two parties directly involved in decision making, the government/regulator and the title holder but, there is another equally interested party, the citizens of Western Australia.

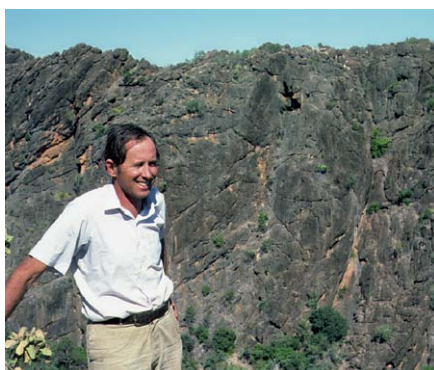
In any assessment and discussion on a decommissioning strategy for a facility or pipeline there are two primary tenets that need to be recognised – risk is in the eye of the beholder and risk needs to be balanced with a commensurate benefit.

Phillip Elliott Playford (1931–2017)

[Compiled by Tony Cockbain, Roger Hocking and Pam Reid from 'Biographical Notes' written by Phil Playford in May 2000]



Phillip Elliott Playford: a life of geology, exploration and history



Phil Playford and the Classic Face of Windjana Gorge

Phillip (Phil) Elliott Playford was born on 27 December 1931 in Guildford, the elder son of Elliott Geoffrey and Alice Mary Playford. He attended the Forrest Street State School (now South Perth Primary School) (1937–1942) and completed his schooling at Perth Modern School (PMS) (1943–1948). He later wrote that he “didn’t like the school [PMS]” and that his “salvation came through tennis, in which I eventually became school champion and captain of the winning team in the inter-school competition”. He won a General

Exhibition in the Leaving Certificate exam and went on to study geology at the University of Western Australia (1948–1953). His honours project was mapping the Jurassic geology of the Geraldton district. Travelling to and from the field area on his motorbike (a Triumph 3T), he collected a large number of ammonites from the Newmarracarra Limestone which he sent to W J Arkell at Oxford University, who was the world-renowned expert on Jurassic rocks. This led to his first major publication (with Arkell, in the *Philosophical Transactions of the Royal Society of London*) that established the Bajocian age for this unit.

After graduating, Phil joined the Bureau of Mineral Resources (BMR) in 1953, working in Alan Condon’s team with two other stalwarts of WA geology, Murray Johnstone and Daryl Johnstone, mapping the southern Carnarvon Basin. In 1953 WAPET (West Australian Petroleum Pty Ltd) discovered oil at Rough

Range, and lured Phil, among others, away from the BMR. In those days oil exploration in Western Australia involved a lot of detailed geological mapping, and Phil has always emphasised the importance of such field work in understanding the geology of a region. This work culminated in McWhae et al’s (1958) extended paper, which laid the foundations of our modern understanding of the stratigraphy of the major sedimentary basins of the State.

Phil’s time with WAPET took him to the Carnarvon and Canning Basins and had four important impacts on his subsequent career. The first was discovering stromatolites at Hamelin Pool in July 1954 when he and Daryl Johnstone were working in the Shark Bay area. This led to his lifelong interest in stromatolites and the geology of the Shark Bay area. The second was meeting stockman Tom Pepper at Tamala station, also in July 1954, who showed him various items that he said came



Investigating the wreck of the Dutch ship, the Zuytdorp, 1954

from a shipwreck at the foot of the coastal cliffs south of Tamala. Thus began Phil's involvement with what he eventually deduced was the wreck of the Zuytdorp. Thirdly, in 1956 he was introduced to the Devonian reef complexes, which started a life-long love affair with these superbly exposed rocks. The Aboriginal cave paintings in these Devonian limestones also fascinated Phil, resulting in his research into the mythological significance of the paintings and the mapping of tribal boundaries. Arising from this interest, in 1964 Phil joined an expedition to the Gibson and Great Sandy Deserts, which successfully located the last known Aborigines who had never before seen Europeans, living almost untouched by the outside world. Phil at times recounted the tale of how, although they had never met Europeans, they knew of "puddy tats", through contacts with other Aborigines.

Phil was awarded a Fulbright Scholarship in 1959, which took

him to Stanford University where he obtained a PhD for his thesis on the geology of the Egan Range, near Lund, eastern Nevada. He completed the project in two years and decided to return to Australia. Not long after his return to Perth he met Cynthia Hogbin, with whom he shared a keen interest in the bush, Phil with the rocks, Cynthia with the plants. They married in 1964 and had two daughters, Julia and Katherine.

While WAPET was keen to re-hire Phil, he saw that fieldwork was a lower priority than before, and instead joined the Geological Survey of Western Australia (GSWA, a branch of the Mines Department – now newly renamed the Department of Mines, Industry Regulation and Safety) in 1962, as Supervising Geologist of the newly created Sedimentary (Oil) Division, which had responsibility for mapping the Phanerozoic basins of the State and assessing their fossil fuel resources. He worked for the department in various positions (Assistant Director GSWA –

1978–1980, Deputy Director GSWA – 1980–1984, Assistant Director General – 1984–1986, Director GSWA – 1986–1992) until his retirement in 1992, except for a short time as Exploration Manager and General Manager of Abrolhos Oil in 1970–1971. After retirement, he wrote up his work on the Zuytdorp and continued to work on the geology of the Devonian reef complexes, Shark Bay, and most recently Rottneest Island, from an office in GSWA until late in 2015.

One of Phil's first recommendations in the GSWA was to ask the Minister for Mines to encourage WAPET to drill the anticline below Barrow Island in the Carnarvon Basin. The subsequent discovery of oil in commercial quantities in 1964 marked the dawn of petroleum production in Western Australia. Under his supervision and as part of GSWA Director Joe Lord's drive to map all of WA at 1:250 000, mapping was undertaken in the major Phanerozoic basins, resulting in the

publication of several bulletins. Phil continued his work on the Devonian reef complexes of the Canning Basin, soon publishing the first GSWA bulletin on their geology (Bulletin 118) in 1966. He then embarked on detailed studies of significant areas of the reef complexes. One of the early results of this work was the realisation that stromatolites in the marginal slope deposits extended down slope to at least 35 m, and probably more than 100 m water depth; this was in conflict with the prevailing view in the 1960s that stromatolites were intertidal, and renewed his interest in the Hamelin Pool stromatolites where he showed that they also extended into the subtidal region. The Devonian reef complexes were the subject of several lecture tours by Phil, through the USA and Canada in 1978 as an AAPG Distinguished Lecturer; through Australia in 1980 as a PESA Distinguished Lecturer; in China in 1988 as an Exchange Scientist for the Australian Academy of Science and Academia Sinica; and through Europe in 1989 as a Guest Fellow of the Royal Society of London.

An ongoing condition of Phil's acceptance of administrative roles in the Mines Department and its later incarnations was that he be allowed to devote time each year to geological research, primarily field work on the Devonian reef complexes. Regular updates on the geology of the complexes continued through the 1980s and 1990s, together with supervision of PhD and post-graduate projects, until their culmination in 2009 with publication of the second GSWA bulletin on the complexes (GSWA Bulletin 145). This also included observations on Permian glacial pavements and subglacial channels, lakes, tunnels, cave systems, tower karst, collapse breccias, and solution dolines. En route to the Kimberley, and as separate short trips, visits to Shark Bay and the Zuytdorp Cliffs continued.

After the second bulletin on the reef complexes, completion of the Shark Bay research became Phil's top priority. The remarkable stromatolites were largely responsible for Shark Bay being declared a World Heritage

Area, but were not the only focus of Phil's work. The project grew to include aspects of Quaternary coastal geology around most of WA, but particularly neotectonism and the recognition of the imprint of ancient major tsunamis on WA, from the Kimberley through the Pilbara to Shark Bay, from large erratic blocks in coastal areas. Phil concluded that major tsunamis, although infrequent, constitute a significant hazard in coastal areas that has not been adequately included in risk assessments. A comprehensive bulletin, again oriented towards the field geology but also including the history of the Shark Bay region, was published in 2013 (GSWA Bulletin 146). Compilation of a similar bulletin integrating Phil's work on Rottnest Island, was underway in late 2015 when Phil was diagnosed with cancer, and sadly will not be completed. Part of the Rottnest work was updating of a field guide, first prepared in 1988. Phil's final paper, reviewing the history of our understanding of the Canning Basin reef complexes is to be published soon in SEPM (Society for Sedimentary Geology) Special Publication 107, which is dedicated to his memory.

Phil's scientific achievements and work through his career promoting the petroleum prospectivity of Western Australia have been recognised in several awards. These include: Special Commendation Award of the AAPG, Lewis G Weeks Gold Medal of APEA, Gibb Maitland Medal from the Geological Society of Australia, Honorary DSc from UWA, Honorary Membership of RSWA, Royal Society Medal from RSWA, and Distinguished Honorary Membership of PESA. He served geology and other sciences as President of the Royal Society of Western Australia, Australian Petroleum Exploration Association Professional Division (WA), Petroleum Exploration Society of Australia (WA), Australian Geoscience Council, and National Trust (WA). He was also Chairman of the Board, WA Museum of Natural Science, Adjunct Professor of Petroleum Geology, Curtin University, and Adjunct Professor

of Geology, University of Notre Dame an Honorary Associate of the Geological Survey of WA and the WA Museum.

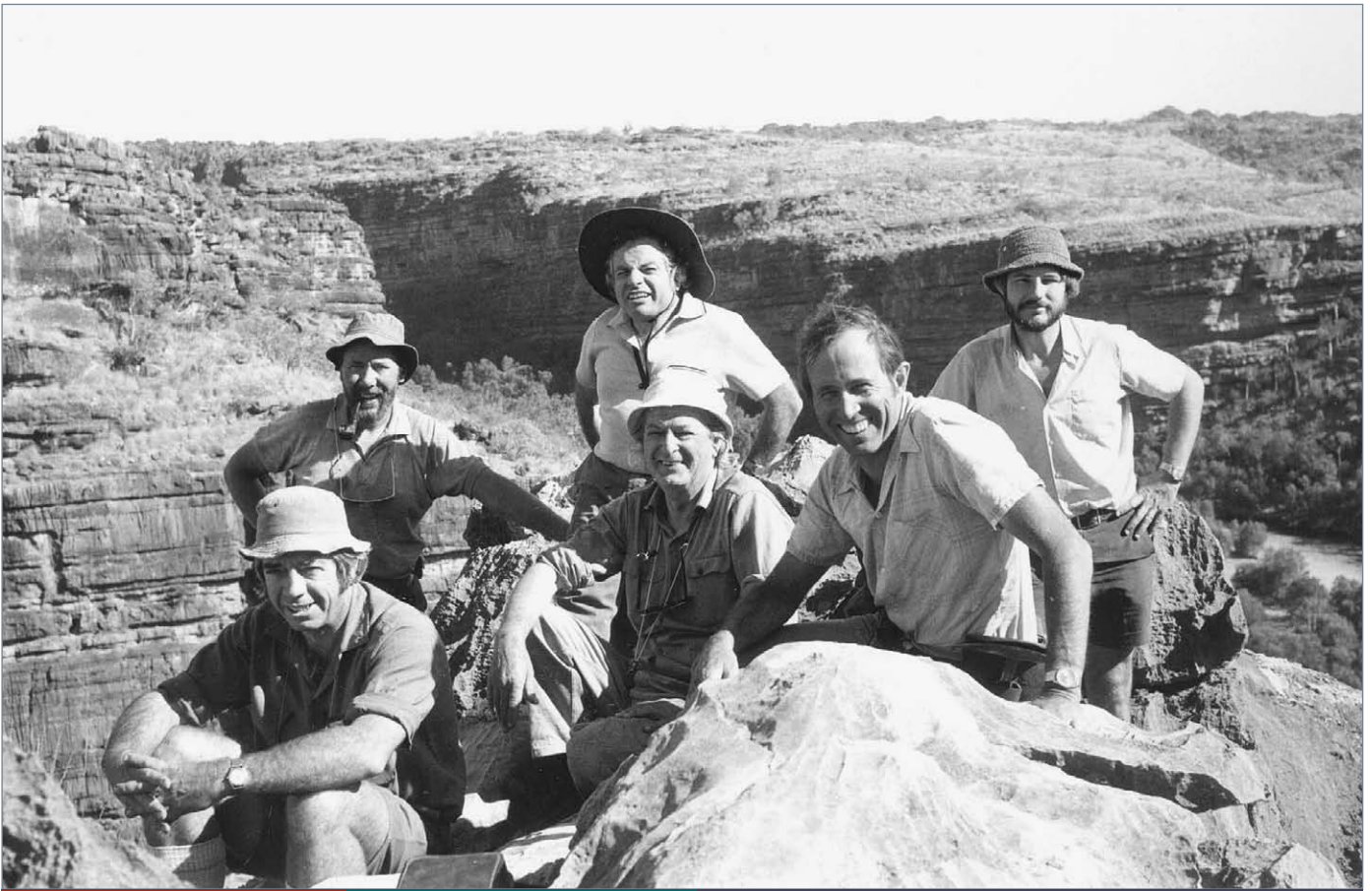
Although Phil's geological legacy is considerable, he may be remembered by the general public for his contributions to WA's history, principally the early Dutch explorers and aspects of Aboriginal art and heritage. Phil's first tasks after his retirement from Director GSWA were a new phase of fieldwork in the Kimberley, and to complete his work on the Dutch wreck the Zuytdorp (in 1994 Phil and Tom Pepper were officially rewarded by the State as being the co-discoverers of this historic wreck). This was published in 1996 as "Carpet of Silver" by UWA Press, received the Premier's Book Award for Historical and Critical Studies in 1997, and was reprinted in 1998 and 2006. He followed this in 1998 with a book on Willem de Vlamingh's voyages, "Voyage of Discovery to Terra Australis: by Willem de Vlamingh, 1696-97", after he discovered de Vlamingh's personal journal; this work was also reprinted. Phil was involved in the 400th anniversary celebrations of the landing of Dirk Hartog in Western Australia and jointly edited "The life and times of Dirk Hartog" published by the Royal Western Australian Historical Society in 2016. These interests also led to several public lectures and articles, the chairing of committees promoting aspects of WA's pre-colonisation history, and the installation of a replica of Dirk Hartog's plate on Dirk Hartog Island. Parts of the bulletins on the Devonian reef complexes and on Shark Bay were devoted to the history and Aboriginal heritage of the West Kimberley and the Shark Bay areas, respectively. In 1998 he was made a Member of the Order of Australia (AM) for 'contributions to geology and the history of early Dutch exploration and shipwrecks in Australia'. His life has truly been that of a renaissance man.

Reference

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Phil Playford with Dutch coins from the wreck of the Zuytdorp, 1954



Back row – Dr A E (Tony) Cockbain, Murray Johnstone and Ian Blayden; Front row – Jim Parry, Rex Prider and Phil Playford at Windjana Gorge in 1975

Overview of petroleum activities in Western Australia in 2017

Dr Nina Triche
Petroleum Geologist
Resources Branch



Photo © Chevron Australia

Construction of Wheatstone LNG Train 2 is progressing as planned

Petroleum activities in Western Australia in the first half of 2017 have focused mainly on appraising and expanding existing projects, as well as decommissioning projects on a number of fields. Summary tables for the 2016–17 fiscal year for wells and annual production by basin can be found at the back of this magazine. No surveys were undertaken in the 2016–17 fiscal year.

Exploration and appraisal

In 2017, petroleum operators concentrated on appraisal drilling and developing existing projects.

The Minister recently declared Buru Energy Ltd's nominated blocks over the Valhalla-Asgard gas discovery in the Canning Basin to be a location, which may serve as a precursor to gaining a future production licence or retention lease. The Valhalla-Asgard accumulation was discovered in 2011 and is expected to produce from the Laurel Formation basin centred tight gas play. It is located in EP 371, approximately 150 km southeast of Derby, just south of the Great Northern Highway.

In May 2017 Buru announced its intention to complete an asset swap with Mitsubishi, a JV partner on many of their petroleum titles, in which Buru would gain 100 per cent interest in the Ungani field and other northern Canning Basin gas plays; while Mitsubishi would gain a 100 per cent interest in the Valhalla discovery and other southern gas exploration permits.

In the Perth Basin, Red Gully North 1, operated by Empire and located in EP 389, 150 km north of Perth, underwent a workover and well test during December 2016 and January 2017. Empire estimates 64 kL/d (400 bbl/d) and 34 m³/d (1.2 Mscf/d) of potential oil and gas production from the Red Gully North discovery. They are planning a further extended well test in the third quarter of 2017, in order to determine commerciality and book reserves. Empire has also completed a tender for a drilling rig to drill the Lockyer Deep 1 and possibly North Erregulla Deep 1 exploration wells.

Following a successful farm-out, Norwest Energy has obtained approval to drill the exploration well Xanadu 1 following completion

of AWE's Waitsia wells. The Xanadu prospect is located in permit TP/15, in the offshore Perth Basin, approximately 250 km north of Perth. The well targets conventional oil in the Dongara and High Cliff Sandstones and the Irwin River Coal Measures. Xanadu will be directionally drilled from onshore in EP 437. Further information about Waitsia appraisal activity is given in the following section.

Development and production

Ungani oilfield update

Buru restarted production at the Ungani oilfield in late June 2017. The field is located in production licences L 20 and L 21, 97 km east of Broome. Buru is currently targeting a production rate of 199 kL/d (1250 bbl/d), with oil being trucked to the port at Wyndham. Ungani had been shut-in since January 2016, during which time Buru successfully completed upgrades to enlarge the Wyndham storage tank. Upgrades to the Ungani facility are planned, including installation of a water recycling system, an artificial lift system and additional tankage.

In 2017, Buru plans to sidetrack the Ungani 3 well and to drill an additional development well, in incremental

stages. Their aim is to capture production from undrained areas of the field; increase production to 477 kL/d (3000 bbl/d) in Q4 of 2017; increase the reserves; and possibly provide a pathway to an export system through Broome. Buru expects an investment decision for the remainder of the project in early 2018.

