Office of Groundwater Impact Assessment

Annual Report 2020

for the Surat Underground Water Impact Report 2019

December 2020

Queensland Government

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Summary

The production of coal seam gas (CSG) involves the pumping of water from coal formations to reduce groundwater pressure and release the gas. This can affect groundwater pressure in overlying and underlying aquifers because of connectivity between the formations. To ensure a comprehensive cumulative groundwater assessment is completed, and to provide clarity on the management responsibilities of individual tenure holders, the Office of Groundwater Impact Assessment (OGIA) carries out an independent cumulative assessment in the 'cumulative management area' (CMA) and prepares an Underground Water Impact Report (UWIR) every three years.

The most recent UWIR is the Surat UWIR 2019, which took effect from 16 December 2019 and superseded the previous two UWIRs from 2012 and 2016.

An annual report is prepared to provide an update on changes to circumstances that would impact on the predictions reported in the UWIR, and to provide updates on the implementation of management strategies specified in the UWIR. This is the first annual report in the current UWIR 2019 reporting cycle.

For the purpose of the annual report, changes to the cumulative industry development profile compared to the one presented and used in the UWIR 2019, are assessed based on the data received up to October 2020. In 2020, the net planned development area had increased by about seven per cent since the UWIR 2019, which is consistent with the increasing trend observed since 2016. The majority of this change is driven by an increase in planned production area from Santos. Despite an increase in the planned production area over the longer term and production in some fields being brought forward, there has been a net slowdown in development in the shorter term, likely to be in response to current market conditions resulting from the COVID-19 situation. With the increase in net footprint, the total number of projected wells has also slightly increased – from about 21,000 reported at the time of the UWIR 2019, to about 22,000 now – while existing wells have increased to about 8,000.

The 2019 groundwater model is used to simulate the impacts from this revised development profile to assess the implications of changes in impact predictions from the UWIR 2019. Predictions based on the current industry development profile suggest that 12 of the 100 Immediately Affected Area (IAA) bores listed in the UWIR 2019 are no longer expected to be impacted by more than five metres in the short term (i.e. prior to the end of 2021), due to the shifting of production to later years in those areas. Expansion of the cumulative industry development profile has also resulted in some relatively minor increases in long-term impacts, particularly in the northern part of the Surat CMA where Santos is proposing expansion in the Bowen Basin. Changes are likely to result in a net increase of 22 long-term impacted bores compared to the UWIR 2019.

A bore assessment was required by the assigned responsible tenure holders for the 100 bores identified as IAA bores in the UWIR 2019, to establish whether bores had, or are likely to have, impaired capacity, and to assess where make-good arrangements are appropriate. Since then the completed bore assessments have resulted in changes to the aquifer assignment of two bores, where they are no longer predicted to be affected by more than the trigger threshold in the short term – hence, they are no longer IAA bores.

There were also 48 water bores where there was insufficient data to determine their status as IAA bores. Since the approval of the UWIR 2019, OGIA has confirmed four of these bores as IAA bores with a further four confirmed not to be IAA bores. The remaining 40 bores are currently under

investigation. As a result of these changes, effectively 102 bores are now IAA bores. There had also been 122 water bores that had been similarly identified as IAA bores in the previous UWIRs where bore assessment and make-good arrangements were progressing or completed. Therefore, so far a total of 224 bores have been identified as IAA bores since the first UWIR in 2012.

Of the 224 effective IAA bores, make-good agreements have now been achieved for 117 bores. In most cases (about 100), the agreement has resulted in financial compensation. In addition, tenure holders have proactively reached 112 agreements for bores not identified as IAA bores at this stage.

The UWIR 2019 includes a Water Monitoring Strategy which specifies a regional monitoring network, comprising groundwater pressure and water chemistry points, as well as the monitoring of water production volumes. At the time of the UWIR 2019, there were 436 operational groundwater pressure monitoring points. Since that time, 11 new monitoring points have been completed, 15 have been repaired and 9 have been replaced. Progress with installation has been slower than anticipated, primarily due to logistical issues relating to the COVID-19 situation.

Monitoring data that has become available since the UWIR 2019 suggests that overall trends in groundwater pressure are similar to those reported in the UWIR 2019.