Waitsia Gas Project update

The Waitsia Gas Project is operated by AWE, under a 50–50 joint venture with Origin Energy, on production licences L 1 and L 2. It is the largest onshore gas discovery in Australia in the past 30 years and lies approximately 16.5 km east-southeast of Dongara. The first commercial gas flow commenced from Waitsia Stage 1A in August 2016.

New infrastructure was installed to connect the Waitsia 1 and Senecio 3 gas wells to the upgraded Xyris Production Facility during Stage 1A. The Xyris Production Facility has now been commissioned with a production capacity of 0.267 Mm³/d (10 TJ/d). Currently 0.224 Mm³/d (8.4 TJ/d) of gas is being delivered to the domestic market by the Parmelia Pipeline.

The Senecio 3 well is producing from the Kingia Formation, while the Waitsia 1 well is flowing from the High Cliff Sandstone. Both wells have performed better than pre-production expectations. An independent review of well performance has indicated gross 2P reserves of 13.02 Gm³ (487 PJ) of gas, 34 per cent higher than AWE's previous estimate of 9.74 Gm³ (364 PJ) of gas.

AWE completed the Waitsia 3 well in June 2017 and the Waitsia 4 well in August 2017. Waitsia 3 confirmed strong gas shows across a 150 m interval of Kingia and High Cliff Sandstone reservoirs. The Kingia was found to be considerably thicker and better in quality than predicted, while gas in the High Cliff extended below the lowest known gas in previous wells in the field.

Data from well testing of Waitsia 2, 3 and possibly 4, combined with production data from Stage 1A, will

enable the reassessment of Waitsia 2P reserves in the second half of 2017. Once in full production, the Waitsia Gas Project, including the Senecio field, is forecast to produce approximately 2.67 Mm³/d (100 TJ/d) of gas from approximately 20 wells, for more than two decades.

AWE has commenced pre-front end engineering design work at Waitsia Stage 2 and undertook a tender process for Waitsia 2 gas sales. The decision to proceed to a full field development will be dependent on securing gas sales agreements; the first of these was agreed with AGL in February 2017, for 15 TJ/d. AWE estimates achieving Final Investment Decision (FID) for the project in late 2017.

Tubridgi gas storage

The Tubridgi gas storage facility is the largest underground gas storage facility in Western Australia, located on production licence L 9, 30 km southwest of Onslow. It is operated by DBP Development Group, which is 100 per cent owned by the DUET Group. The wells for the project were drilled between December 2016 and April 2017. The facility commenced gas injection on 10 June 2017, into the TGS 1 well, with further injection to follow at TGS 3, 5, 6 and 9.

Tubridgi is connected to Compressor Station 2 on the Dampier to Bunbury Natural Gas Pipeline, by existing gas transmission lines. The Sino Iron magnetite project is the foundation customer under a 10 year gas storage agreement.

Gorgon Project update

The Gorgon Project is located 60 km off the northwest coast of Western Australia and is one of the world's largest natural gas projects. All three planned trains are now producing gas, along with a 15.6 million tonne per annum (Mt/a) liquefied natural gas (LNG) facility, a domestic gas plant with a capacity to supply 8 Mm³/d (300 TJ/d) of natural gas, and a carbon dioxide injection facility.

Gas for the Gorgon Project is supplied from the Gorgon and Jansz–lo

gasfields, located 65 km west of Barrow Island and 130 km northwest of Barrow Island, respectively. As of January 2017, the JV has moved Gorgon Stage 2 into the FEED stage, pending future FID.

The Gorgon Project is operated by an Australian subsidiary of Chevron (47.3 per cent interest), in joint venture with the Australian subsidiaries of Exxon Mobil (25 per cent interest), Shell (25 per cent interest), Osaka Gas (1.25 per cent interest), Tokyo Gas (1 per cent interest) and Chubu Electric Power (0.147 per cent interest).

Gorgon's first LNG cargo sailed from Barrow Island in March 2016, while production from Train 3 commenced on 28 March 2017, at a capacity of 5.3 Mt/a, ahead of its original schedule. Gorgon currently supplies the domestic gas market with an initial 4 Mm³/d (150 TJ/d) of gas, fed through the Dampier to Bunbury Natural Gas Pipeline. At full production, the domestic gas plant capacity will be equivalent to generating enough electricity for 2.5 million households.

The first two production facilities at Gorgon are operating near capacity, producing approximately 18 ML of oil equivalent (230,000 BOE) per day of LNG and domestic gas. The Gorgon Project produced its 50th cargo in early March 2017 and is now fully operational. Twenty two cargoes of LNG were shipped between January and March 2017.

The Gorgon Carbon Dioxide Injection Project is continuing, with first CO₂ injection expected to occur in mid-2018. Commissioning of the project is planned to occur once the Gorgon gas processing plant is in steady-state operations. Approximately 3.4 to 4 million tonnes of reservoir CO₂ will be injected each year, reducing greenhouse gas emissions from the Gorgon Project as a whole by approximately 40 per cent. The JV expects to inject approximately 100 million tonnes of CO₂ over the life of the project.



Mt Horner 9 in its production heyday



Monitoring Mt Horner 9 following well decommissioning before wellhead removal

The GCLN 3D Seismic Survey was completed on 29 April 2017 and will serve as a baseline for 4D seismic, to be shot over the future CO₂ plume under Barrow Island.

Wheatstone Project update

The Wheatstone Project is located at Ashburton North, 12 km west of Onslow on the Pilbara coast of Western Australia. The project is comprised of the Wheatstone and Iago fields, an offshore platform, a pipeline to shore and an onshore plant located near Onslow. The onshore plant will include two LNG trains with a combined capacity of 8.9 Mt/a, and a 5.3 Mm³/d (200 TJ/d) domestic gas plant. LNG and condensate will be exported and domestic gas transported by a pipeline to the Dampier to Bunbury Natural Gas Pipeline.

The Wheatstone Project is a joint venture between Australian subsidiaries of Chevron (64.14 per cent interest), Kuwait Foreign Petroleum Exploration Company (KUFPEC) (13.4 per cent interest), Woodside Petroleum Limited (1.46 per cent interest) together with PE Wheatstone Pty Ltd, part owned by JERA (8 per cent interest). Eighty per cent of the Wheatstone Project's foundation capacity will be fed with natural gas from the Wheatstone and Iago fields, with the remaining 20 per cent of gas being supplied from the Julimar and Brunello fields operated by Woodside.

All modules for Trains 1 and 2 were set on foundations in January 2017, with installation of piping, electrical and instrumentation continuing as planned. Permanent power to the LNG plant was also achieved, with the start-up of the first gas turbine generator. The storage and loading system is now ready for commissioning, and the LNG storage tanks and export loading jetty are complete.

The first LNG cargo from Train 1 is expected in late 2017, with Train 2 to follow six to eight months later.

Decommissioning

A number of companies are currently in the process of decommissioning non-producing fields and wells in onshore and State waters areas. Chevron commenced decommissioning a number of offshore fields related to Thevenard Island, which ceased production in 2014. These include Saladin, Cowle, Yammaderry, Crest, Roller and Skate. Chevron used a jackup mobile offshore drilling unit (MODU) to isolate the reservoir in the wells associated with the offshore platforms. The focus has now moved to decommissioning the onshore Thevenard Island wells and the oil and gas processing facilities.

Quadrant Energy's decommissioning program in 2016–17, also using a jackup MODU, commenced with the decommissioning of Chervil 5 and Chervil 6 in the Chervil field. The Marley 1 subsea well was also decommissioned. The wells on Harriet Alpha have all been decommissioned and wells on other Harriet platforms have been suspended. The work will continue in the future with the decommissioning of those suspended wells, followed by the decommissioning of the platforms.

AWE's similar program to decommission non-producing wells and fields is continuing as planned and will progress over a number of years. In January of 2011, the AWE-operated Mt Horner oilfield on production licence L 7, 21 km northeast of Dongara, was shut-in and put into care and maintenance, as the field was deemed uneconomic. Mt Horner wells 4, 8, 9, 12 and 14 were decommissioned during December 2016 and January 2017.

AWE also ceased production at the Dongara and Corybas gasfields, and both assets are being considered for transition to care and maintenance following an upcoming technical review. AWE decommissioned Dongara 10 and

12 in May 2017, as well as Hovea 3 and 4ST1.

Origin Energy's Jingemina field in the northern Perth Basin has been in care and maintenance for several years. The Jingemina 11 well was decommissioned to resolve a well integrity issue. The field has since been sold to Cyclone Energy, which has plans to re-life the field.

Five year petroleum acreage release strategy

Richard Bruce
Petroleum Exploration Geologist
Petroleum Division



Introduction

The State Government has adopted a five year strategic approach for the future release of petroleum exploration areas within the State.

This approach aims to provide greater transparency to the oil and gas exploration industry and to other stakeholders regarding proposed future release of areas for competitive work program bidding. Advertising blocks for competitive bidding is the department's preferred mechanism for industry to acquire a petroleum exploration title in Western Australia.

Configuration of release areas

Within a given region, the process of deciding if and how much acreage will be released involves a rigorous evaluation based on selection criteria, which includes petroleum prospectivity, environmental factors, land use considerations and native title and cultural heritage considerations. The locations of environmental/iconic assets have been identified for the Canning Basin (see Figure 1). It cannot

be presumed that access for petroleum and gas exploration and development will be permitted at such locations.

Industry is also encouraged to nominate specific areas for acreage release, which will be considered before the next acreage release. Where there have been overlapping Special Prospecting Authority with Acreage Option (SPA-AO) applications, areas may be configured for release, taking into account these same selection criteria. Areas from previous releases, which did not attract successful bids in the first instance, may be considered for a future re-release.

The size of each acreage release discrete area may be limited to approximately 80 5"x5" graticular blocks. This release area size is considered to be an area that could be effectively explored within a sixteen (16) year period from first grant of the title (initial six years and two five year renewal options).

Historically, five to ten areas have been released for each bid round, however the number of areas will depend in future on the market.

Indicative release maps

Maps of future proposed releases in the Canning and Perth Basins will advise stakeholders of regions:

- likely to contain acreage release areas in upcoming bid rounds
- not currently available for Special Prospecting Authority with Acreage Option (SPA-AO) applications owing to future planned bid rounds
- that are likely not to be available for application owing to GSWA/ Geoscience Australia (GA) pre-competitive research.

The Acreage Release Strategy maps of the Canning (Figure 1) and Perth (Figure 2) Basins highlight regions that contain potential acreage release areas, which may be successively opened in competitive work program bid rounds over a five year period, from 2018 to 2021.

The legend 2018-2019, for example, means acreage will be considered for release in either 2018 or 2019. In addition to the mapped regions, upcoming relinquishment acreage may also be considered for release in future rounds.

Strategy maps provide a high-level indication of where consideration will be given to the release of exploration acreage in future. Just because a region has been highlighted for consideration on these maps does not mean any or all of the region will be released in a bid round. Acreage that is highlighted and currently under title would, of course, not be available for acreage release until such time as it is relinquished.

Timing

Timing of acreage releases for the next five years is planned to coincide with key promotional events such as the autumn APPEA conference and the September DMIRS Petroleum Open Day. Releases may occur at least once a year, with two releases scheduled when available acreage and levels of industry interest allow. Acreage releases have historically been open for six months (gazetted date to close

of bids). This timeframe provides potential applicants sufficient time to prepare bid packages and gain corporate approval to bid.

The acreage release schedule is intended to be updated at least once a year after each acreage release round, and when significant amounts of new prospectivity data or acreage become available and warrant a review.

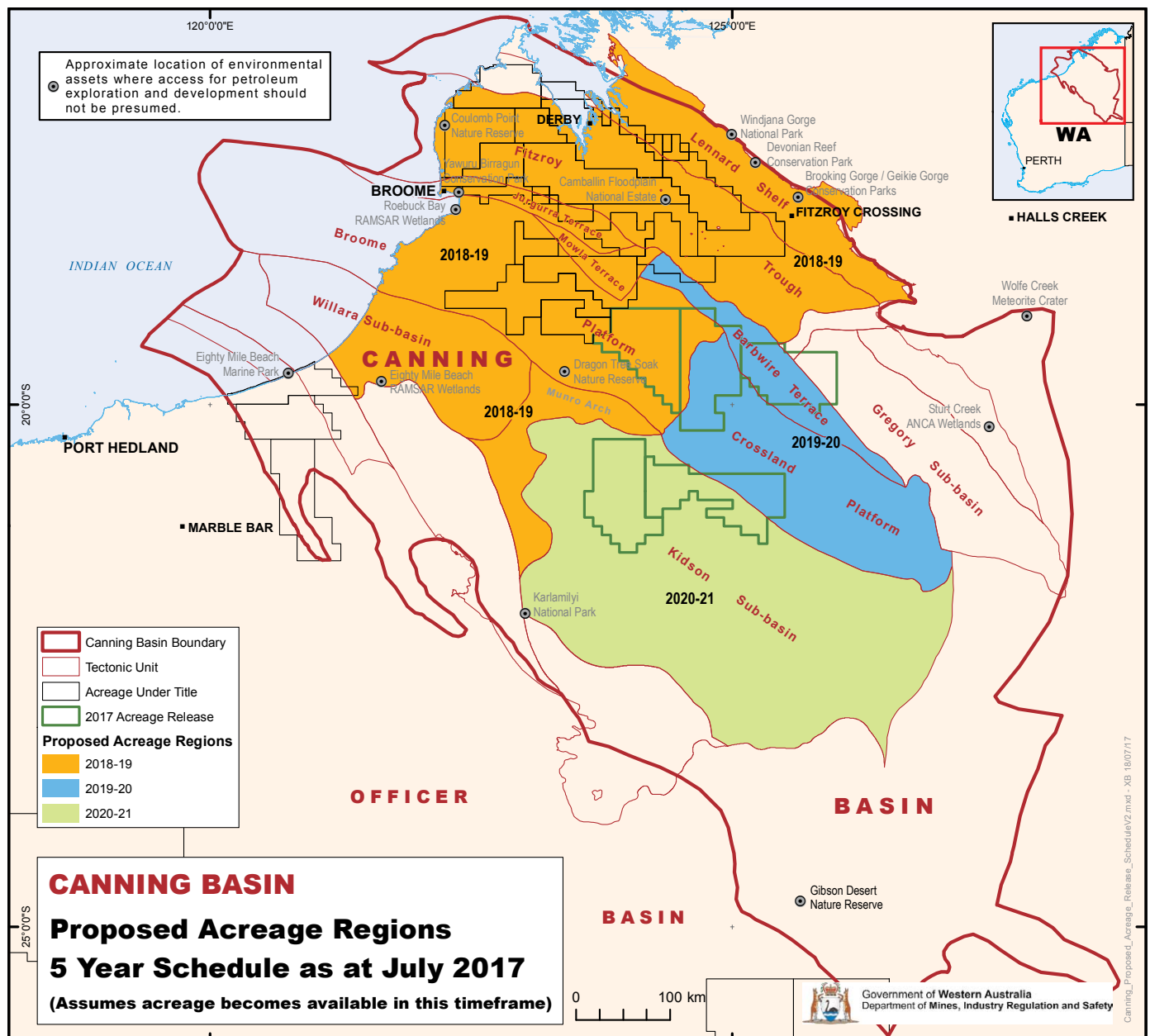


Figure 1: Proposed acreage regions under the five year schedule for the Canning Basin

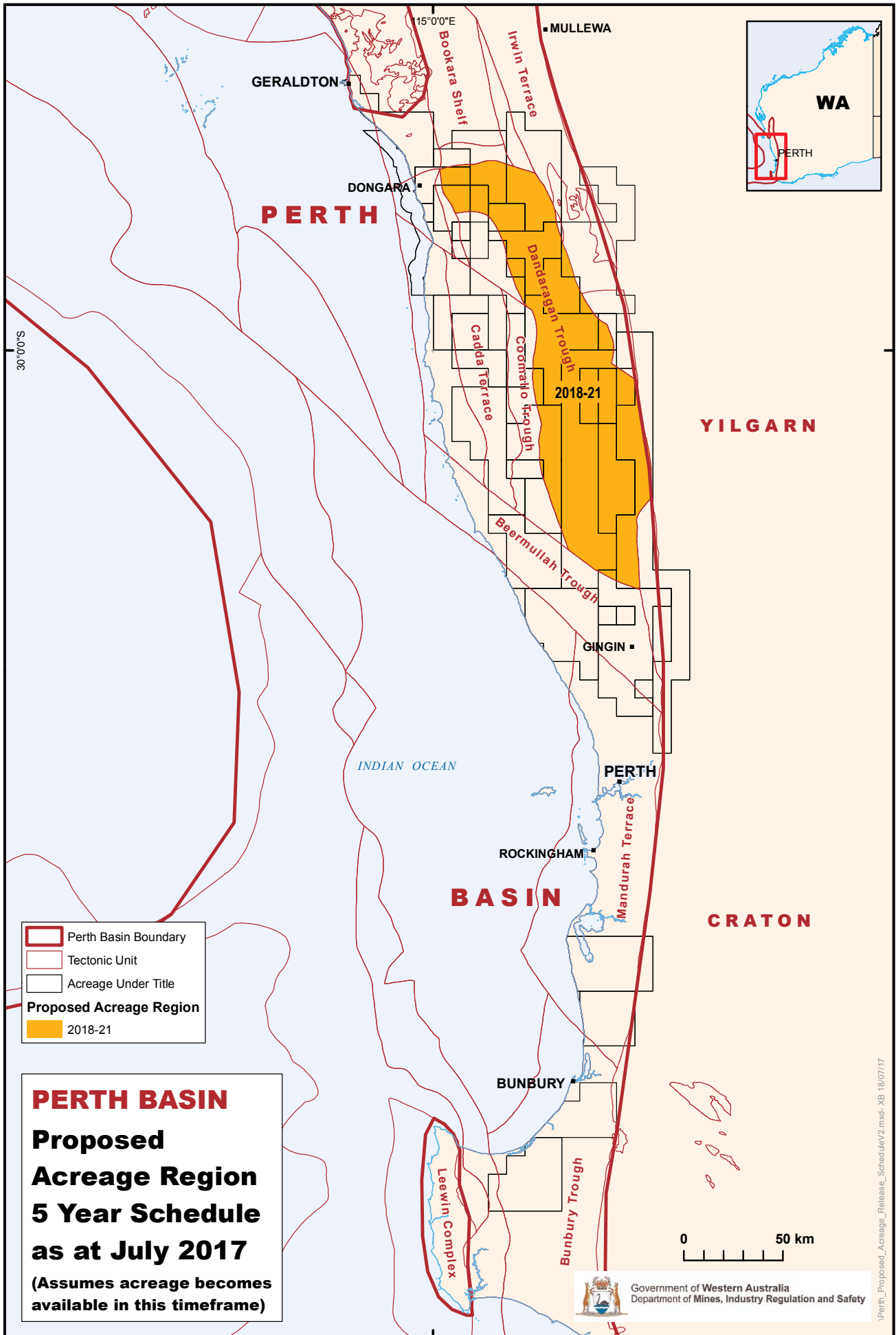


Figure 2: Proposed acreage region under the five year schedule for the Perth Basin



Poole Sandstone overlying Grant Group in the Fitzroy Trough

Environment 2020: a vision for the regulation of the petroleum environment

Marnie Leybourne
Acting General Manager Resources
Petroleum Division



Regulating environmental management can sometimes feel like a thankless task. On the one hand, communities call for more stringent environmental regulation while on the other, industry complains about the increasing "green" tape and cost of meeting legislative requirements. No-one is ever happy.

So my 2020 vision is for the petroleum industry to be operating perfectly in the regulatory environment and for the Western Australian community to recognise that our environmental standards are second to none.

Is this achievable? I think it is. However it will require a change in mindsets right across the board.

It is clear that we are not winning the hearts and minds of our communities and that the petroleum industry's social licence to operate is at risk. At this point in time, the best way to increase community confidence in the industry is to be transparent, demonstrate best practice and engage and support communities in a more proactive manner.

This all sounds like it will be more costly to industry. However, my

expectation is that it won't. This article will outline some ideas that the Department of Mines, Industry Regulation and Safety (DMIRS) are considering as part of the Petroleum 2020 goal to amalgamate and modernise petroleum legislation in relation to environmental management. It will also cover some suggestions for industry to mull over.

Environmental risk

DMIRS has a risk-based and outcomes-focussed approach to environmental regulation and expects industry to apply the principle of ALARP – as low as reasonably practicable – when considering risks and mitigation strategies to reduce them (Figure 1). This means that if the risk is too high and cannot be mitigated sufficiently, even after ALARP is applied, the proposed activity will be refused.

It also means that in terms of assessment and compliance, effort should be proportionate to the scale of the risk. DMIRS is looking to modify the *Mining Act 1978* to include a "low impact notification"

process, where small scale and low risk activities on Mining Act tenements can receive an automatic green light when the operator notifies the department that the activities will take place. The online notification system will be able to undertake an automated assessment to ensure there are no environmental issues in the proposed area to be worked and that the scale and risks are in the "acceptable region" of Figure 1.

DMIRS proposes to introduce a similar mechanism for low risk petroleum activities, such as aerial electromagnetic surveys and seismic surveys along roads. At present, full Environment Plans (EPs) – at least 20 to 30 pages – are required for these types of activities that cause minimal environmental risk and impact. It makes sense to have simple application and approval processes for activities that pose no environmental risk.

DMIRS is currently streamlining applications for minor modifications to already approved EPs where neither the environmental footprint nor the risk profile change and this is expected to be further embedded into the new legislation.

Industry can help here, as well. The Australian Pipelines and Gas Association Ltd has had a Code of Environmental Practice for Onshore Pipelines since 2005 and the standard of EPs submitted for pipelines is consistently better compared to those submitted for other activities. Codes of practice, if followed, can help improve community understanding of how the petroleum industry operates. There needs to be increasing 'self-regulation' by industry through peer group pressure, as one bad operator has the potential of destroying the whole industry's image and social licence.

Compliance focus

DMIRS's risk-based approach to compliance means that operations that are considered higher risk are audited and/or inspected more regularly. The high risk profile may be due to the location (for example, an environmentally sensitive area) and type of operation, however operators themselves may be considered high risk due to past practices.

DMIRS is working towards a whole-of-government approach to compliance as it is recognised that if there are compliance issues in

one aspect of an operation, it is likely that there will be issues elsewhere. DMIRS already works closely with the Department of Water and Environmental Regulation (DWER) to ensure a coordinated approach to the regulation of issues such as contaminated sites and water resource protection and management.

The Western Australian community expects strong compliance and DMIRS delivers on that expectation by targeting higher risk operations at the same time as undertaking random inspections of all sites. In the 2016–17 financial year, the Environment Division of DMIRS undertook 24 site inspections, audits and reviews of annual environmental reports relating to petroleum activities. To these figures should be added other inspections that DMIRS conducts during well drilling operations to ensure adherence to the highest possible standards and the lowest environmental risk.

Given the compliance focus on sites or operators (registered holders) that pose potential higher risks to the environment, DMIRS is effectively providing an incentive that best practice is followed.

Many companies have long understood that protecting the environment is a lot more cost effective than environmental repair and damage to their social licence. This message needs to permeate throughout the industry. I would like to see environmental consciousness as embedded into company best practice as safety is now. A strong safety culture is obviously in everyone's best interest, and similarly we need to build a regime where all companies realise they have a vested interest in ensuring the environment is appropriately managed.

The idea of a Petroleum Rehabilitation Fund (PRF) has been discussed since Western Australia's Mining Rehabilitation Fund (MRF) was implemented in 2013. In the MRF, Mining Act tenement holders contribute one per cent of the cost of rehabilitation each year, which can be used in cases where the tenement is abandoned. Tenement holders are still obliged to undertake all rehabilitation work. A PRF could be established in a similar way and could potentially also have a graduated levy scale depending on the scale of risk of either the operation or the operator. This would reward good operators and increase costs to those that are less compliant with their obligations.

Engaging and supporting communities

The most effective way to garner community support is to proactively engage with and support local communities. They can also be the best ambassadors as their stories will have the highest impact amongst their peers.

There was one recent example where a petroleum company undertook baseline soil chemical testing, not just for the proposed petroleum site but for the broader farm. The farmer told a powerful story, as the tests showed chemical contamination of soil had already occurred from past agricultural practices and the pesticide treatment of power poles, which had affected livestock meat quality. The farmer's message was

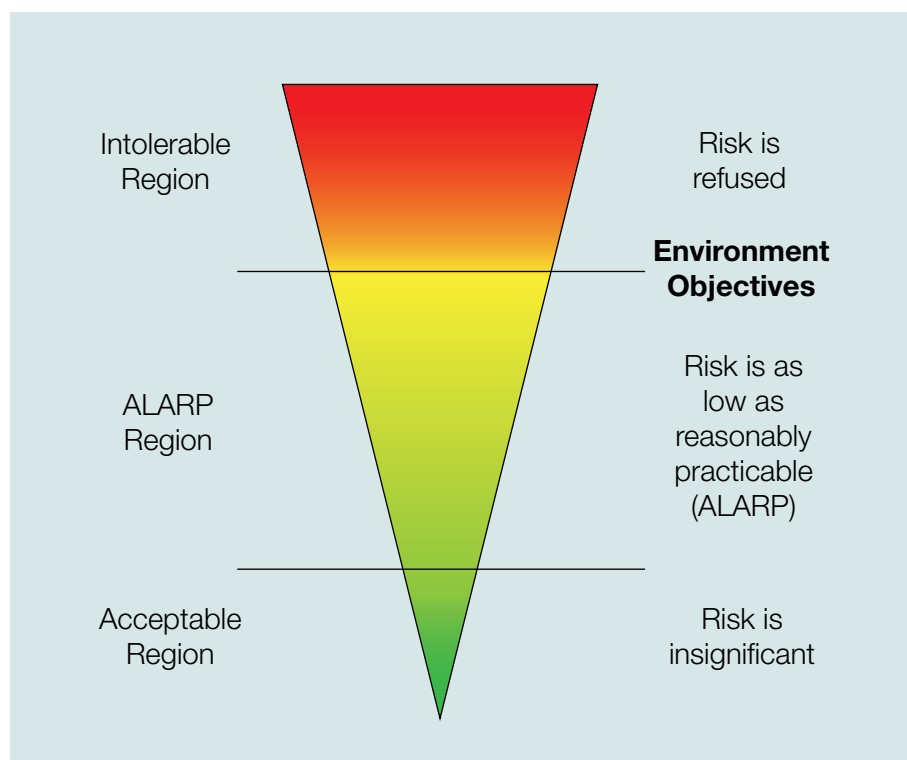


Figure 1: ALARP principle in action

that landowners needed to look at the bigger picture, including their own practices, rather than just blaming petroleum operators that, as in this case, may not have caused any harm at all.

Baseline and active monitoring should be standard for petroleum operations and operators should involve the landholders and/or the local community so that the results are understood by everyone.

There are a myriad of ways to improve relations with the local communities and many good examples across the State, including the creation of work readiness programs and provision of infrastructure. Petroleum sites that I have visited have shown that petroleum activities can operate in tandem with other uses of the land and companies could perhaps explore, in consultation with local communities, other ideas. For example, water recycling could be considered; drilling muds may be able to be used as a soil conditioner.

DMIRS offers two awards each year, the Golden Gecko for environmental excellence and the Community Partnership for engagement excellence. While these awards could be a goal, the best entries each year may also provide some intellectual fodder that could be modified to suit other sites. DMIRS holds a public briefing session prior to the presentation of the awards so that industry can learn about the best projects of that year. This will be held towards the end of October, with a third safety award, now offered (see article on pages 44–45).

Transparency

The point here is simple. Being transparent shows there is nothing to hide. Western Australia already requires full chemical disclosure and Environment Plan summaries, at the least, to be published on the DMIRS website. A survey of industry by DMIRS has shown some support for the full Environment Plans to be published, however most companies are still opting to have only summaries published.

DMIRS is considering publishing decision statements so that the assessment process is transparent. Decision statements are already published for Native Vegetation Clearing Permit applications, which DMIRS assesses under delegation in accordance with the *Environmental Protection Act 1986*. Once legislation allows, it can also be achieved for all assessments under the *Petroleum and Geothermal Energy Resources Act 1967* and the *Mining Act 1978*.

DMIRS is also looking at options to publicly report compliance issues, a sort of naming and shaming approach, that will reward good behaviour and encourage improvements in those where improvement is warranted. Given the precarious nature of industry's social licence, this should be seen by all good operators as a positive move.

Conclusion

In the next three years, DMIRS will actively explore ways to rationalise and streamline environmental regulatory processes for the petroleum industry and any suggestions will be most welcome. At the same time, the industry needs to look at how it can elevate its environmental credentials, not just as individual companies but as an industry as a whole.



Farmland south of Dongara, northern Perth Basin

Petroleum Division's future Petroleum Gateway

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General Manager Strategic Business
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What is the Petroleum Gateway?

In 2016–17, the Department of Mines, Industry Regulation and Safety's (DMIRS) Petroleum Division commenced a pilot project called the Petroleum Gateway where all petroleum applications, communications and approvals can be viewed electronically across all divisions in the department, simplifying information processes.

The Petroleum Gateway extends particular elements of the Petroleum Geothermal Register (PGR), such as details of a petroleum title including its status, expiry date, work commitments and current applications, to provide a holistic approvals and assessment data view.

The initiatives of the project are not only making petroleum information more transparent within the

agency, but also to industry and the community, through a phased approach over the next three years.

The Petroleum Gateway is being designed to enable a user quick access to petroleum information with a new integrated spatial viewer.

End to end processing

End to end visibility of an entire process, starting from 'process initiation', or lodgement, through to

A screenshot of the Petroleum Gateway landing page. On the left, there is a 'Base Title details' section with a green arrow pointing to 'EP XXX' and 'ACTIVE Exploration Permit (05 Dec 2014 - 04 Dec 2020)'. Below this is a 'Links' section with a green arrow pointing to a list of menu items: 'Switch', 'Contact', 'Go To', 'Approvals', 'Under Assessment', 'Audit & Inspection Plans', 'Follow Up (Non-Compliances, Directions & Audit Actions)', 'What's Due', and 'Library'. On the right, there is a 'Location Map' section with a green arrow pointing to a map showing a geographical area with various markers. Below the map is another green arrow pointing to the 'Title Details List'.

Figure 1: The landing page for Petroleum Gateway

'process completion', or final determination, will be visible through the gateway. The outcomes of this initiative will include links and views to other systems that deal with environmental, geotechnical, royalty and safety matters.

The data views that will be available from the Petroleum Gateway project include:

- Approvals
- Under Assessment
- Audit and Inspection Plans (priority flags)
- Follow Up (non-compliance recording and reporting)
- What's Due
- Library (transaction history)
- Individual company analysis with enhancements of the Petroleum Report Card

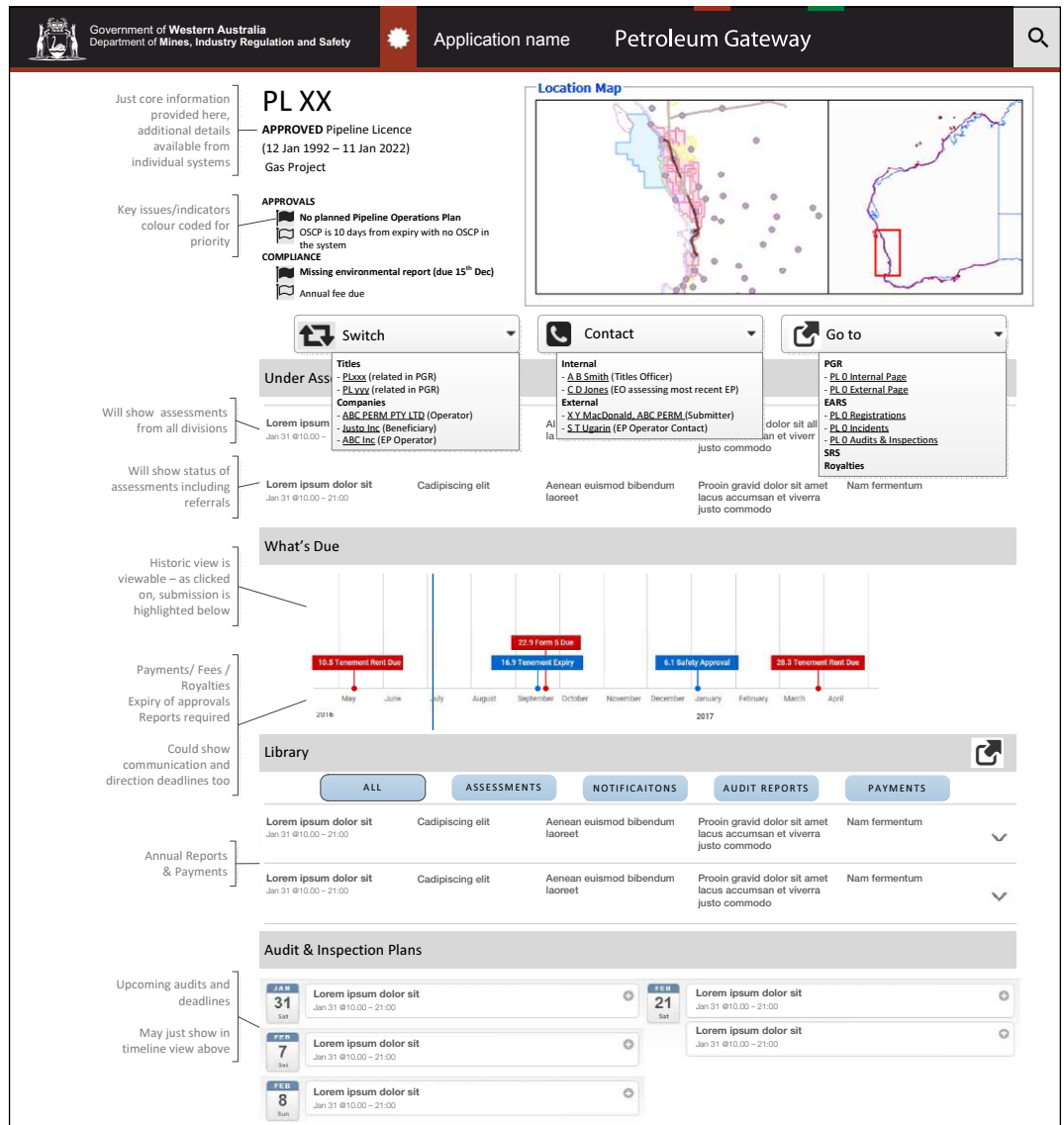


Figure 2: Proposed data viewing screen

- New spatial viewing map

- Finalisation and deployment of the Customer Self Administration module to allow security management by industry administrators.

The Petroleum Gateway will provide:

- Improved information sharing to provide transparency and consistency in the assessment and decision-making processes
- End to end paperless working environment with a single application viewing platform
- Data sharing of petroleum information stored in systems such as the Environmental Assessment and Regulatory System (EARS), SRS, Royalties Online, and WAPIMS are taken into account and all

accessible when factoring in the solution functionality required to achieve end to end processing

- Record keeping requirements are easily retrievable
- Seamless data sharing between internal and external stakeholders
- Better communication with stakeholders on petroleum matters
- The ability to generate more sophisticated and informative reports on ongoing and completed assessments.

It is envisaged that hardcopy approval documents will only be required at the end of the process to meet legislative requirements.

Systems integration

This initiative will create efficiencies and reduce assessment timeframes, costs and duplication by eliminating the need to go into separate process systems within the department dealing with the one application approval process.

The gateway is complimentary to the DMIRS Systems Integration Strategy and will be made available on a company by company basis to assist self-management initiatives, essential for petroleum automated recording and reporting.

It should also be noted that this pilot project is not only for petroleum matters in DMIRS, but is also a roadmap to achieving the same goal for mining information.