Based on the predictions of impacts and a follow-up risk assessment, six groups of springs were identified for mitigation actions in the UWIR 2019 and required the responsible tenure holder – Santos – to develop a plan and actions to mitigate predicted impacts. While the plan is yet to be finalised, the overall approach is to run three parallel streams of work as part of the plan: (1) mitigation actions that would bring the residual risk to ‘low’ based on the current risk profile and predictions identified in the UWIR, unless there is evidence to suggest that the risk profile is different to that identified in the UWIR; (2) trigger reporting by OGIA based on its assessment of CSG impacts on groundwater pressure from monitoring data at leading indicator sites; and (3) ongoing investigations at number of spring groups to further improve knowledge about impact pathways and springs’ responses to those impacts.

Since the UWIR 2019, a range of additional data sets have become available, particularly geological and formation properties data from additional CSG wells and groundwater monitoring data, established through the UWIR obligations as well industry’s own monitoring initiatives. OGIA is now in the process of building knowledge from these additional data sets. OGIA has been progressing this research work in parallel with its inception work relating to the integration of coal mining impacts in the Surat Basin, following an amendment to the Surat CMA in January 2020.

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1 Introduction

1.1 Regulatory framework

Under the Queensland regulatory framework, petroleum and gas (P&G) tenure holders have a limited right for the extraction of groundwater in the process of producing P&G. This right is subject to responsibilities to 'make good' impairment of private groundwater supplies caused by the water extraction activities and to carry out monitoring and other management activities. Effective from December 2016, legislative changes have now extended these arrangements to the mining sector.

In an area of concentrated development of P&G, such as coal seam gas (CSG), the impacts on groundwater pressures caused by individual projects can overlap. In these situations, it is difficult for individual tenure holders to assess cumulative groundwater impacts and to determine individual tenure holder responsibilities for monitoring and make-good obligations. To ensure a comprehensive cumulative groundwater assessment is completed and to provide clarity on the management responsibilities of individual tenure holders, such an area can be declared a 'cumulative management area' (CMA) under Queensland legislation.

Where a CMA is established, the Office of Groundwater Impact Assessment (OGIA) is responsible for independently undertaking assessments, establishing management arrangements and identifying responsible tenure holders to implement specific aspects of those management arrangements. Responsible tenure holders have a statutory obligation to implement management arrangements and OGIA oversees the implementation of those arrangements, while compliance is managed by the Department of Environment and Science (DES). These assessments and management arrangements are set out in an Underground Water Impact Report (UWIR) which is revised every three years. Once approved, the UWIR becomes a statutory instrument and provides a basis for ongoing management of groundwater impacts in line with the strategies outlined therein.

There is currently one CMA in Queensland – the Surat CMA, declared in 2010 in response to rapid CSG development in the Surat Basin.

1.2 The Surat Underground Water Impact Report

The first Surat UWIR was prepared by OGIA (then part of the Queensland Water Commission) in 2012, followed by a second UWIR in 2016. Those earlier UWIRs are now superseded by the UWIR 2019.

Following the release of a consultation draft in May 2019, the UWIR 2019 was finalised and approved in November 2019, and took effect on 16 December 2019. Currently being implemented, the UWIR 2019 provides:

- a description of current groundwater pressure trends
- predictions of short-term and long-term cumulative impacts on groundwater pressures in aquifers
- a regional water monitoring strategy
- a regional spring impact management strategy
- assignment of management responsibilities to individual tenure holders
- a research program to build knowledge and improve predictions of impacts.

The UWIR 2019 applies to P&G tenures only. Subsequent to the release of the UWIR 2019, in January 2020, the Surat CMA was amended to include coal mines in the Surat Basin. As a result, OGIA is now working on the integration of coal impacts in the next iteration of the UWIR, which is due in late 2021.

1.3 Purpose of the Annual Report

An Annual Report is not an update of the UWIR. Rather, the annual report is prepared to provide an update on changes to circumstances that would impact on the predictions reported in the UWIR, and to provide updates on the implementation of management strategies specified in the UWIR.

This is the first annual report in the current UWIR 2019 reporting cycle and should be read in conjunction with the UWIR 2019.

2 Update on industry development profile

2.1 Planned development for the UWIR

Many factors can change industry's plans for development over time. Changes can relate to the timing of development of individual petroleum lease areas, or to the long-term footprint of development.

Any change to the cumulative industry development profile directly affects the extent and timing of predicted impacts on groundwater pressure. In order to prepare the UWIR 2019, a whole-of-life cumulative industry development profile was prepared and used as the input scenario for the regional groundwater flow model for impact predictions. Output from the model provided short-term (within three years) and long-term (any time in the future) predicted cumulative impacts on groundwater pressures in aquifers for the given development profile.

The cumulative industry development profile for the UWIR 2019 was prepared based on information available in late 2018 about historic and planned development from individual tenure holders. A summary of the development profile was provided in Figure B-1 and B-2 of the UWIR 2019. Those figures illustrate the planned time of commencement and cessation of production on tenures across the CMA.

2.2 Description of changes to planned development

Since the UWIR 2019, OGIA has received annual updates from tenure holders about their current development profiles – the latest being from October 2020. Based on this information, OGIA has compiled a revised whole-of-industry cumulative development profile. Figure 1 presents the changes in the development profile compared to the one presented in the UWIR 2019. Significant changes are described below.

2.2.1 Overview of the cumulative changes

In 2020, the net planned development area has increased by about seven per cent since the UWIR 2019, which is consistent with the trend observed since 2016. The majority of this change is driven by an increase in planned production area from Santos. The increase is within the potential development area for which tenure holders primarily hold approvals required for development.

Despite an increase in the planned production area over the longer term and a bringing forward of production in some fields, there has been a net slowdown in development in the shorter term. The slowdown is likely to be in response to current market conditions related to the COVID-19 situation.

Growth of existing and proposed wells across the footprint is shown in Figure 2. At the time of the UWIR 2019, there were about 6,800 existing CSG production wells. This number has now increased to about 8,000. With the increase in net footprint, the total number of projected wells has also slightly increased – from about 21,000 reported at the time of the UWIR 2019, to about 22,000 now. There have also been some changes to proposed well densities: the average well density is about 1.7 wells per km^2, with individual tenure holders' well densities ranging from 1.3 to 1.8 wells per km^2.