Gorgon Carbon Dioxide Injection Project Regulatory compliance

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Strategic Resource Management Team
Petroleum Division



Chevron personnel conducting a seismic survey on Barrow Island

Introduction

The Gorgon Project sailed its first LNG cargo in March 2016, started the supply of domestic gas to the Western Australia market in December 2016, and commenced the operation of third of the three LNG trains in March 2017. Commissioning of the last major part of the Gorgon Project – the Gorgon Carbon Dioxide (CO₂) Injection Project is well under way. This will bring into operation the world's largest carbon capture and storage (CCS) project, more than three times bigger than Shell's Quest Project, which is the largest CCS project currently in operation. When fully operational, the Gorgon CO₂ Injection Project will inject between 100-120 million tonnes of CO₂ into a saline aquifer at approximately 2 to 2.5 km depth beneath Barrow Island. It will cut the greenhouse gas emissions from the entire Gorgon Project by approximately 40 per cent.

Carbon dioxide removed from the gas at the Gorgon LNG processing plant will be transported by a 7.3 kilometre pipeline to three injection well centres, and injected

into the Dupuy Formation. Figure 1 shows the location of the CO₂ injection infrastructure on Barrow Island, comprising the Gorgon CO₂ data well drilled in 2006 (which has been converted to a reservoir surveillance well), nine CO₂ injection wells, six pressure management wells (four water producers and two water injectors), and two reservoir surveillance wells. Detailed information about the project can be found on the websites of the Department of Mines, Industry Regulation, and Safety (DMIRS) (Reference 1) and Chevron (Reference 2).

Over the past 15 years the State Government has conducted due-diligence studies to ensure that the project is based on a sound understanding of the various geotechnical parameters, robustness of the resulting predictive models and appropriateness of the monitoring and mitigation plans. As the project is about to enter the operational (injection) phase, the government's role has shifted to ensuring regulatory compliance of the project.

In the decade since the release of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Carbon Dioxide Capture and Storage in 2005, carbon capture and storage has been recognised as a major climate change mitigation option, and included in all major global greenhouse gas reduction scenarios. In November 2006, the Commonwealth Government of Australia pledged \$60 million to the proposed Gorgon CO₂ Injection Project, as funding support for a commercial-scale demonstration project.

An overview of the project's regulatory regime and compliance requirements

Barrow Island Act 2003

When Gorgon Joint Venturers (GJV) submitted the application for development of the Gorgon gasfield and disposal of CO₂ at Barrow Island in 2003, an Environmental, Social and Economic (ESE) review was conducted. At that time it was recognised that no legislation was available for approving the proposed CO₂ injection project. This review accelerated the development of the first CCS related legislation in the world, the *Barrow Island Act 2003*

(BIA). Subsequently, 'in-principle' approval was given for the Gorgon LNG plant and disposal of CO₂ from the Gorgon Project to be based at Barrow Island. BIA adopted a project-specific approach to the regulation of CCS activities associated with the Gorgon Gas Project; it also covered the gas processing component of the Gorgon Project on Barrow Island among other issues as described in Schedule 1 (Gorgon Gas Processing and Infrastructure Project Agreement 2003 between the State and the GJV) of the BIA.

Section 11 of BIA relates to the transportation of CO₂ from the LNG plant to the injection wells on Barrow Island. It amended the *Petroleum Pipelines Act 1969* (PPA) to include CO₂ resulting from gas processing on Barrow Island in the definition of 'petroleum' in section 4(1) of PPA. The definition of 'pipeline' in section 4(1) of PPA was also amended to include pipelines for conveyance of CO₂ on Barrow Island for the purpose of disposal of CO₂ in an underground reservoir or other subsurface formation. Section 13 of BIA relates to the underground disposal of carbon dioxide. Carbon dioxide injection into a geological formation requires the approval of the Minister responsible for the Barrow Island Act. A penalty of \$50,000 can be imposed for breach of this requirement.

BIA Section 13 – Approval to inject

On 14 September 2009, the Minister for State Development in his capacity as the Barrow Island Act Minister signed the *Barrow Island Act 2003* (WA) Section 13 – Approval to dispose of carbon dioxide by injection into subsurface formation (Section 13 Approval), subject to several conditions and restrictions. These conditions established the regulatory regime under which the project was to operate.

The Section 13 Approval was granted subject to the Collateral Deed between the WA Government and the GJV, and a CO₂ Disposal

Management Plan (CDMP) and its periodic revisions. The GJV agreed in the Collateral Deed to indemnify the State against all third party claims arising out of or in connection with the CO₂ Injection Project until site closure. The Collateral Deed also identified the closure process for the CO₂ injection site following the cessation of injection.

The Section 13 Approval sets the requirements regarding the composition of injected CO₂, and injection volume and rate. The conditions state that the injected CO₂ will contain at least 97 per cent of

carbon dioxide; the average annual daily injection rate is not to exceed 9.2 Mm³/d, and daily injection rate must not exceed 9.9 Mm³/d. The operating injection rates, however, will be set to that reservoir and seal integrity is ensured at all times.

The Section 13 Approval requires the CO₂ project to comply with other legal requirements. In particular, it requires the GJV to construct, operate, monitor and maintain the injection and monitoring facilities (pipeline, wells and ground beds) in accordance with the legal requirements of the *Petroleum Pipelines Act 1969*,

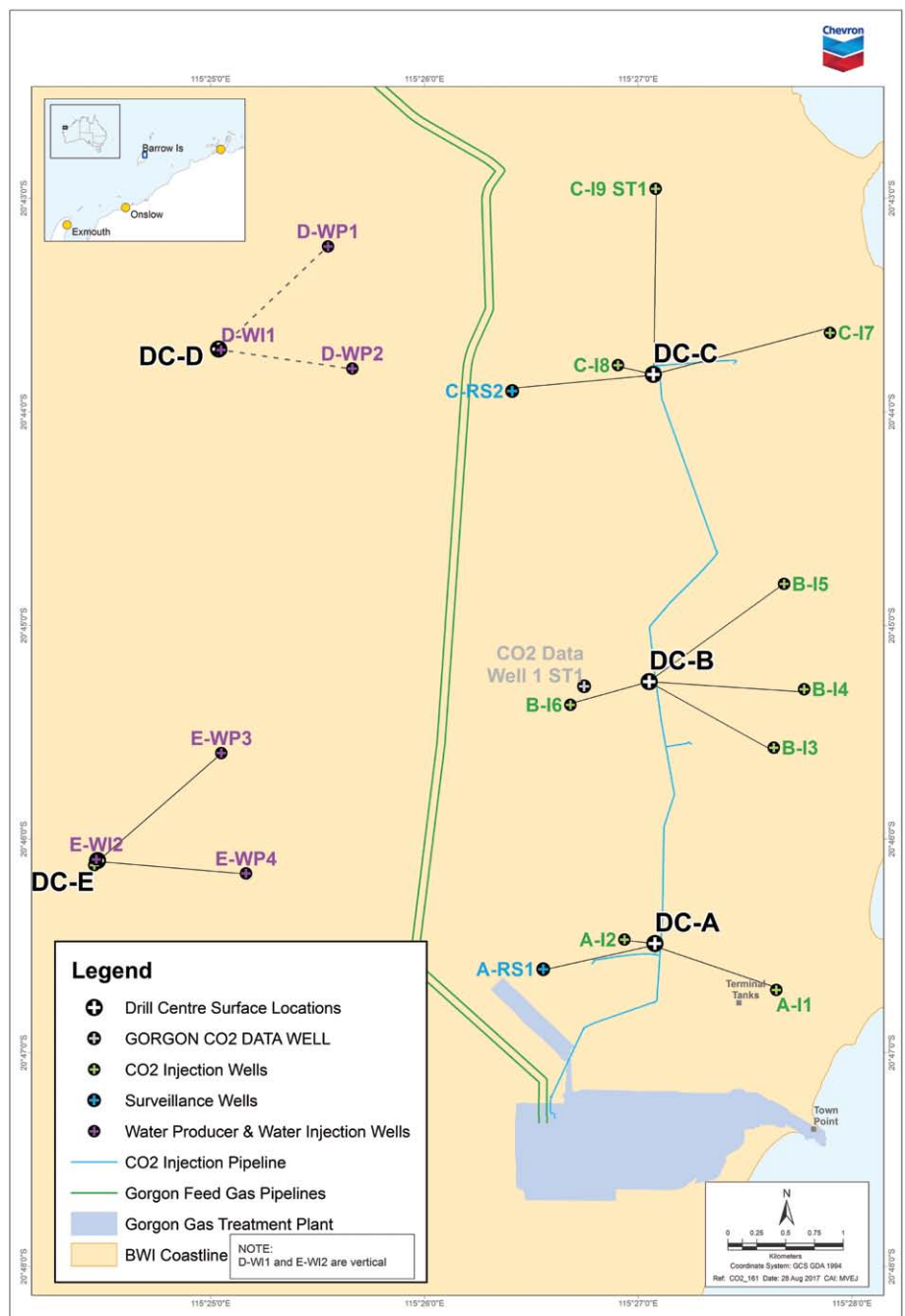


Figure 1: Location of wells and drill centres for the Gorgon CO₂ Injection Project

Environmental Protection Act 1986, Land Administration Act 1997, and Dangerous Goods Safety Act 2004 as illustrated in Figure 2.

The Section 13 Approval requires that the injection operations do not interfere with the rights of navigation, fishing, and the conservation of the resources etc., and that the GJV pay an annual fee to recover State's cost and expenses in regulating the CO₂ Injection Project.

Other conditions include provisions for annual internal audit, annual compliance and operational reports, and incident reporting. It also covers administrative conditions such as failure to comply with the conditions and revocation.

Environmental approval

The Gorgon CO₂ Injection Project environmental approvals are covered by the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and *Western Australia's Environmental Protection Act 1986*.

The process for environmental approvals to undertake the Gorgon Project on Barrow Island commenced in February 2003 and concluded in August 2009 with the grant of the approvals subject to several conditions.

In 2003, an ESE review on the proposed Gorgon Gas Development, including CO₂ injection, on Barrow Island was conducted. The review found that the injection of CO₂ on Barrow Island to be technically feasible and not cost prohibitive. In 2005, an Environmental Impact Assessment (EIA) which included the injection project was carried out, the outcomes of which satisfied State and Federal legislation. It was the first EIA of a large scale greenhouse gas storage project in the world. This process included a significant amount of public review and comment. In 2008, due to the Gorgon Project expansion from two trains to three trains, a second round EIA was conducted. Consequently, an approval under the *Environmental Protection Act 1986* (WA) was granted to the

Project in August 2009 subject to conditions outlined in Ministerial Statement 800.

Ministerial Statement 800, published on 10 August 2009, requires that the injection system is capable of disposing by underground injection 100 per cent of the volume of CO₂ removed during routine gas processing operations. Additionally, the GJV are required to implement all practicable means to ensure that at least 80 per cent of CO₂ removed during gas processing operations is injected over a five year rolling average.

PL 93 and land tenure

In December 2011, pipeline licence PL 93 authorising the construction of a pipeline for the conveyance and disposal of CO₂ was approved under PPA. This included the construction of 19 wells for injection, reservoir surveillance and pressure management in accordance with the Schedule of Onshore Petroleum Exploration and Production Requirements 1991.

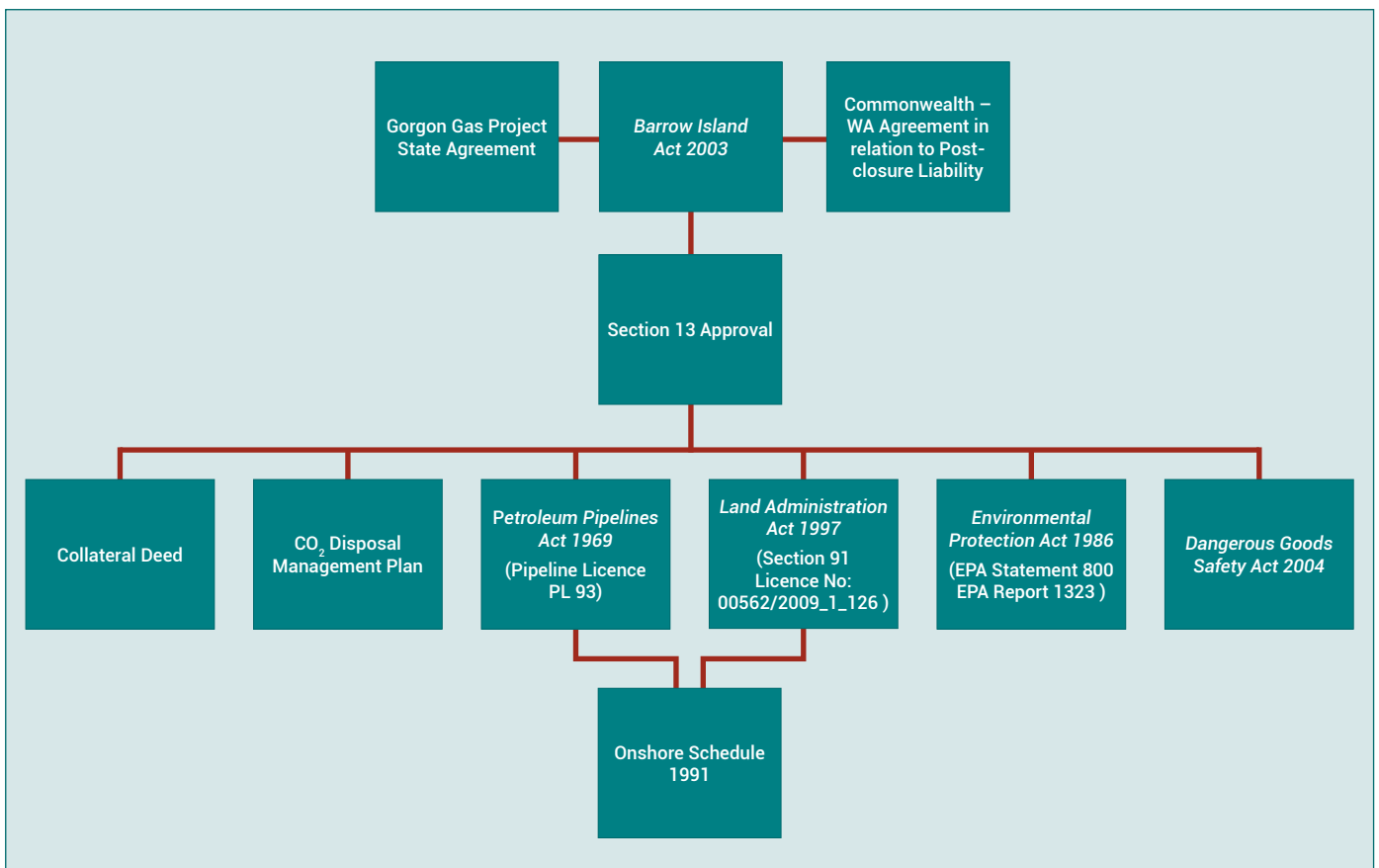


Figure 2: Gorgon CO₂ Injection Project regulatory regime under WA legislation



Photo © Chevron Australia

Subject to PL 93, the land tenure required (leases, licences and easements) for the construction, operations and monitoring of all project infrastructure was granted under the *Land Administration Act 1997* in accordance with the BIA.

Indemnity and long-term liability

On 13 February 2015, an agreement was signed between the Commonwealth of Australia and the State of Western Australia to indemnify the State of Western Australia for a portion of the long-term common law liability in respect of CO₂ injected under Barrow Island pursuant to the Gorgon Gas Processing and Infrastructure Project Agreement 2003. The agreement came into effect on 8 May 2015 after the passing of the BIA Amendment Bill that provides for the GJV to be indemnified for long-term post closure liability resulting from the underground disposal of CO₂. Under this agreement, the Commonwealth will indemnify WA against 80 per cent of the liability under the State indemnity, which is limited to the scope of the Common Law Liability of the GJV to independent third parties arising after the liability assumption date.

Before the liability can be transferred, the Commonwealth and State Governments must

be satisfied that the injected CO₂ plume is behaving as predicted and there is no significant risk of leakage, or a significant adverse impact on the geotechnical integrity of the reservoir, environment or other geological resources, and human health and safety. The conditions of liability transfer require that there is no injection of CO₂ for at least 15 years other than approved plume monitoring and management activities after the cessation date, which is the date the GJV notify the Minister responsible for the Barrow Island Act that the injection of CO₂ has ceased permanently.

Summary and way forward

Regulating the Gorgon CO₂ Injection Project on Barrow Island is very complex and is carried out through multiple State and Commonwealth legislation. Western Australia is the sole regulator for the Gorgon CO₂ Injection Project on Barrow Island, except for the requirements to comply with the provision of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The *Barrow Island Act 2003* is the key legislation governing the Gorgon Project, and the Gorgon CO₂ Injection Project approvals are covered under the *WA Petroleum Pipelines Act 1969*, *Barrow Island Act*

2003, *Environmental Protection Act 1986*, *Land Administration Act 1997* and *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

The government is now focused on ensuring regulatory compliance of the project as the project is about to enter the operational (injection) phase. DMIRS is responsible for monitoring the performance of the Gorgon CO₂ sequestration project operations over the long term whilst ensuring compliance with the approval conditions, for example, the CO₂ plume is behaving as expected, and GJV's monitoring and mitigation plans are effective.

DMIRS is ensuring appropriate data management systems are in place for storing the large-scale monitoring data from the project and facilitating data sharing between the State and Commonwealth Governments under the intergovernmental agreement in relation to sharing of post-closure long-term liability.

References

Gorgon CO₂ Injection Project, <http://www.dmp.wa.gov.au/Petroleum/Gorgon-CO2-injection-project-1600.aspx>

Carbon Dioxide Injection, <https://www.chevronaustralia.com/our-businesses/gorgon/carbon-dioxide-injection>



WESTERN AUSTRALIA

Opportunities to Explore – BIDS INVITED FOR ACREAGE

PETROLEUM ACREAGE

Onshore Canning Basin

Interest in the Canning Basin has revived significantly in recent years, with new oil plays discovered at Ungani 1 and Ungani Far West 1. There are five release areas in the central and southern Canning Basin. The southern two release areas are mainly in the Kidson Sub-basin whereas the northern three release areas are mainly in platform and terrace tectonic elements.

Release area size ranges from 5324 km² to 6667 km². These areas may have subsalt (Ordovician) and suprasalt (Devonian) plays.

'The best remaining frontier prospects lie ... in older basins with a high preservation potential such as intracratonic basins with evaporite seals.'

Duncan S Macgregor, BP, 1996

**Bids close on Thursday 1 February 2018.
Applications can only be made online.**

Acreege release information became available from the department's website from the gazettal date of 16 May 2017:
www.dmp.wa.gov.au/acreege_release

Release information includes prospectivity of release areas and of the Canning Basin, available data listings, work program bid assessment guidelines, land access and environment considerations, and instructions regarding how to make a valid application for an Exploration Permit. This information is also available on a USB.

GEOHERMAL ACREAGE

Acreege is available for the whole of the State not covered by permits or applications. Application is by a Geothermal Special Prospecting Authority (GSPA) with Acreege Option (AO).

Companies are invited to apply for areas with sizes up to 160 5'x5' graticular blocks.

Companies interested in geothermal acreege are allowed to bid for multiple areas and are expected to drill at least one well during the first two years of obtaining a geothermal title.

Geothermal acreege information is available from DMIRS on the web at:
www.dmp.wa.gov.au/acreege_release



**BIDS CLOSE
1 FEBRUARY
2018**

Photo Courtesy of Kimberley Oil

**FURTHER
INFORMATION:**

RICHARD BRUCE, Petroleum Division, Department of Mines, Industry Regulation and Safety
Telephone: +61 8 9222 3314 • Email: petroleum.acreege@dmirs.wa.gov.au

www.dmp.wa.gov.au/acreege_release

CSIRO northern Perth Basin baseline characterisation study

Sunil Varma
Principal Petroleum Technologist
Petroleum Division



CSIRO, in collaboration with the University of Western Australia and four onshore gas explorers (Latent Petroleum, AWE Limited, Origin Energy and Norwest Energy), and the WA Department of Mines, Industry Regulation

and Safety (DMIRS) have established a coordinated research program into methods of establishing baseline values of environmental indicators for the development of onshore gas resources.

The research program is considering monitoring aspects in three environmental domains: shallow sub surface, surface and near-surface atmosphere in the region between Gingin and Dongara north of Perth forming



Photo © CSIRO

CSIRO 4WD with the mobile methane sensing equipment

part of the northern Perth Basin geological area. The studies carried out during 2015 and 2016, included atmospheric methane measurements, soil gas (methane) flux around the Warro gasfield, and an assessment of groundwater levels and chemistry of the key aquifers.

Figures 1 to 5 depict the mobile survey data collected in the northern Perth Basin study area. Methane concentrations and wind direction and speed are shown on each map for the day of the survey.

The atmospheric methane surveys, covering approximately 2300 km, found that the majority of the methane data across the area lie close to the mean value of 1.77 parts per million (ppm) similar to the methane levels from the latest greenhouse gas data from one of the cleanest air sources in the world at Cape Grim in Tasmania available at <http://www.csiro.au/greenhouse-gases/>.

Higher concentrations of atmospheric methane (up to 4.5 ppm) were measured downwind of the Dongara Processing Facility (DPF). According to CSIRO, the measurements were taken early in the morning, before the wind had risen, the source has not been identified and may be due to higher density methane settling overnight.

The measurements were repeated in the afternoon and methane concentrations had returned to background levels. DMIRS is aware that the facility has been mostly on temporary shut-in status after these measurements were taken and is planned to be put on care and maintenance this year.

Atmospheric methane measurements taken around well sites were consistent with the low background levels. Atmospheric methane

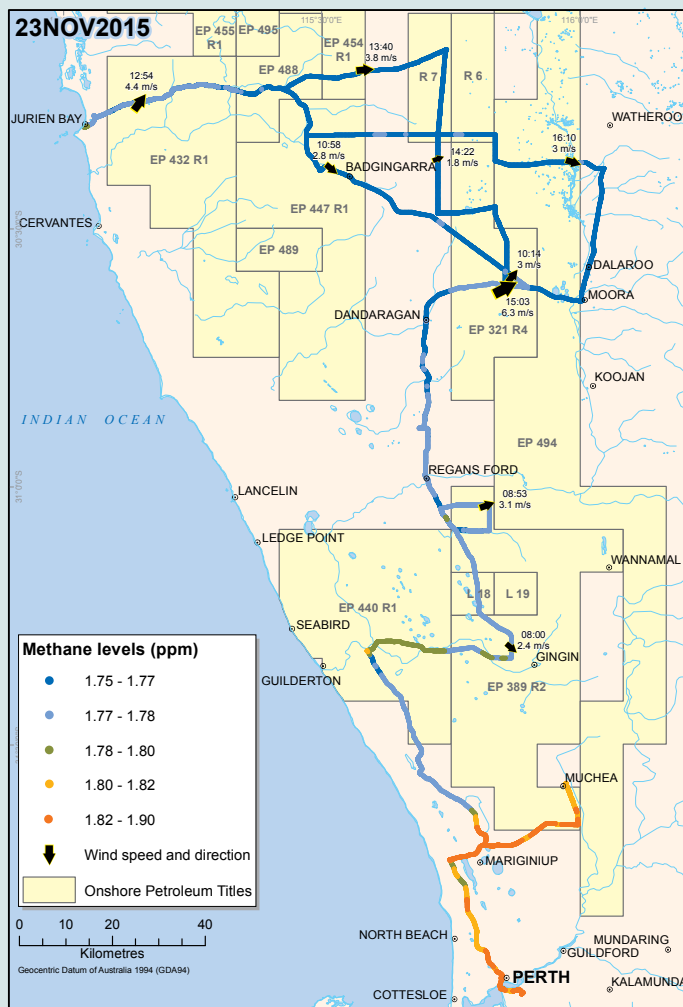


Figure 1. Mobile survey data collected on 23 November 2015

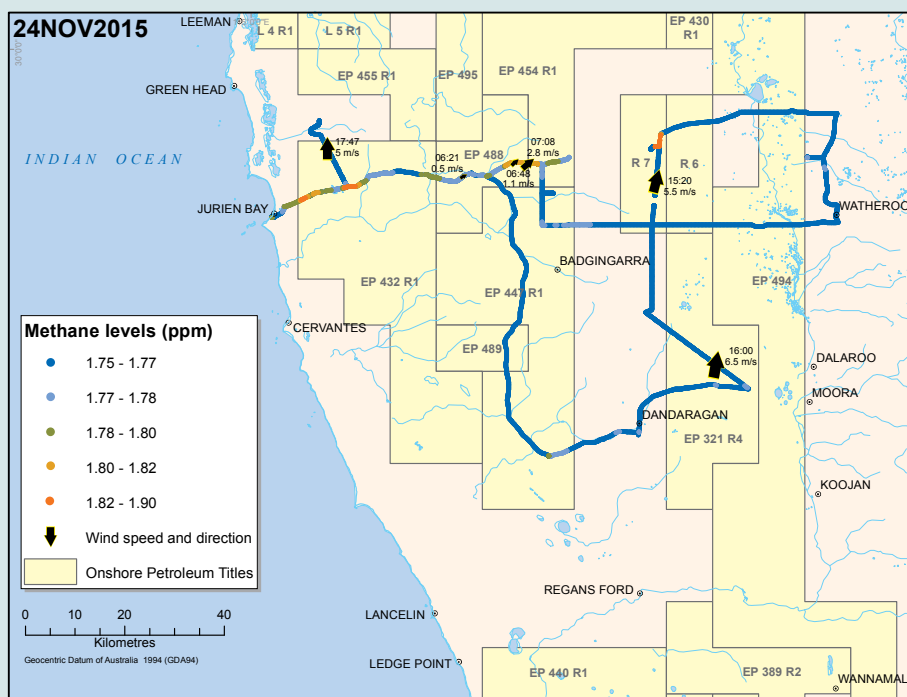


Figure 2. Mobile survey data collected on 24 November 2015

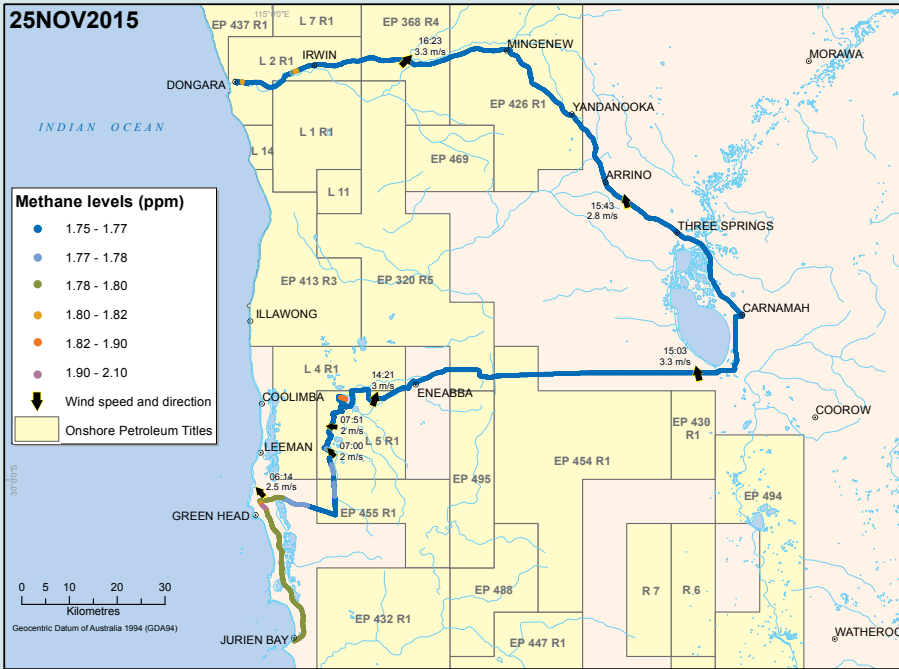


Figure 3. Mobile survey data collected on 25 November 2015

concentrations recorded across the region were too low to carry out any isotopic analysis to investigate the sources of methane.

Soil gas (methane) flux surveys were carried out at 40 sites around the Warro gasfield, which included sites near wells that were hydraulically stimulated, as well as some 'control' sites at a distance from the field for comparison. Two sets of surveys were conducted at the Warro field, neither of which detected any anomalous methane flux at the sites. Future surveys may include a larger area across the northern Perth Basin.



Soil methane flux measuring equipment used by the CSIRO

Titles in Western Australia

Henrietta Wong and Alyssa Carstairs
Petroleum Titles Team
Petroleum Division

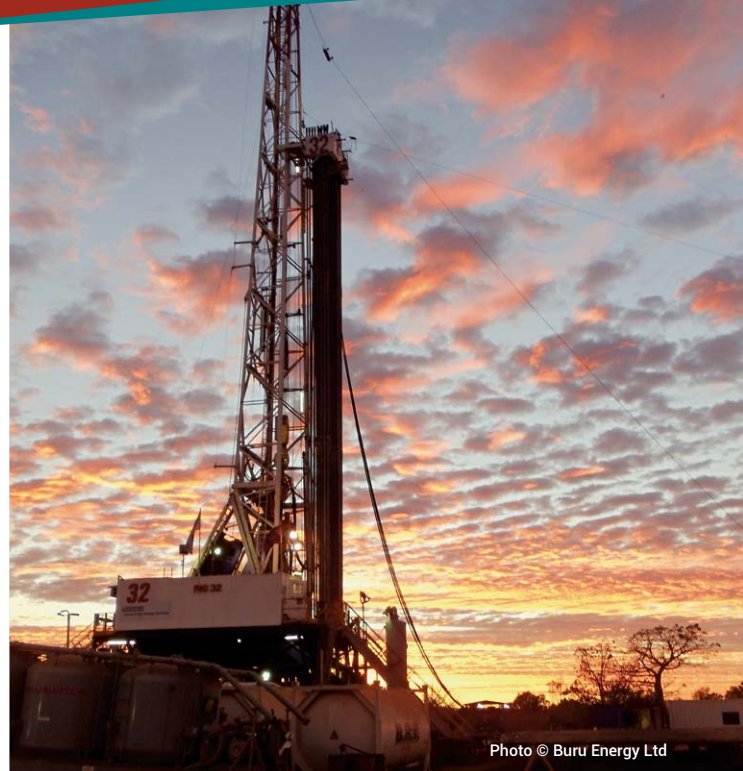


Photo © Buru Energy Ltd

The Petroleum Tenure and Land Access Branch ('PTLAB') of the Petroleum Division of the Department of Mines, Industry Regulation and Safety (DMIRS) is assigned responsibility of the management of petroleum titles in Western Australia, and the assessment and processing of title applications in accordance with petroleum legislation.

The Titles Team ('Titles') within PTLAB assesses applications submitted under the *Petroleum and Geothermal Energy Resources Act 1967*, *Petroleum (Submerged Lands) Act 1982*, and *Petroleum Pipelines Act 1969*. Recommendations and advice are provided to the Minister (or his delegate) to inform decisions on key petroleum title matters, such as:

- Title grants (eg grant or renewal of petroleum exploration, retention or production titles)
- Ongoing administration of titles (eg dealings and transfers of titles, and receipt of application, registration and annual fees)
- Compliance applications (eg variations to titles conditions and extensions of title terms)

- Cessation of titles (eg surrenders or cancellations).

Titles' purpose is to provide consistent, timely and compliant regulatory and advice services for titles and application management. Transparency and consistency is achieved through efficient and timely processing of applications and the maintenance of the Titles Register.

Applications are received through the online Petroleum and Geothermal Register ('PGR') with applicants required to provide sufficient information to meet the minimum criteria established by legislation, and to have regard to relevant published guidelines, policies, and explanatory notes. The purpose of guidelines, such as the 'WA Petroleum and Geothermal Guideline for Exploration Permit Management', is to serve as a mechanism for facilitating the receipt of applications that meet the Petroleum Division's expectations the first time, and to inform and provide consistency and transparency of decision making against the Minister's discretionary powers under legislation.

Security of tenure given by the legislation provides for title holders to

negotiate and obtain land access. The complexity of land access as a factor of assessment necessitates early and regular engagement with stakeholders such as Ministers, other government agencies, industry, and community representative groups. The Petroleum Division monitors title holders' good corporate governance responsibility for land access, including:

- Compliance with the *Native Title Act 1993* prior to the grant of titles
- Maintenance of sufficient land tenure for ongoing access to sites where petroleum activities such as wells or surveys are being undertaken, or pipelines or processing facilities are being constructed and utilised
- Consideration of land owners and occupiers and other interested parties affected by these activities
- Seeking consent to access reserved lands for the purpose of conducting petroleum operations.

A whole-of-government approach to approvals is necessary to ensure the Division's core functions can be managed. In pursuing its purpose, Titles engages with internal and

external stakeholders to contextualise diverse views and interests to enable sound decision making in accordance with legislation. Internal stakeholders such as the Petroleum Resources, Environment, Land Access, Resources Safety and Strategic Business Development teams support Titles by providing timely advice and recommendations in respect of technical, land access, financial, strategic and geospatial considerations, which are essential to ensuring decision making is accountable and transparent. Through regular communication with its stakeholders, Titles aims to achieve a shared understanding of issues.

The Petroleum Division, through the Minister's delegate, is also involved in decision making in Commonwealth waters offshore of Western Australia, as the State representative of the Joint Authority given responsibility for making certain decisions under the *Offshore Petroleum Greenhouse Gas Storage Act 2006*.

Should you require any information regarding petroleum titles management or applications, please refer to

the department's website www.dmirs.wa.gov.au or email petroleum.titles@dmirs.wa.gov.au.

Western Australian Petroleum Titles Summary: March 2017 to July 2017

The ownership of Australia's petroleum resources is vested in the Crown, as is the right to provide access to those resources. For petroleum resources within the limits of Western Australia that ownership is administered by the Government of Western Australia. Through legislation, the State Government provides an equitable system by which the rights to explore for, and produce, petroleum resources are awarded to the private sector.

Petroleum titles do not, of themselves, authorise exploration, appraisal or development activities. The exercise of the rights granted by a petroleum title is subject to the requirements of legislation, specific conditions endorsed on the title, and all other relevant laws of the land. Primarily, the work to be undertaken will need to be carried

out with due regard to public and worker safety, protection of the environment and the interest of others who also have an interest in the land.

Petroleum exploration and development activity in Western Australia and its adjacent waters is subject to three Acts:

Petroleum and Geothermal Energy Resources Act 1967 (WA):

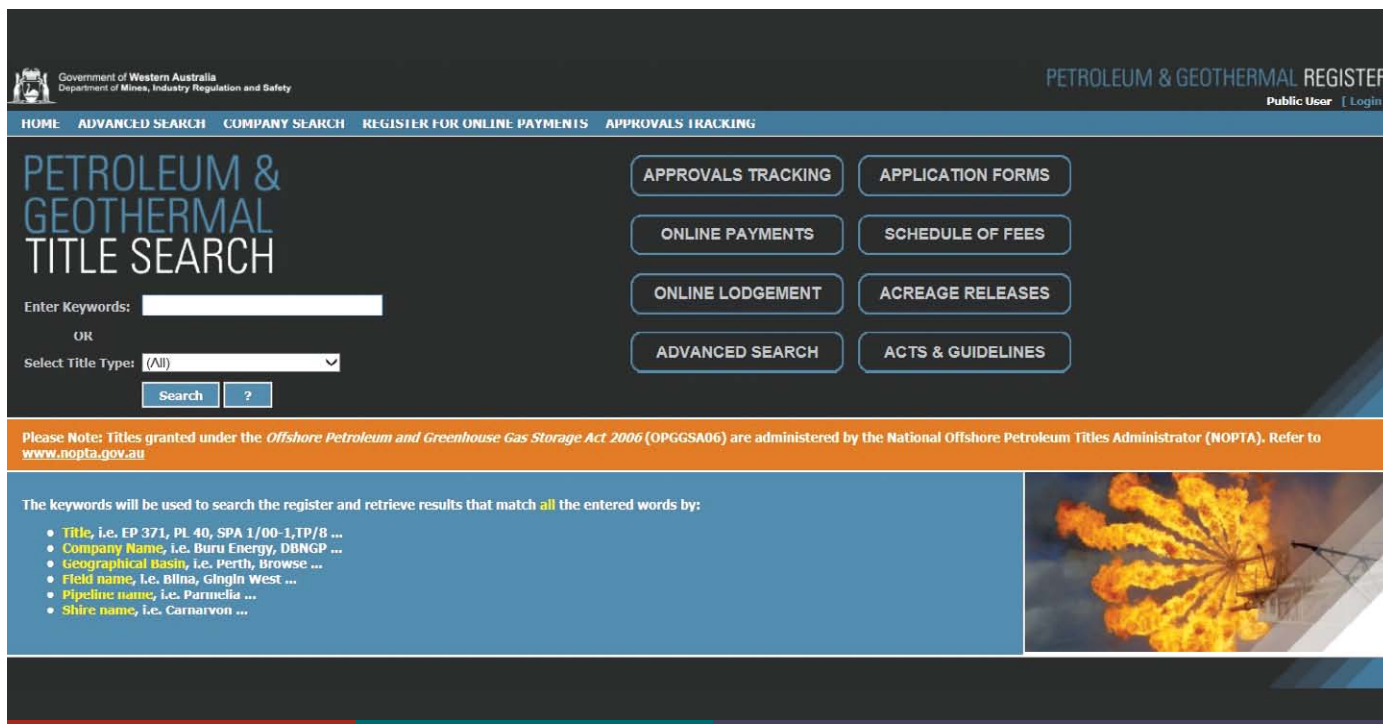
Covers all onshore areas of the State, including its islands, and in certain circumstances, areas of submerged lands adjacent to the State.