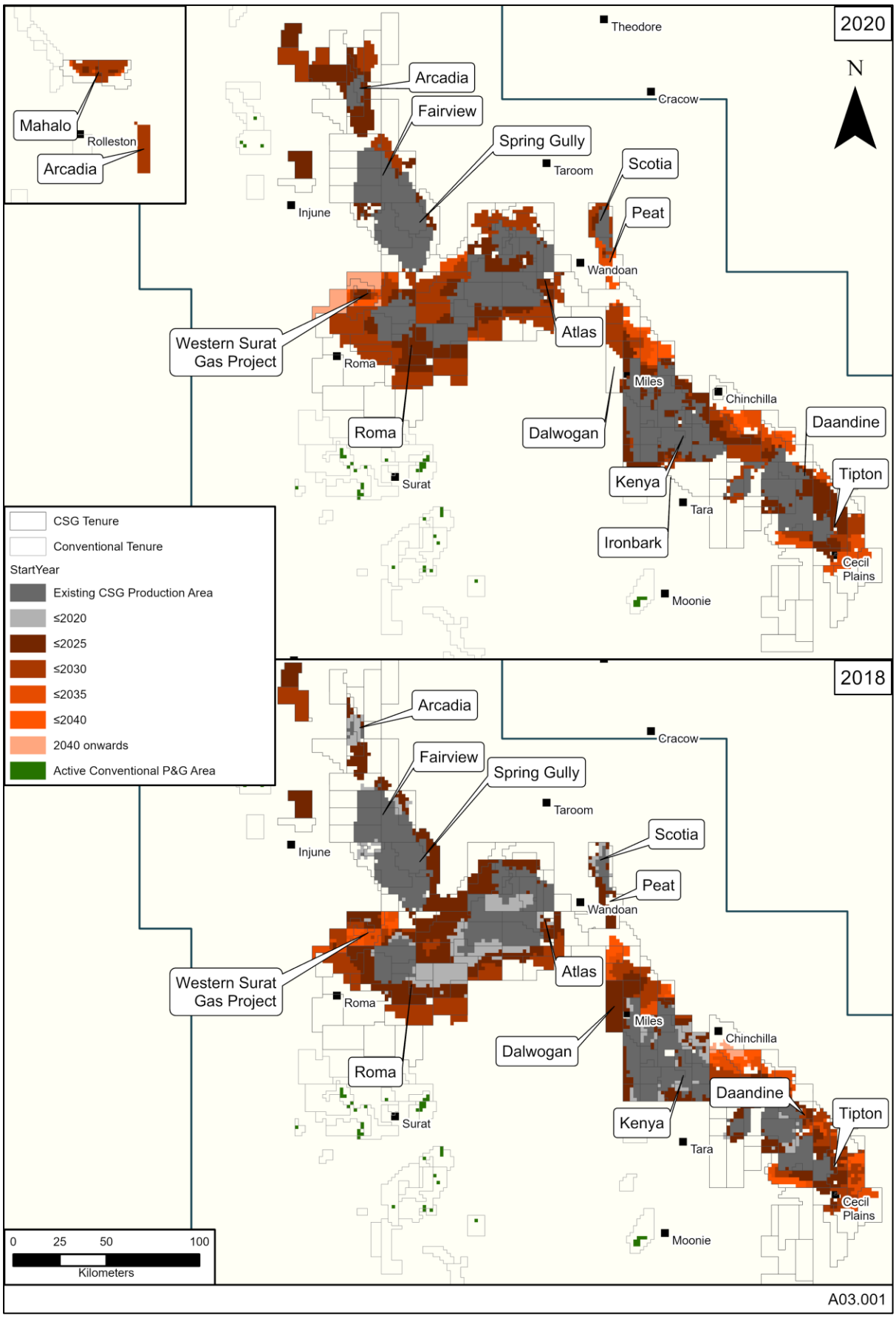

Figure 1 – A comparison of CSG development profiles between late 2018 (used for the UWIR 2019) and the current (October 2020)

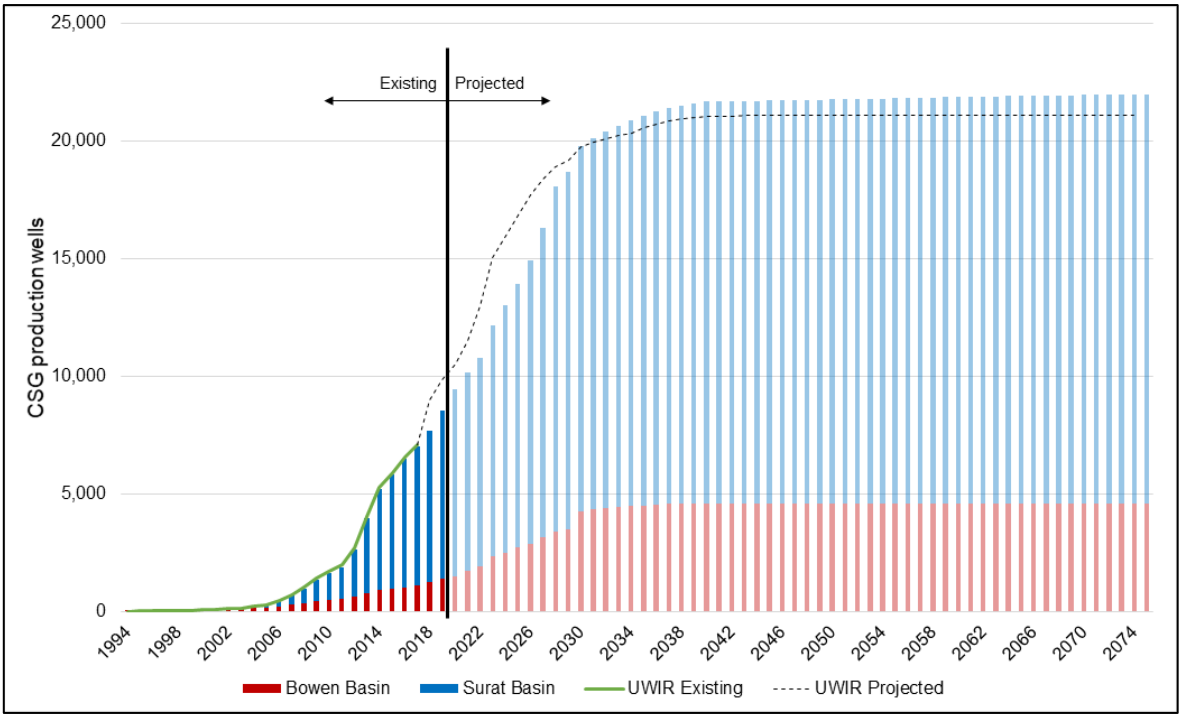

Figure 2 – Existing and projected CSG wells in the Surat CMA in current and planned production areas

Based on the monitoring data, updated actual associated water extraction by P&G tenure holders in the Surat CMA is presented in Figure 3. Since the UWIR 2019, extraction rates have dropped by about 5,000 ML/year to a current level of about 55,000 ML/year. This is primarily due to a combination of slower growth rate, reduction in extracted water over time from existing wells and infilling of new wells in areas where partial depressurisation has already occurred.