Petroleum (Submerged Lands) Act 1982 (WA):

Applies to Western Australia's territorial sea, designated as the adjacent area, (three nautical miles seaward of the baseline), including the territorial sea around State islands, and under some circumstances, some pre-existing titles in the State's internal waters.

Petroleum Pipelines Act 1969 (WA):

Applies to petroleum pipelines in onshore areas.



Homepage of the Petroleum and Geothermal Register (PGR)

March 2017

One petroleum title was renewed in March 2017.

Title:	Petroleum Retention Lease R 3 (Renewal 2)
Legislation:	<i>Petroleum and Geothermal Energy Resources Act 1967</i>
Registered Holder(s):	OIL BASINS LIMITED
Commencement:	2 March 2017
Term:	5 years
Location:	Northern Carnarvon Basin
Area:	One graticular block Approximately 80 km ²

One petroleum title was surrendered in March 2017.

Title:	Petroleum Special Prospecting Authority SPA 20 AO
Legislation:	<i>Petroleum and Geothermal Energy Resources Act 1967</i>
Registered Holder(s):	GULLIVER PRODUCTIONS PTY LTD
Surrendered:	17/03/2017
Location:	Canning Basin
Area:	Six graticular blocks Approximately 491 km ²

April 2017

No petroleum titles were granted or renewed in April 2017.

No petroleum titles ceased in April 2017.

May 2017

One petroleum title was renewed in May 2017.

Title:	Petroleum Retention Lease TR/3 (Renewal 3)
Legislation:	<i>Petroleum (Submerged Lands) Act 1982</i>
Registered Holder(s):	QUADRANT NORTHWEST PTY LTD
Commencement:	15 May 2017
Term:	5 years
Location:	Northern Carnarvon Basin
Area:	Two graticular blocks Approximately 32 km ²

No petroleum titles ceased in May 2017.

June 2017

No petroleum titles were granted or renewed in June 2017.

No petroleum titles ceased in June 2017.

July 2017

No petroleum titles were granted or renewed in July 2017.

No petroleum titles ceased in July 2017.

Overview of domestic gas supply in Western Australia

Marnie Leybourne, Jianhua Liu, Sunil Varma
Resources Branch
Petroleum Division

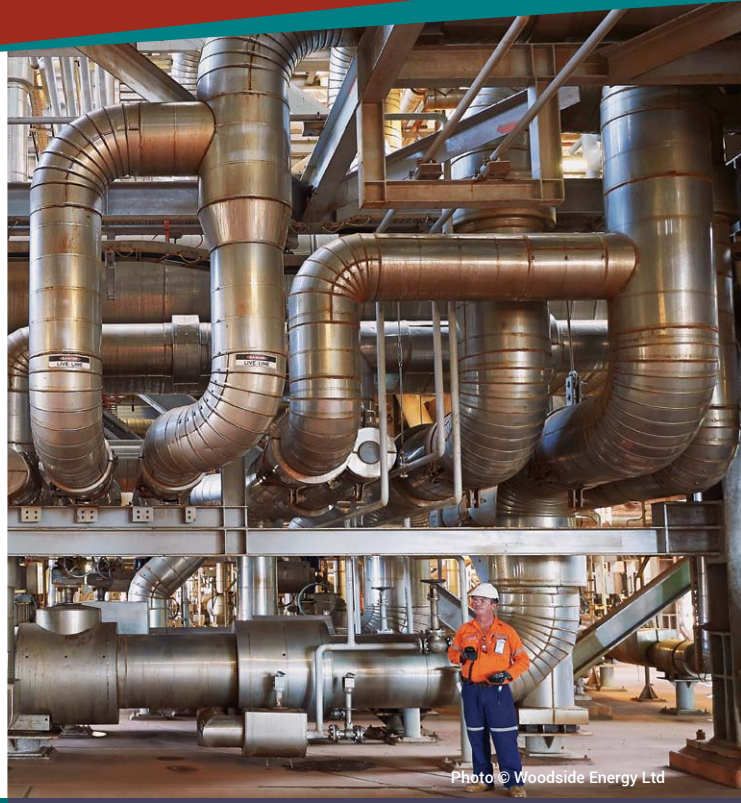


Photo © Woodside Energy Ltd

Karratha Gas Plant

Introduction

Western Australia has been producing natural gas since 1971 with the first field located at Dongara in the Mid West. Domestic consumption of gas has steadily increased over this time, with current domestic use at just over 1000 terajoules a day (TJ/d). Despite historical trends, future growth in demand for domestic gas is expected to remain relatively flat over the next decade.

Natural gas is a petroleum product. In Western Australia, it is either sold directly to the domestic market or cooled and liquefied to be exported overseas as liquefied natural gas (LNG). LNG is currently Western Australia's second most valuable export after iron ore.

While Western Australia remains highly prospective with large contingent resources both offshore and in unconventional sources from shale and tight rocks onshore, the conventional reserves that have been proved up as being commercially viable are starting to decline, affecting both domestic gas and LNG exports unless further development occurs.

Western Australia's domestic gas policy

LNG producers favour gas exports over the domestic market and control 97 per cent of gas reserves in Western Australia and off its coastline. The State Government's domestic gas policy aims to secure WA's long-term energy needs by ensuring LNG producers also make gas available to the domestic market.

The State's domestic gas policy is administered by the Department of Jobs, Tourism, Science and Innovation (JTSI) and requires LNG exporters to make gas equivalent to 15 per cent of their LNG exports available to the domestic market. LNG exporters comply as a condition of project approval by reserving gas, developing or obtaining access to the domestic gas supply infrastructure and marketing gas to consumers.

The policy provides for gas prices and contract terms to be determined in the market. It does not force producers to supply gas if the market is well supplied for a time. Unsold gas is reserved for when market conditions improve.

The Department of Mines, Industry Regulation and Safety (DMIRS) provides

information and advice to JTSI on matters relating to gas reserves and resources, particularly in relation to adequacy of the reserves and resources for domestic gas supply.

Domestic gas supply facilities

Currently, there are nine domestic gas processing facilities in Western Australia, where gas from both onshore and offshore fields are processed. The total processing capacity of these plants is about 1600 TJ/d, well above the current consumption level of around 1000 TJ/d. Table 1 lists gas processing plants and their nameplate processing capacity.

The Karratha Gas Plant – the North West Shelf Project's (NWS) domestic gas processing facility – is the largest and one of the oldest facilities in the State. As a condition of its most recent LNG export approval, the NWS Joint Venture has agreed to maintain access to domestic gas infrastructure in line with a domestic gas commitment of around 100 TJ/d. Access to domestic gas capacity above this volume would be necessary if third party LNG exporters toll gas through the NWS.

TABLE 1: DOMESTIC GAS PROCESSING FACILITIES IN WESTERN AUSTRALIA

Domestic gas processing facility	Nameplate capacity (TJ/d)	Operator	Basin
Beharra Springs	19.6	Origin	Perth
Devil Creek	220	Quadrant	Carnarvon
Dongara	7	AWE	Perth
Gorgon Phase 1*	156	Chevron	Carnarvon
Karratha Gas Plant (NWS)	630	Woodside	Carnarvon
Macedon	200	BHP	Carnarvon
Red Gully	10	Empire Oil and Gas	Perth
Varanus Island	360	Quadrant	Carnarvon
Wheatstone**	200	Chevron	Carnarvon
Xyris	10	AWE	Perth

*The full supply capacity of the Gorgon domestic gas facility is 300 TJ/d.

**Commissioning of the Wheatstone domestic gas facility is expected in 2018.



Photo © Woodside Energy Ltd

Aerial view of Karratha Gas Plant



Photo © Woodside Energy Ltd

Pluto LNG Plant

Domestic gas use and demand forecast

Gas was first produced in Western Australia in 1971 at Dongara. By 1990, domestic gas demand was around 400 TJ/d and this has steadily climbed to just over 1000 TJ/d. Western Australia's actual domestic

gas supply and future demand forecasts are provided in Figure 1.

Demand forecasts are based on estimates by the Australian Energy Market Operator (AEMO). AEMO expects slight growth in domestic gas demand over the next decade (average annual growth of 0.1 per cent) with

demand from existing large users, such as mineral processing facilities and gas powered electricity generators, expected to remain flat over this period. Additional gas supply might be required to accommodate a switch from diesel to gas in mining and petroleum operations or a transition from coal to renewables in the State's energy mix.

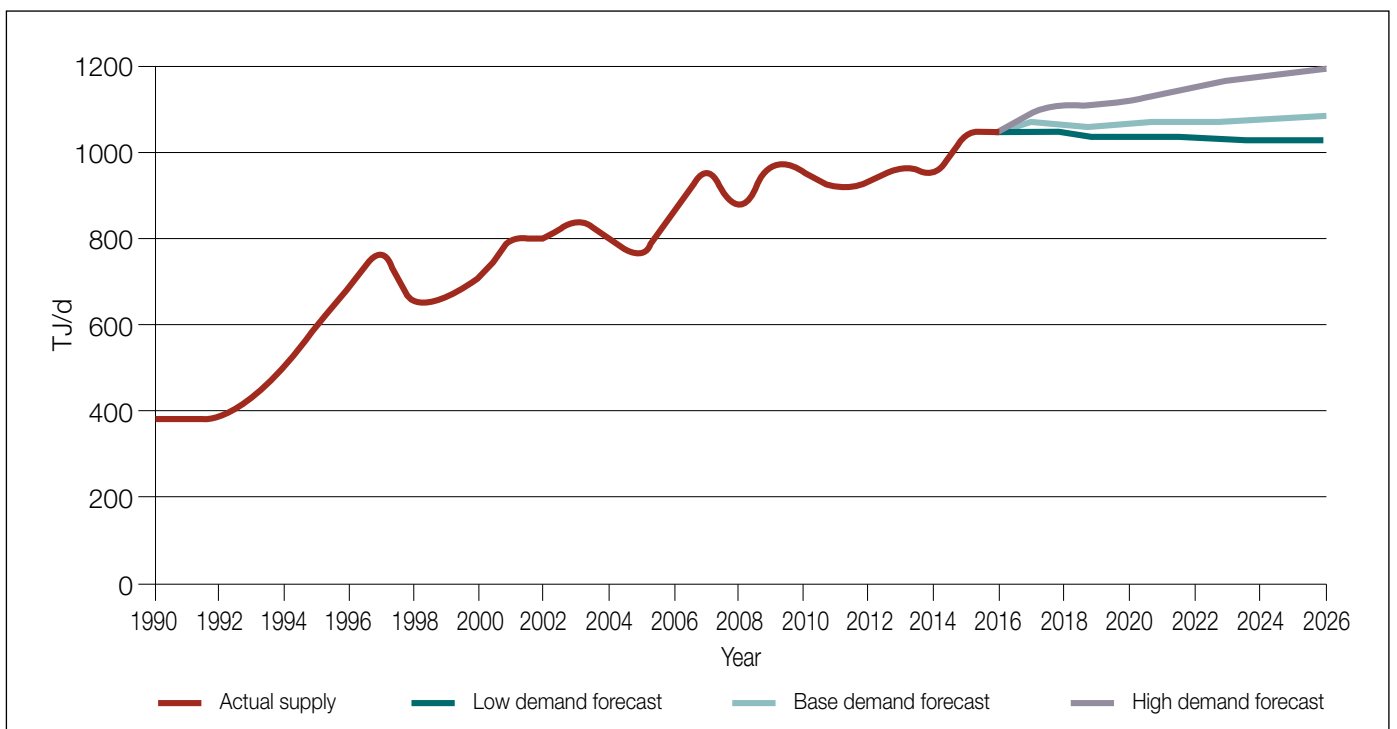


Figure 1: Actual domestic gas supply to 2016 and future demand forecast for WA

Domestic gas supply prospects for Western Australia

Gas is supplied to the domestic market from three categories of sources:

- Offshore LNG projects falling under the domestic gas policy, such as the North West Shelf (NWS) Project, the Gorgon Project and, from 2018, the Wheatstone LNG Project.
- Domestic gas only projects in offshore Commonwealth waters, such as Macedon, John Brookes, Halyard and Reindeer.
- Domestic gas only projects from onshore and offshore fields under Western Australian jurisdiction, such as Waitsia, Beharra Springs and Red Gully.

The NWS is the largest contributor to Western Australia's domestic gas supply. This is expected to change as the NWS's large domestic gas contracts come to an end in 2020. DMIRS estimates that the domestic gas supply will continue to adequately meet demand until the mid-2020s, due to the NWS supplying gas against its long term domestic gas obligations (100 TJ/d), and Gorgon (300 TJ/d) and Wheatstone (200 TJ/d) starting to deliver against their own domestic gas obligations.

New sources of supply will be required beyond the mid-2020s to meet demand. Additional supply could come from new domestic gas obligations of third party LNG exporters tolling gas

through the NWS; the Pluto LNG project, consistent with its domestic gas commitment; or development of some contingent resources by domestic gas only projects.



Photo © Woodside Energy Ltd.

Aerial view of Pluto LNG loading jetty

Annual awards program showcases environmental, community and safety achievements

Kirsty Moore

Communications and Events Officer
Communications and Marketing Branch



Department of Mines, Industry Regulation and Safety

AWARDS FOR EXCELLENCE

Golden Gecko • Safety & Health
• Community Partnership

Western Australian resources sector operators who are going beyond their regulatory obligations to protect the environment, developing legacy community partnerships and finding innovative safety solutions will be showcased through the prestigious 2017 Awards for Excellence.

The annual Department of Mines, Industry Resources and Safety (DMIRS) awards program now acknowledges three streams of excellence – the Golden Gecko Awards, Community Partnership Awards and, for the first time this year, the Safety and Health Resources Sector Awards.

The 2017 Awards for Excellence Ceremony will be held at the Parmelia Hilton Hotel in Perth on 26 October at 6.00pm with free seminars featuring a selection of case studies from each of the award categories to be held at 2.30pm.

DMIRS Director General David Smith said the awards recognise exceptional advances and innovations throughout the resources sector.

"The awards are designed to encourage higher industry standards to help develop and maintain community confidence in mineral and petroleum activities," Mr Smith said.

"The successful nominees show that the resources sector is able to offer positive outcomes for employees, the community and the environment that extend well beyond the life of an individual mining project."

Safety and Health Resources Sector Awards

The DMIRS inaugural Safety and Health Resources Sector Award recognises individuals, teams and companies that have developed a new initiative or an original solution to specific safety and health problems in the workplace.

The aim is to promote the application of safety and health innovation across the Western Australian resources sector, which may involve new initiatives and leadership which support the safety, health and wellbeing of the workforce.

This could be through the implementation of a new process, procedure, design and/or introduction of innovation or new equipment in response to specific safety and health challenges.

The three award categories include:

- Safety Representatives – Safety and health innovations and leadership by an elected Safety and Health Representative.
- Systems and People – Innovative implementation and/or design of systems or procedures to improve safety, health and wellbeing.
- Engineering – Innovation in maintenance, engineering and/or infrastructure to enhance safety and health.

A total of 28 nominations were received across the three categories with projects ranging from technological solutions for identified problems and improvements in efficiency, to processes that expand on the traditional occupational health and safety considerations for workers.

Golden Gecko Awards for Environmental Excellence

Established since 1992, the Golden Gecko Awards recognise leading practice and innovation in environmental management.

Since the inception of the Golden Gecko Awards, the department has presented 59 Award recipients and 51 Certificates of Merit in acknowledgment of outstanding contributions to developing WA's resources in a responsible manner.

The awards provide an opportunity to share experiences between government, industry and the community, while helping operators to build the reputation of being a responsible corporate citizen with a responsible attitude to the environment.

This year five finalists will be vying for the Golden Gecko Award for environmental excellence. Three of the finalists have a rehabilitation focus, while the other entries include a fauna protection program and a system for reducing the environmental impacts of exploration.

The variety of rehabilitation projects is a reflection of the different environments and types of mines in Western Australia – from sand mining in the Swan Coastal Plain, to Banded Ironstone Ranges in the Mid West and the large scale iron ore mines in the Pilbara. Western Australian miners are demonstrating there can be a balance between mining and nature through successful rehabilitation.

Community Partnership Resources Sector Award

Introduced last year, the Community Partnership Award publicly recognises partnerships between resource companies and communities that surpass the normal obligations and requirements to leave a positive and lasting legacy.

That recognition aims to build the reputation of resources and extractive industry operators that are working closely with communities, or community groups, to understand local concerns and issues, provide constructive outcomes and promote strong guiding behaviour for industry.

The nine successful nominees this year have demonstrated that the resources sector can form meaningful partnerships with community groups that extend beyond the reach and lifetime of a mine.

From the South West to the Kimberley, the projects tackle a range of issues that impact on communities, including cultural awareness, conservation, road safety, education and employment.

Visit the DMIRS website for more information about the awards, or to book tickets to the gala evening and case study sessions at the Parmelia Hilton Hotel on 26 October.

www.dmp.wa.gov.au/About-Us-Careers/Awards-for-excellence-19157.aspx



Community Partnership
Resources Sector Award



GOLDEN GECKO
Awards for Environmental Excellence



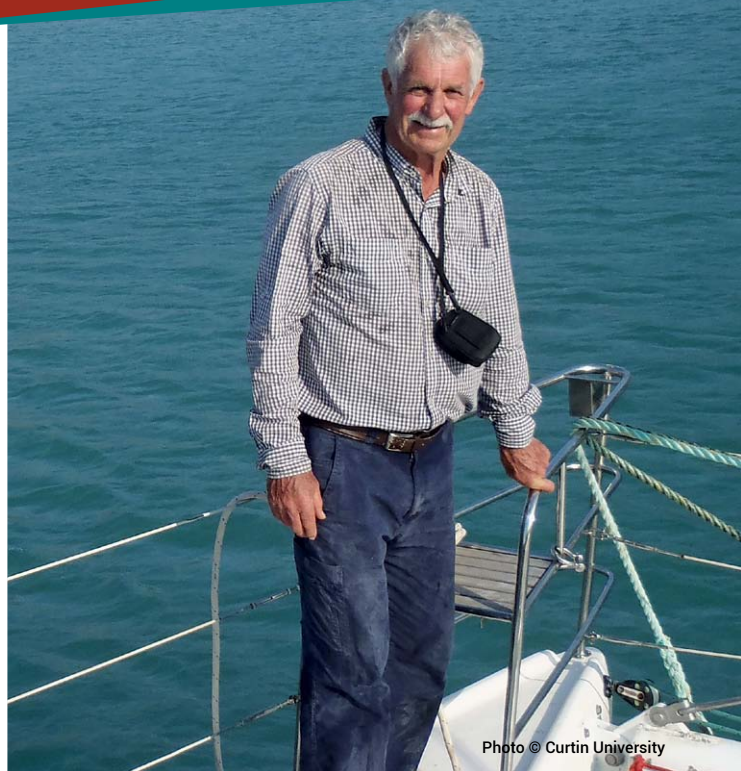
SAFETY & HEALTH
RESOURCES SECTOR AWARDS



2016 Awards for Excellence Ceremony

Professor Lindsay Collins and the Lindsay Collins collection

Josh Williams
Geoscience Support Officer
Perth Core Library, GSWA



Western Australia has a long history of some of the most notable geological icons in Australia and the world.

Some of these icons include the Earth's oldest mineral grains at Jack Hills in the State's Mid West, the earliest evidence of life on Earth with 3.5 billion year old rocks in the Pilbara, 2.5 billion year banded iron formations, the Devonian barrier reef in the Kimberley and the modern stromatolites at Shark Bay.

These geological icons and more can be found in the catalogue of the Perth Core Library. In 2016 the Perth Core Library took receipt of the Lindsay Collins collection of sedimentary and paleontological specimens and samples from Curtin University. This collection is the largest personal collection ever donated to the core library.

The substantial collection includes a one quarter piece (also known as a presentation piece) of the dolomite / sandstone sequence from the Acacia 1 and Santalum 1A wells from the Willara and Goldwyer Formations that

form part of the Canning Basin south of Broome in the Kimberley. The collection also includes the one quarter portion of the Boab 1 well, with samples of the mid-Devonian aged Tandalgoo Sandstone, and sandstones from the Ficus 1 well.

A large part of the collection is comprised of stromatolites from the Shark Bay area and sedimentary samples from the Abrolhos Islands and North West Shelf.

The living stromatolites at Shark Bay are world famous. These modern-day analogues of Archean stromatolites are little altered from their ancestors that were first found 3400 million years ago, and flourished about 2800 million years ago. The stromatolites flourish in a placid super-saline environment.

Stromatolites are renowned as the most extensive and diverse organisms of their kind found anywhere on Earth. They were first discovered by former Executive Director of the Geological Survey of Western Australia (GSWA), Dr Phil Playford, in 1954 and were largely responsible for Shark Bay being listed as a World Heritage Area.

Lindsay Collins was a respected geologist from Western Australia. His research interests at Curtin University encompassed continental shelf sedimentology and substrate mapping, the coral reefs of the Western Australian continental margin, clastic and carbonate petroleum reservoirs, coastal mapping using GIS, tertiary limestone deposition and evolution, stromatolites, and warm and cool water carbonates. His most recent research was focused on Shark Bay, with which he had a long association, and the little known coral reefs of the Kimberley.

Professor Collins also worked in petroleum exploration as a specialist sedimentologist, and as a researcher in continental shelf, coral reef and coastal geology, specialising in carbonate sedimentation.

He investigated coastal vulnerability at Geraldton Port and in the Mid West region, the evolution of stromatolites and thrombolites in coastal embayments and lakes, the growth history of coral reef systems of Australia's western margin, and slope and coastal processes and sediments.

He has been Chief Scientist aboard RV Franklin, a national research vessel, on several instances. Professor Collins had assisted as Assistant Director of CRC LEME, and Head of Applied Geology at Curtin for six years. Up until his death he was a member of the Australia-New Zealand Science

Council for the Integrated Ocean Drilling Program (IODP) and a Project Leader for the WA Marine Science Institution (WAMSI) Kimberley Research Program. A long association with Shark Bay led to the Curtin Shark Bay Project and the Caring for Our Country Shark Bay Project.

Sadly he passed away on 2 September 2015, but his legacy lives on in his personal extensive collection now housed in the Perth Core Library.

To view the Lindsay Collins collection please email corelibrary.requests@dmirs.wa.gov.au



Photo © Curtin University

Professor Lindsay Collins on Adele reef

Petroleum statistics and titles tables

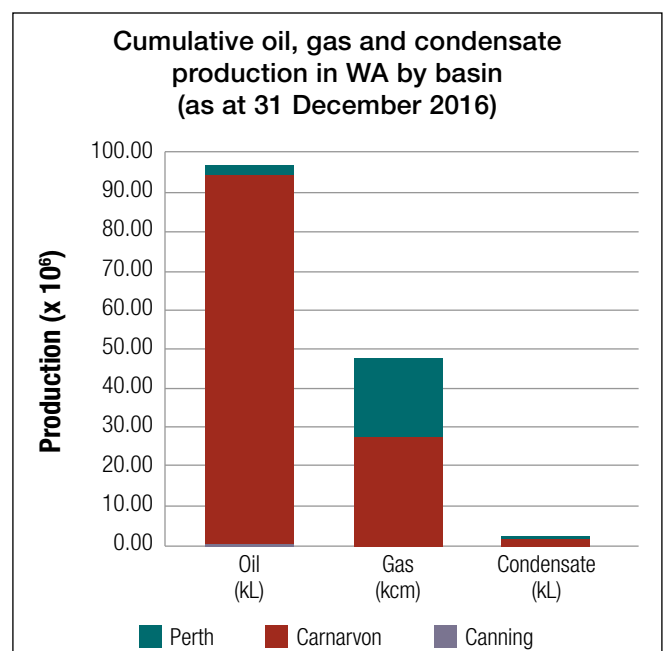
TABLE 1. WESTERN AUSTRALIA'S ANNUAL PETROLEUM PRODUCTION (ONSHORE AND STATE WATERS)

Year	Oil (kL)	Gas (kcm)	Condensate (kL)
1955	2,687.00	0.00	0.00
1966	221.63	12.83	0.00
1967	772,657.88	92,412.25	0.00
1968	1,714,309.22	245,042.20	0.00
1969	2,130,358.29	292,421.22	0.00
1970	2,654,001.69	391,800.94	0.00
1971	2,577,750.11	359,891.39	234.03
1972	2,457,768.60	862,154.92	7,521.69
1973	2,296,583.00	979,649.43	4,925.06
1974	2,181,116.09	965,754.61	5,252.69
1975	2,066,084.56	947,674.78	4,922.89
1976	1,856,387.69	963,985.11	3,960.84
1977	1,846,504.16	939,302.15	3,606.37
1978	1,771,112.71	915,821.54	2,976.19
1979	1,473,257.98	939,106.92	3,055.91
1980	1,636,621.63	1,025,820.31	3,152.45
1981	1,356,562.70	962,742.91	2,669.50
1982	1,278,978.80	1,047,800.43	3,544.30
1983	1,297,530.74	1,213,046.09	4,010.73
1984	1,245,139.10	1,014,555.35	3,780.07
1985	1,223,135.51	735,346.27	2,651.45
1986	1,624,066.23	757,352.36	2,485.08
1987	1,684,644.60	579,244.57	1,376.22
1988	2,125,982.26	463,781.69	822.47
1989	2,229,963.10	498,972.74	952.99
1990	4,629,302.81	760,373.49	1,788.18
1991	4,743,271.74	734,737.04	1,565.03
1992	4,758,780.48	1,033,606.03	14,579.10
1993	3,889,610.39	1,149,306.17	42,418.91
1994	4,345,512.87	1,353,219.43	62,834.73
1995	4,302,059.52	1,445,089.24	70,138.81
1996	3,313,886.27	1,562,854.90	69,543.10
1997	3,175,376.22	1,725,538.21	80,961.41
1998	2,538,397.81	1,294,505.82	72,270.52
1999	1,995,733.50	1,346,736.41	78,847.65
2000	1,675,667.28	1,528,725.46	94,673.17
2001	1,653,904.20	1,591,370.68	107,597.19
2002	1,934,453.86	1,296,244.21	103,308.67
2003	2,283,718.26	1,407,606.99	118,647.16
2004	2,008,019.60	1,432,581.43	213,174.70
2005	1,567,838.53	1,960,260.20	243,073.81
2006	1,158,028.49	1,459,035.29	167,371.63
2007	1,189,848.78	1,427,496.85	164,258.44
2008	750,144.83	894,067.79	64,285.23
2009	736,308.40	1,168,135.56	90,403.69
2010	643,191.74	1,160,650.58	90,655.90
2011	559,417.14	1,034,038.35	72,463.65
2012	521,358.47	623,687.56	28,629.00
2013	462,395.02	490,849.95	28,293.15
2014	406,187.66	455,545.67	19,003.91
2015	349,320.09	503,632.67	21,155.88
2016	287,067.75	318,420.74	14,016.88
cumulative	97,382,226.97	48,352,009.70	2,197,860.44

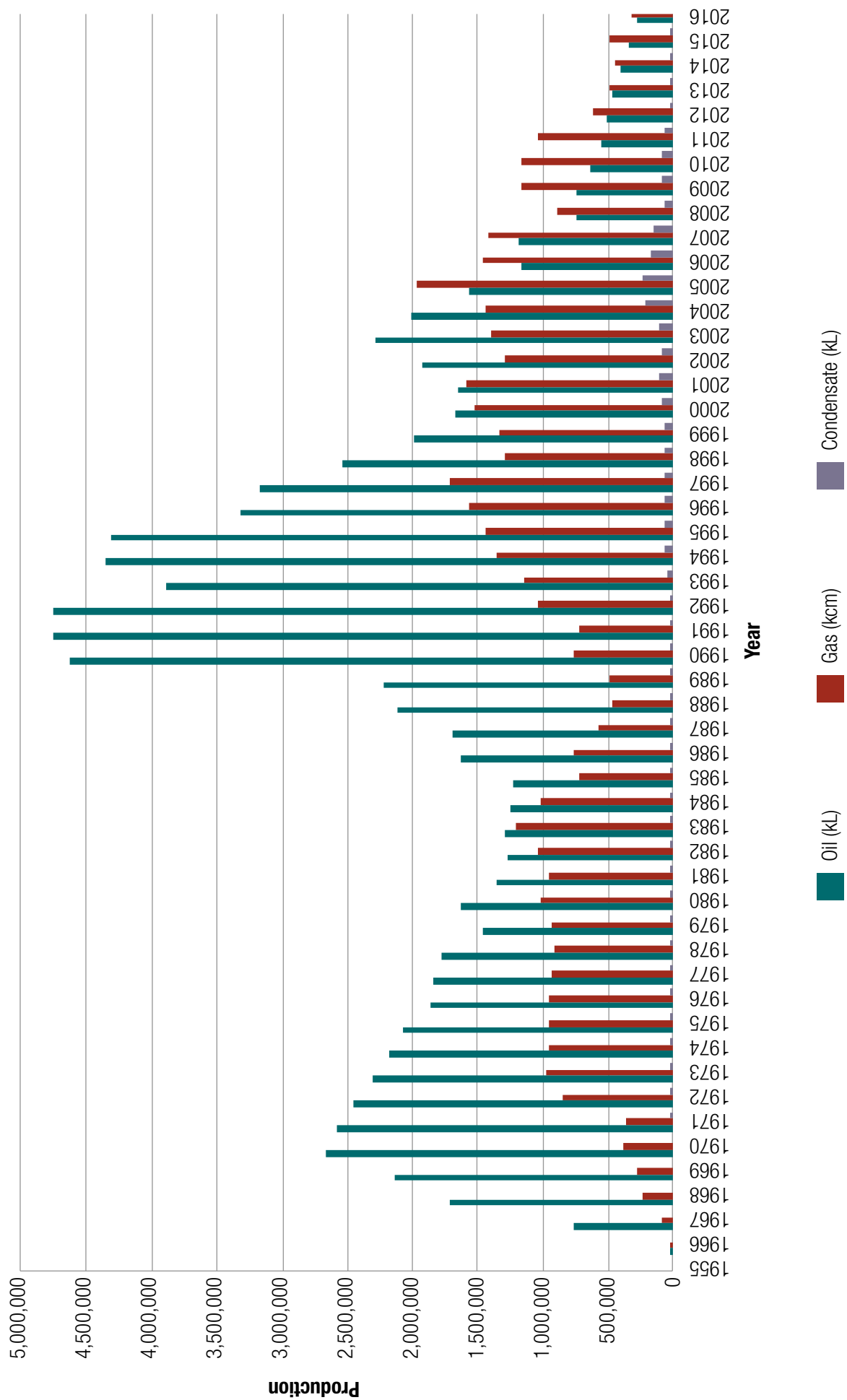
Under the Petroleum and Geothermal Energy (Resource Management and Administration) Regulations 2015, as of 1 July 2015 annual production information by well or by licence area post 1 July 2015 is permanently confidential information, and as such the Department of Mines, Industry Regulation and Safety will no longer publish this information in the PWA magazine.

TABLE 2. PRODUCTION TO 31 DECEMBER 2016

Basin	Oil (kL)	Gas (kcm)	Condensate (kL)
Canning	782,438.79	37,065.77	546.80
Carnarvon	93,943,860.13	28,477,350.93	2,030,266.09
Perth	2,655,928.05	19,837,593.00	167,047.55
cumulative	97,382,226.97	48,352,009.70	2,197,860.44



WA Petroleum Production History



**TABLE 3. PETROLEUM WELLS IN WESTERN AUSTRALIA
– ONSHORE AND STATE WATERS 2016–17 FISCAL YEAR**

Well Name	Class	Offshore	Title	Well Operator	Latitude	Longitude	Spud Date	TD Date	Rig Release Date
NORTHERN CARNARVON BASIN									
TGS 1	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.773	114.851	22/11/2016	29/12/2016	11/12/2016
TGS 3	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.773	114.839	1/1/2017	6/1/2017	13/1/2017
TGS 4	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.764	114.850	14/12/2016	14/12/2016	25/12/2016
TGS 4A	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.764	114.850	16/1/2017	22/1/2017	23/3/2017
TGS 5	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.793	114.848	13/4/2017	19/4/2017	28/4/2017
TGS 6	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.800	114.836	24/5/2017	31/5/2017	8/6/2017
TGS 7	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.763	114.851	30/4/2017	2/5/2017	22/5/2017
TGS 7A	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.763	114.851	11/5/2017	17/5/2017	22/5/2017
TGS 9	STORAGE	N	L 9 R1	DDG Tubridgi Pty Limited	-21.764	114.838	26/3/2017	2/4/2017	10/4/2017
PERTH BASIN									
Waitsia 3	EXT	N	L 1 R1	AWE Perth Pty Ltd	-29.351	115.103	19/5/2017	20/6/2017	29/6/2017

TABLE 4. LIST OF PETROLEUM TITLES AND HOLDERS IN WESTERN AUSTRALIAN JURISDICTIONS AS AT 3 AUGUST 2017

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Exploration Permit**

Title	Registered Holder(s)
TP/7 R4	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
TP/8 R4	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TP/15 R2	WESTRANCH HOLDINGS PTY LTD
TP/25	FINDER NO 3 PTY LTD
TP/27	CARNARVON PETROLEUM LTD
TP/28	CONOCOPHILLIPS (BROWSE BASIN) PTY LTD ORIGIN ENERGY BROWSE PTY LTD PETROCHINA INTERNATIONAL INVESTMENT (AUSTRALIA) PTY LTD

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Pipeline Licence**

Title	Registered Holder(s)
TPL/1 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TPL/2 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TPL/3 R1	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
TPL/4 R1	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
TPL/5 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TPL/6 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TPL/7 R2	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
TPL/8	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TPL/9 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TPL/10	BHP BILLITON PETROLEUM (AUSTRALIA) PTY LTD* INPEX ALPHA LTD MOBIL EXPLORATION & PRODUCING AUSTRALIA PTY LTD
TPL/11	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD