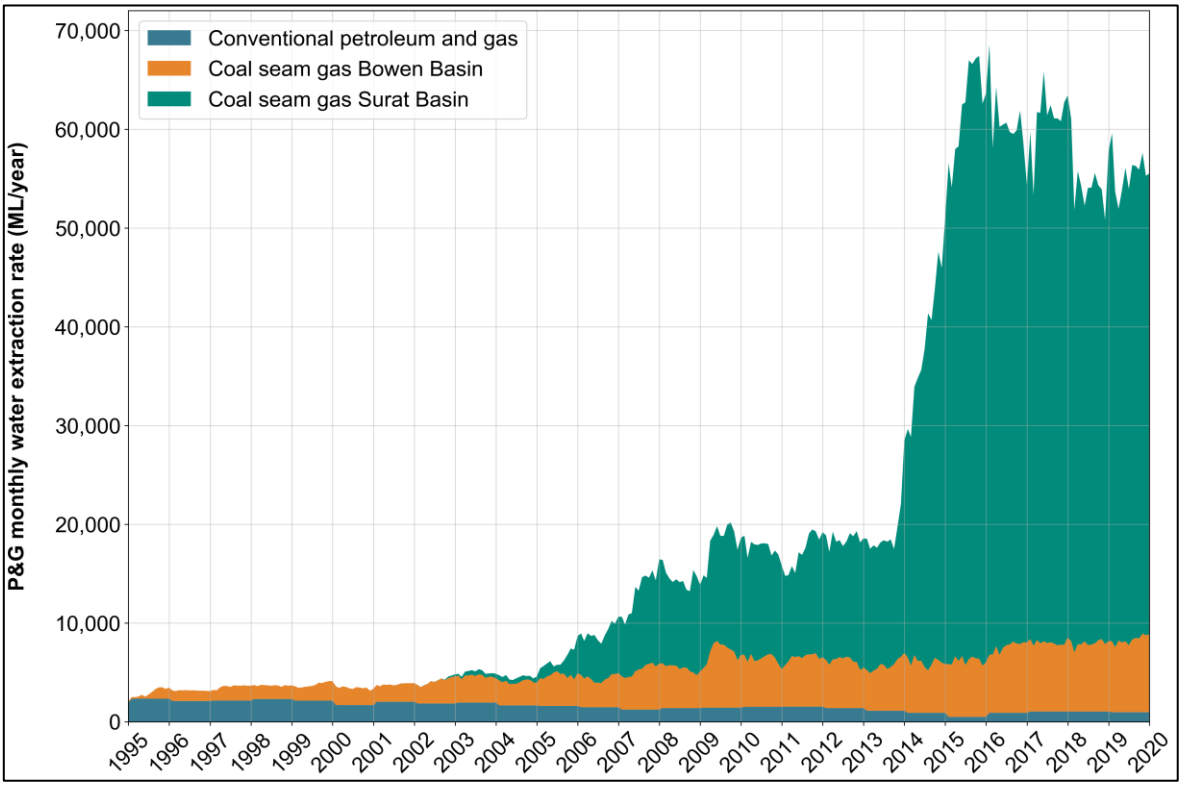

Figure 3 – P&G water extraction

2.2.2 Santos

Santos's planned production area has increased by approximately 25%. The majority of this planned increase is around two established gas fields – Roma and Arcadia – and an additional development area located to the north of Arcadia, which is scheduled to commence production in 2028.

Santos plans to implement infill wells across the Fairview gas field, commencing around 2021. The planned development adjacent to the existing Arcadia gas field has been brought forward slightly. Arcadia West is planned to expand, resulting in a corridor that will join it to the Arcadia gas field to the east. The planned production start for the Arcadia West area is 2023. Santos has submitted an application for a petroleum lease in this area, increasing the likelihood of planned production going ahead.

Along with some slight expansion planned, the scheduled Scotia gas field development has generally been delayed by several years.

2.2.3 Origin

Origin has reduced the planned development area in the Dalwogan and Woleebee gas fields, whilst adding the Ironbark and Mahalo gas fields to the development plan. Ironbark is set to begin production in 2024, subject to the petroleum lease application being approved. Mahalo, for which the petroleum lease already exists, is planned to begin production in 2025. These changes effectively have no net effect on the total development area for Origin. They do, however, result in Origin having approximately 200 fewer total planned development wells.

Across the majority of Origin's gas fields, the planned production has been scheduled for later development, except in some small pockets. More significant change is seen in the Peat gas field, which has been shifted as much as 14 years later.

2.2.4 QGC

Since the UWIR 2019, there is little change to the QGC total planned development footprint, except slight expansion in the northern development area.

QGC's existing production area represents two thirds of QGC's current development plan footprint. The remaining planned development footprint is located in pockets across the southern, central and northern development areas. Planned development has predominantly been shifted to later years, by three to four years.