TPL/12	QUADRANT EAST SPAR PTY LTD QUADRANT KERSAIL PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD
TPL/13	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT EAST SPAR PTY LTD QUADRANT KERSAIL PTY LTD QUADRANT NORTHWEST PTY LTD* QUADRANT OIL AUSTRALIA PTY LTD SANTOS (BOL) PTY LTD
TPL/14	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TPL/15	BHP BILLITON PETROLEUM (NORTH WEST SHELF) PTY LTD BP DEVELOPMENTS AUSTRALIA PTY LTD CHEVRON AUSTRALIA PTY LTD JAPAN AUSTRALIA LNG (MIMI) PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE ENERGY LTD*
TPL/16	BHP BILLITON PETROLEUM (NORTH WEST SHELF) PTY LTD BP DEVELOPMENTS AUSTRALIA PTY LTD CHEVRON AUSTRALIA PTY LTD JAPAN AUSTRALIA LNG (MIMI) PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE ENERGY LTD*
TPL/17	QUADRANT NORTHWEST PTY LTD* SANTOS (BOL) PTY LTD
TPL/18	A.C.N. 008 939 080 PTY LTD A.C.N. 008 988 930 PTY LTD ROC OIL (WA) PTY LTD*
TPL/19	KANSAI ELECTRIC POWER AUSTRALIA PTY LTD TOKYO GAS PLUTO PTY LTD WOODSIDE BURRUP PTY LTD*
TPL/20	QUADRANT NORTHWEST PTY LTD* SANTOS OFFSHORE PTY LTD
TPL/21	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD
TPL/22	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD
TPL/23	BHP BILLITON PETROLEUM (AUSTRALIA) PTY LTD* QUADRANT PVG PTY LTD
TPL/24	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD
TPL/25	CHEVRON (TAPL) PTY LTD* KUFPEC AUSTRALIA (JULIMAR) PTY LTD KYUSHU ELECTRIC WHEATSTONE PTY LTD PE WHEATSTONE PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE ENERGY JULIMAR PTY LTD

TABLE 4. LIST OF PETROLEUM TITLES AND HOLDERS IN WESTERN AUSTRALIAN JURISDICTIONS AS AT 3 AUGUST 2017

PETROLEUM (SUBMERGED LANDS) ACT 1982 Production Licence

Title	Registered Holder(s)
TL/1 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TL/2 R1	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
TL/3 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TL/4 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TL/5 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TL/6 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TL/7	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TL/8	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TL/9	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
TL/10	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*

PETROLEUM (SUBMERGED LANDS) ACT 1982 Retention Lease

Title	Registered Holder(s)
TR/3 R3	QUADRANT NORTHWEST PTY LTD
TR/4 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
TR/5 R2	BP DEVELOPMENTS AUSTRALIA PTY LTD JAPAN AUSTRALIA LNG (MIMI BROWSE) PTY LTD PETROCHINA INTERNATIONAL INVESTMENT (AUSTRALIA) PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE BROWSE PTY. LTD.*
TR/6 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD

PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967 Access Authority

Title	Registered Holder(s)
AA 5	FINDER NO 5 PTY LTD

PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967 Exploration Permit

Title	Registered Holder(s)
EP 61 R7	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
EP 62 R7	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
EP 104 R6	GULLIVER PRODUCTIONS PTY LTD* INDIGO OIL PTY LTD
EP 129 R6	BURU ENERGY LTD
EP 307 R6	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
EP 320 R5	AWE (BEHARRA SPRINGS) PTY LTD ORIGIN ENERGY DEVELOPMENTS PTY LTD*
EP 321 R4	ALCOA OF AUSTRALIA LTD LATENT PETROLEUM PTY LTD*
EP 358 R3	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
EP 359 R3	BOUNTY OIL & GAS NL LANSVALE OIL & GAS PTY LTD PACE PETROLEUM PTY LTD PHOENIX RESOURCES PLC ROUGH RANGE OIL PTY LTD
EP 368 R4	EMPIRE OIL COMPANY (WA) LTD* WESTRANCH HOLDINGS PTY LTD
EP 371 R2	BURU ENERGY LTD DIAMOND RESOURCES (CANNING) PTY LTD
EP 386 R3	ONSHORE ENERGY PTY LTD
EP 389 R2	EMPIRE OIL COMPANY (WA) LTD
EP 391 R3	BURU ENERGY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD
EP 408 R2	CALENERGY RESOURCES (AUSTRALIA) LTD
EP 413 R3	AWE PERTH PTY LTD BHARAT PETRORESOURCES LTD NORWEST ENERGY NL*
EP 416 R2	EMPIRE OIL COMPANY (WA) LTD PILOT ENERGY LTD*
EP 426 R1	EMPIRE OIL COMPANY (WA) LTD* WESTRANCH HOLDINGS PTY LTD
EP 428 R1	BURU ENERGY LTD DIAMOND RESOURCES (CANNING) PTY LTD
EP 430 R1	EMPIRE OIL COMPANY (WA) LTD
EP 431 R1	BURU ENERGY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD
EP 432 R1	EMPIRE OIL COMPANY (WA) LTD*
EP 435 R1	AUSTRALIAN OIL COMPANY NO 3 PTY LTD BLACK FIRE MINERALS LTD BOUNTY OIL & GAS NL PHOENIX RESOURCES PLC ROUGH RANGE OIL PTY LTD

TABLE 4. LIST OF PETROLEUM TITLES AND HOLDERS IN WESTERN AUSTRALIAN JURISDICTIONS AS AT 3 AUGUST 2017

EP 436 R1	BURU ENERGY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD
EP 437 R1	KEY PETROLEUM (AUSTRALIA) PTY LTD PILOT ENERGY LTD REY OIL AND GAS PERTH PTY LTD
EP 440 R1	EMPIRE OIL COMPANY (WA) LTD
EP 447 R1	GCC METHANE PTY LTD UUL ENERGY LTD*
EP 454 R1	EMPIRE OIL COMPANY (WA) LTD*
EP 455 R1	AWE PERTH PTY LTD* GLOBAL ENERGY VENTURES LTD
EP 457 R1	BURU FITZROY PTY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD REY OIL AND GAS PTY LTD
EP 458 R1	BURU FITZROY PTY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD REY OIL AND GAS PTY. LTD.
EP 469	WARREGO ENERGY PTY LTD*
EP 475	CARNARVON PETROLEUM LTD
EP 480	EMPIRE OIL COMPANY (WA) LTD PILOT ENERGY LTD*
EP 481	NEW STANDARD ONSHORE PTY LTD
EP 482	NEW STANDARD ONSHORE PTY LTD
EP 483	FINDER NO 3 PTY LTD
EP 487	OIL BASINS LTD REY LENNARD SHELF PTY LTD*
EP 488	UUL ENERGY LTD
EP 489	UUL ENERGY LTD
EP 490	CARNARVON PETROLEUM LTD
EP 491	CARNARVON PETROLEUM LTD
EP 493	FINDER SHALE PTY LTD
EP 494	MACALLUM GROUP LTD* SOUTHERN SKY ENERGY PTY LTD
EP 495	OCEANHILL PTY LTD

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Petroleum Lease**

Title	Registered Holder(s)
L 1H R2	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Production Licence**

Title	Registered Holder(s)
L 1 R1	APT PARMELIA PTY LTD AWE PERTH PTY LTD* ORIGIN ENERGY DEVELOPMENTS PTY LTD
L 2 R1	AWE PERTH PTY LTD* ORIGIN ENERGY DEVELOPMENTS PTY LTD
L 4 R1	AWE PERTH PTY LTD
L 5 R1	AWE PERTH PTY LTD

L 6 R1	BURU ENERGY LTD
L 7 R1	AWE PERTH PTY LTD
L 8 R1	BURU ENERGY LTD
L 9 R1	DDG TUBRIDGI PTY LTD
L 10 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
L 11	AWE (BEHARRA SPRINGS) PTY LTD ORIGIN ENERGY DEVELOPMENTS PTY LTD*
L 12	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
L 13	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
L 14	CYCLONE ENERGY PTY LTD* NORWEST ENERGY NL RCMA AUSTRALIA PTY LTD
L 15	GULLIVER PRODUCTIONS PTY LTD* INDIGO OIL PTY LTD
L 16	AUSTRALIAN OIL COMPANY NO 3 PTY LTD BOUNTY OIL & GAS NL ROUGH RANGE OIL PTY LTD
L 17	BURU ENERGY LTD
L 18	EMPIRE OIL COMPANY (WA) LTD*
L 19	EMPIRE OIL COMPANY (WA) LTD*
L 20	BURU ENERGY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD
L 21	BURU ENERGY LTD* DIAMOND RESOURCES (FITZROY) PTY LTD

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Retention Lease**

Title	Registered Holder(s)
R 1 R2	GULLIVER PRODUCTIONS PTY LTD* INDIGO OIL PTY LTD
R 2 R2	BP DEVELOPMENTS AUSTRALIA PTY LTD JAPAN AUSTRALIA LNG (MIMI BROWSE) PTY LTD PETROCHINA INTERNATIONAL INVESTMENT (AUSTRALIA) PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE BROWSE PTY LTD*
R 3 R2	OIL BASINS LTD
R 4 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
R 6	ALCOA OF AUSTRALIA LTD LATENT PETROLEUM PTY LTD*
R 7	ALCOA OF AUSTRALIA LTD LATENT PETROLEUM PTY LTD*

TABLE 4. LIST OF PETROLEUM TITLES AND HOLDERS IN WESTERN AUSTRALIAN JURISDICTIONS AS AT 3 AUGUST 2017

PETROLEUM PIPELINES ACT 1969

Pipeline Licence

Title	Registered Holder(s)
PL 1 R1	APT PARMELIA PTY LTD
PL 2 R1	APT PARMELIA PTY LTD
PL 3 R1	APT PARMELIA PTY LTD
PL 5 R1	APT PARMELIA PTY LTD
PL 6 R3	AWE PERTH PTY LTD
PL 7 R1	BURU ENERGY LTD
PL 8 R1	MITSUI IRON ORE DEVELOPMENT PTY LTD NIPPON STEEL & SUMIKIN RESOURCES AUSTRALIA PTY LTD NIPPON STEEL & SUMITOMO METAL AUSTRALIA PTY LTD NORTH MINING LTD ROBE RIVER MINING CO. PTY LTD*
PL 12 R1	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
PL 14 R1	HYDRA ENERGY (WA) PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD TAP (SHELFAL) PTY LTD
PL 15 R1	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
PL 16	DBP DEVELOPMENT GROUP NOMINEES PTY LTD
PL 17	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
PL 18	AWE (BEHARRA SPRINGS) PTY LTD ORIGIN ENERGY DEVELOPMENTS PTY LTD*
PL 19	DBP DEVELOPMENT GROUP NOMINEES PTY LTD
PL 20	DBP DEVELOPMENT GROUP NOMINEES PTY LTD
PL 21	CHEVRON (TAPL) PTY LTD CHEVRON AUSTRALIA PTY LTD* MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD SANTOS OFFSHORE PTY LTD
PL 22	APA (PILBARA PIPELINE) PTY LTD
PL 24	ALINTA ENERGY GGT PTY LTD SOUTHERN CROSS PIPELINES (NPL) AUSTRALIA PTY LTD SOUTHERN CROSS PIPELINES AUSTRALIA PTY LTD*
PL 25	SOUTHERN CROSS PIPELINES AUSTRALIA PTY LTD
PL 26	SOUTHERN CROSS PIPELINES AUSTRALIA PTY LTD
PL 27	SOUTHERN CROSS PIPELINES AUSTRALIA PTY LTD
PL 28	SOUTHERN CROSS PIPELINES (NPL) AUSTRALIA PTY LTD
PL 29	QUADRANT EAST SPAR PTY LTD QUADRANT KERSAIL PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD
PL 30	QUADRANT EAST SPAR PTY LTD QUADRANT KERSAIL PTY LTD QUADRANT OIL AUSTRALIA PTY LTD* SANTOS (BOL) PTY LTD
PL 31	APA (PILBARA PIPELINE) PTY LTD

PL 32	APT PIPELINES (WA) PTY LTD
PL 33	APT PIPELINES (WA) PTY LTD
PL 34	NORTHERN STAR RESOURCES LTD
PL 35	NORTHERN STAR RESOURCES LTD
PL 36	AUSTRALIAN PIPELINE LTD
PL 37	NORILSK NICKEL CAWSE PTY LTD
PL 38	APA (PILBARA PIPELINE) PTY LTD
PL 39	ORIGIN ENERGY PIPELINES PTY LTD
PL 40	DBNGP (WA) NOMINEES PTY LTD
PL 41	DBNGP (WA) TRANSMISSION PTY LTD
PL 42	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT EAST SPAR PTY LTD QUADRANT KERSAIL PTY LTD QUADRANT NORTHWEST PTY LTD* QUADRANT OIL AUSTRALIA PTY LTD SANTOS (BOL) PTY LTD
PL 43	APT PIPELINES (WA) PTY LTD* REGIONAL POWER CORPORATION
PL 44	APT PARMELIA PTY LTD
PL 46	APT PARMELIA PTY LTD
PL 47	DBNGP (WA) TRANSMISSION PTY LTD
PL 48	ENERGY GENERATION PTY LTD
PL 52	APT PARMELIA PTY LTD
PL 53	APT PARMELIA PTY LTD
PL 54	APT PIPELINES (WA) PTY LTD* REGIONAL POWER CORPORATION
PL 55	WODGINA LITHIUM PTY LTD
PL 56	WODGINA LITHIUM PTY LTD
PL 57	AUSTRALIAN GOLD REAGENTS PTY LTD
PL 58	BHP BILLITON PETROLEUM (NORTH WEST SHELF) PTY LTD BP DEVELOPMENTS AUSTRALIA PTY LTD CHEVRON AUSTRALIA PTY LTD JAPAN AUSTRALIA LNG (MIMI) PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE ENERGY LTD*
PL 59	ESPERANCE PIPELINE CO PTY LTD
PL 60	EII GAS TRANSMISSION SERVICES WA (OPERATIONS) PTY LTD
PL 61	APT PARMELIA PTY LTD
PL 62	HARRIET (ONYX) PTY LTD KUFPEC AUSTRALIA PTY LTD QUADRANT NORTHWEST PTY LTD*
PL 63	EII GAS TRANSMISSION SERVICES WA (OPERATIONS) PTY LTD
PL 64	AWE PERTH PTY LTD* ORIGIN ENERGY DEVELOPMENTS PTY LTD
PL 65	SARACEN METALS PTY LTD
PL 67	HAMERSLEY IRON PTY LTD

TABLE 4. LIST OF PETROLEUM TITLES AND HOLDERS IN WESTERN AUSTRALIAN JURISDICTIONS AS AT 3 AUGUST 2017

PL 68	EII GAS TRANSMISSION SERVICES WA (OPERATIONS) PTY LTD	PL 93	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD
PL 69	DBNGP (WA) NOMINEES PTY LTD	PL 94	DBNGP (WA) NOMINEES PTY LTD
PL 70	A.C.N. 008 939 080 PTY LTD A.C.N. 008 988 930 PTY LTD ROC OIL (WA) PTY LTD*	PL 95	DBNGP (WA) NOMINEES PTY LTD
PL 72	EDL NGD (WA) PTY LTD	PL 96	EMPIRE OIL COMPANY (WA) LTD
PL 73	REDBACK PIPELINES PTY LTD	PL 97	MITSUI IRON ORE DEVELOPMENT PTY LTD NIPPON STEEL & SUMIKIN RESOURCES AUSTRALIA PTY LTD NIPPON STEEL & SUMITOMO METAL AUSTRALIA PTY LTD NORTH MINING LTD ROBE RIVER MINING CO PTY LTD*
PL 74	EDL LNG (WA) PTY LTD	PL 98	ESPERANCE PIPELINE CO. PTY LTD
PL 75	EIT NEERABUP POWER PTY LTD ERM NEERABUP PTY LTD*	PL 99	CHEVRON (TAPL) PTY LTD* KUFPEC AUSTRALIA (JULIMAR) PTY LTD KYUSHU ELECTRIC WHEATSTONE PTY LTD PE WHEATSTONE PTY LTD SHELL AUSTRALIA PTY LTD WOODSIDE ENERGY JULIMAR PTY LTD
PL 76	SOUTHERN CROSS PIPELINES AUSTRALIA PTY LTD	PL 100	DBNGP (WA) NOMINEES PTY LTD
PL 77	SINO IRON PTY LTD	PL 101	DBNGP (WA) NOMINEES PTY LTD
PL 78	HAMERSLEY IRON PTY LTD	PL 102	SUB161 PTY LTD
PL 80	ALCOA OF AUSTRALIA LTD LATENT PETROLEUM PTY LTD*	PL 103	DBP DEVELOPMENT GROUP NOMINEES PTY LTD
PL 81	QUADRANT NORTHWEST PTY LTD SANTOS OFFSHORE PTY LTD	PL 104	APA (PILBARA PIPELINE) PTY LTD
PL 82	APA (PILBARA PIPELINE) PTY LTD	PL 105	DDG FORTESCUE RIVER PTY LTD* TEC PILBARA PTY LTD
PL 83	ATCO GAS AUSTRALIA PTY LTD	PL 106	MITSUI IRON ORE DEVELOPMENT PTY LTD NIPPON STEEL & SUMIKIN RESOURCES AUSTRALIA PTY LTD NIPPON STEEL & SUMITOMO METAL AUSTRALIA PTY LTD NORTH MINING LTD ROBE RIVER MINING CO PTY LTD*
PL 84	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD	PL 108	APA OPERATIONS PTY LTD
PL 85	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS GORGON PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD	PL 109	BURU ENERGY LTD
PL 86	QUADRANT NORTHWEST PTY LTD* SANTOS OFFSHORE PTY LTD	PL 110	DDG ASHBURTON PTY LTD*
PL 87	BHP BILLITON PETROLEUM (AUSTRALIA) PTY LTD* QUADRANT PVG PTY LTD	PL 111	AWE PERTH PTY LTD* ORIGIN ENERGY DEVELOPMENTS PTY LTD
PL 88	BHP BILLITON PETROLEUM (AUSTRALIA) PTY LTD* QUADRANT PVG PTY LTD	PL 112	DBP DEVELOPMENT GROUP NOMINEES PTY LTD
PL 89	CROSSLANDS RESOURCES PTY LTD		
PL 90	BHP BILLITON PETROLEUM (AUSTRALIA) PTY LTD* QUADRANT PVG PTY LTD		
PL 91	DBNGP (WA) NOMINEES PTY LTD		
PL 92	CHEVRON (TAPL) PTY LTD* JERA GORGON PTY LTD MOBIL AUSTRALIA RESOURCES COMPANY PTY LTD OSAKA GAS AUSTRALIA PTY LTD SHELL AUSTRALIA PTY LTD TOKYO GAS GORGON PTY LTD		

*denotes Nominee

Please consult DMIRS's online Petroleum and Geothermal Register for the most current information on Titles and Holdings.

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