2.2.5 Arrow Energy

Although Arrow's planned development area has retracted in parts, most notably west of Tipton, the total gas field footprint has only reduced by less than five percent. There have been some noticeable shifts in development timing. Development between Dalby and Cecil Plains has generally been brought forward, as has planned development between Kogan and Chinchilla. Arrow's northern development area, located north of Miles, has generally been scheduled later, except for the furthest northern part of this gas field, which has been brought forward by up to 10 years. The northern development area is planned to begin production over a 17-year period from 2022 to 2039.

Arrow's plans show the overall well density across its gas fields has decreased, resulting in approximately 600 fewer development wells compared to the UWIR 2019.

2.2.6 Senex

Senex's proposed Western Surat Gas Project has experienced better than predicted results from its gas fields; as such, Senex's planned production schedule has undergone major change since the UWIR 2019. The Rhea, Dione, Phoebe, and Pandora gas fields have all been scheduled later, with the earliest production from these fields planned for 2043.

Development planned to occur in the short term has been focused around the current development area in Eos and Glenora; production start times increase with distance from this area. Consistent with this, the closer Tethys and Titan gas fields have been brought forward.

The total number of wells across the Western Surat Gas Project and Atlas projects has increased by approximately 100 wells since the UWIR 2019.

3 Update on predicted impacts on groundwater pressures

3.1 Overview of predicted impacts in the UWIR 2019

The UWIR 2019 identified the IAA for each aquifer. For a consolidated aquifer, such as sandstone, the IAA is the area where groundwater pressure is predicted to decline by more than five metres within three years as a result of water extraction for P&G development. Water supply bores accessing water in the affected area of an aquifer become IAA bores. For these bores, relevant tenure holders are then required to undertake bore assessments and, if bore impairment is likely, then enter into make-good arrangements with bore owners.

The UWIR 2019 identified the Long-term Affected Area (LAA) for each aquifer. The LAA for a consolidated aquifer is the area where groundwater pressure is predicted to decline by more than five metres at any time in the future. A total of 571 existing bores were predicted to be impacted in the long term – including the IAA bores.

The UWIR 2019 identified 100 additional water supply bores as IAA bores, based on the predicted impacts to the end of 2021. This was in addition to 122 IAA bores that were identified in two previous UWIRs, for which bore assessment and make-good arrangements were in place or progressing at the time of the UWIR 2019.

3.2 Assessing changes to predicted impacts

A revised regional groundwater flow model was constructed to support the preparation of the UWIR 2019 (the 2019 groundwater model). It was used to predict the impact of the cumulative industry development profile on groundwater pressures in aquifers.

For the purpose of this annual report, the same 2019 groundwater model is used to simulate the impacts from the current development profile as described in the previous chapter. Results from the simulations were then compared with UWIR 2019 predictions to assess the implications of changes in the development profile.

3.3 Changes to long-term impacts

Expansion of the cumulative industry development profile has resulted in some relatively minor increases in long-term impacts, particularly in the northern part of the Surat CMA, where Santos is proposing expansion in the Bowen Basin. Changes are likely to result in a net increase of an additional 22 LAA bores compared to the UWIR 2019.

In the north, additional long-term impacts are predicted to occur in the Bandanna Formation from proposed development by Origin – in and around the Mahalo fields and in the Rewan Formation, west of Fairview.

3.4 Changes to short-term impacts

Revised model predictions based on the current industry development profile suggest that 12 of the 100 IAA bores listed in the UWIR 2019 are no longer expected to be impacted by more than five metres in the short term (i.e. prior to the end of 2021). These bores are generally north of Roma and around Chinchilla, where short-term predicted impacts are lesser due to production shifting to later years in those areas.

It is to be noted that while the predicted impacts on some IAA bores are less than the trigger threshold of five metres, those bores still remain IAA bores. The status of a bore as an IAA bore is based on the IAA that is established through a current UWIR, based on the development profile at the time. As stated in the UWIR 2019 (s7.1), the IAA for an aquifer does not change between UWIRs, but a bore status as an IAA bore can change based on the new information available about the bore, such as changes in location, authorisation, physical status or aquifer attribution. Such changes to IAA bores are detailed further in the next chapter.

4 Updates to bore information

The UWIR 2019 identified 100 bores within the IAA which required bore assessment by the assigned responsible tenure holders. This section of the report provides an overview of the status of bores identified as IAA bores, in relation to the completion of bore assessments, their works status, and an update on progress with make-good agreements.

4.1 Baseline assessment

Prior to commencing production, resource tenure holders must complete baseline assessments for water bores located on tenure. The schedule for their completion is specified in baseline assessment plans (BAP) which are submitted by the responsible tenure holders to DES for approval.

For water bores located off tenure, but within the LAA, the UWIR Water Monitoring Strategy includes a program for the assessment of these bores – based on a prediction of groundwater pressure decline of more than one metre within the next three years (see Figure 8.6, UWIR 2019).

Baseline data is collected by tenure holders and reported to OGIA. The data is available to interested parties to support the development of make-good agreements between bore owners and resource tenure holders.

OGIA currently holds information collected from 4,696 baseline assessments, 682 of which relate to bores located outside the Surat CMA.

4.2 Bore assessment

Upon approval of a UWIR, responsible tenure holders are required to complete a bore assessment of bores identified as accessing aquifers within the aquifer's IAA – commonly referred to as IAA bores. These water supply bores are listed in Table G-1 of the UWIR 2019. Separately, DES may also direct a tenure holder to undertake a bore assessment.

A bore assessment is undertaken to establish whether a bore has (or is likely to have) an impaired capacity and to assess whether make-good arrangements are appropriate. OGIA is not involved with undertaking bore assessments or the negotiations around make-good agreements.

OGIA maintains a statutory database of the outcome of the bore assessments. Currently, bore assessments for 201 bores are held, 141 of which relate to IAA bores. In consideration of the COVID-19 situation, DES has granted various extensions to tenure holders for completion of bore assessment of IAA bores. As a result, many of the bore assessments are yet to be completed.

Bore assessments often provide new or updated information including location, depth, water chemistry and water level. As a result, in the post-UWIR period, some IAA or LAA bores may be reassessed as accessing water from aquifers other than those predicted to be affected. Conversely, bores not previously identified as IAA or LAA bores may be found to be accessing water from affected aquifers. As a result, the number of IAA bores may change during a UWIR cycle without a change being made to the IAA footprint.

Since the UWIR 2019, bore assessments have resulted in changes to aquifer assignment of two bores (RN 21795 and RN 172028) that are consequently no longer predicted to be affected by more than the trigger threshold in the short term; hence, they are no longer IAA bores.

4.3 Changes to IAA bores

Where a bore assessment by a responsible tenure holder determines an IAA bore is impaired (or likely to be impaired) as a result of P&G water extraction, the responsible tenure holder must enter into an agreement with the bore owner about measures to make good the impairment.

As stated in the previous Chapter, the IAA does not change between the UWIRs, but the status of a bore as an IAA bore can change based on the new information available about the bore, such as the location, authorisation, physical status or aquifer attribution.

Along with the maps showing the IAAs, the UWIR 2019 included a list of 100 water bores understood to tap aquifers within the aquifers' IAAs (Table G-1, UWIR 2019), based on the information available at the time. These 100 bores were identified as IAA bores for the first time.

At the time of preparing the UWIR 2019, there were 48 water bores where there was insufficient data to determine their status as IAA bores (Table G-3, UWIR 2019). These included bores where the screened aquifer could not be confidently determined and/or where there was uncertainty about the bore's authorisation for the take of water from the aquifer. OGIA planned to undertake further assessment of those bores, including some field investigations.

Since the UWIR 2019, OGIA has confirmed four of those 48 bores (RN 14369, RN 15079, RN 19964 and RN 21787) as IAA bores, and four others (RN 6778, RN 30553, RN 32507 and RN 58451) confirmed not to be IAA bores. The relevant landholders, responsible tenure holders and DES were advised of these outcomes in August 2020.

OGIA is awaiting advice from the Department of Regional Development, Manufacturing and Water (DRDMW) on the authorisation status of a further 21 bores before determining their status as IAA bores. The remaining 19 bores are currently under investigation by OGIA and will likely require some field verification to determine their status as IAA bores. Field verification has been significantly delayed due to the COVID-19 situation. OGIA will advise DES of the outcome of the investigations as they become available.

Due to the above changes, four IAA bores have been added from the Table G-3 and two IAA bores have been removed from the Table G-1 as a result of bore assessment, resulting in effectively 102 bores so far from the UWIR 2019.

In the UWIR 2019, there had also been 122 water bores similarly identified as IAA bores in previous UWIRs (Table G-2, UWIR 2019), for which bore assessment and make-good arrangements were progressing or completed. Added to the up-to-date list of 102 IAA bores, there is therefore a total of 224 bores that have been identified as IAA bores since the first UWIR in 2012.

Tenure holders have recently reported that some IAA bores could not be found during the bore assessment or similar processes, or that land holders may not have relevant authorisations for the bores. A review of the tenure holder submissions and relevant bore data is underway to determine their eligibility as IAA bores. Until a determination has been made, these bores' IAA status will remain. OGIA is also concurrently working with relevant agencies to clarify matters relating to Chapter 3 of the Act regarding the physical and legal status of a water bore.

4.4 Make-good arrangements

The regulatory framework under the Act allows for the provision of make-good arrangements where a bore is determined to be impaired, or likely to be impaired, as a result of P&G water extraction.

Generally, make-good negotiations will follow the completion of a bore assessment, which will determine if the bore is (or is likely to be) impaired. In some cases, however, make-good agreements are reached in advance of bore assessment.

An agreement about the make-good arrangement between the tenure holder and bore owner may not necessarily involve decommissioning of the water bore. The agreement may provide some form of compensation while the bore continues to serve. The agreement may also provide for a period of ongoing monitoring and a future date for review of the agreement.

Of the 224 effective IAA bores identified so far, make-good agreements have now been achieved for 117 bores. In most cases (about 100), the agreements have resulted in financial compensation. Additionally, tenure holders have proactively reached 112 agreements for bores that are not identified as IAA bores at this stage.

5 Implementation of the Water Monitoring Strategy

5.1 Overview of the UWIR 2019 Water Monitoring Strategy

The UWIR 2019 includes a Water Monitoring Strategy (WMS) which specifies a regional monitoring network, comprising groundwater pressure and water chemistry points, as well as the monitoring of water production volumes. The WMS monitoring network is designed for the collection of data to meet multiple objectives related to regional groundwater assessment. The primary objectives are to:

- improve understanding of system response within production areas
- identify pressure changes near specific areas of interest
- improve understanding of background trends in pressure
- provide sufficient data for model calibration.

The UWIR 2019 identifies each required monitoring point's location, target formation and responsible tenure holder, as well as a date by which the monitoring point must be established. As with previous UWIRs, the UWIR 2019 recognises that the locations of the identified sites may need to be altered during implementation due to practical operational issues. Tenure holders may propose, to OGIA, implementation requirement variations that overcome operational constraints while not undermining the overall objectives of the monitoring network.

During the design of the WMS monitoring network, each existing monitoring point was reviewed in terms of design criteria, network coverage and performance. Some monitoring points were added to the network, some were scheduled for repair, and some were removed due to there already being sufficient network coverage or due to updated predictions of impact. A summary of progress with the implementation of network since the UWIR 2019 is provided in the following sections.

The WMS monitoring network has progressively expanded since the initial Surat UWIR in 2012. In addition to the network required under the UWIR, OGIA also receives other data (non-UWIR data) from tenure holders within the Surat CMA. Overall, OGIA collectively receives data for more than 1,000 monitoring points every six months.

5.2 Implementation summary

In response to the COVID-19 situation, the movement of tenure holders into regional areas was progressively limited in late March 2020. During this early period of the pandemic, OGIA engaged proactively with DES to discuss the potential for COVID-19-related delays to the WMS implementation and any potential implications on OGIA's impact assessment. Since that time, a number of tenure holders have made representations to OGIA and DES seeking extensions on the construction of new monitoring completions and repairs due in 2020. In response to these requests, OGIA and DES have met on a number of occasions to discuss implications on a case-by-case basis. Extensions of between 6 and 12 months were approved by DES at some locations.

Additionally, in recent network implementation reports, tenure holders have reported a number of issues relating to meeting their WMS monitoring obligations. Issues currently being presented for consideration include the unavailability of deep-drilling rigs and land access. Since the UWIR 2019, OGIA has considered requests for moving 103 monitoring points compared to locations specified in the WMS. Reasons primarily relate to overcoming land access issues, requests to use nearby existing well pads or infrastructure, and the suitability of the identified infrastructure for ongoing monitoring

point (i.e. in the case of production well water chemistry sampling). Some of the proposals are currently under consideration by OGIA.

5.3 Groundwater pressure

At the time of the UWIR 2019, there were 436 operational groundwater pressure monitoring points. A further 69 were identified for replacement or repair, 83 were proposed to be added and 34 had not yet been completed from the previous UWIR. Since that time, 11 new monitoring points have been completed, 15 have been repaired and 9 have been replaced. The current number of operational monitoring points is 471. Progress with installation has been slower than anticipated, primarily due to logistical issues relating to the COVID-19 situation.

5.4 Groundwater chemistry

At the time of the UWIR 2019, there were 86 operational monitoring points for groundwater chemistry. A further 2 were identified for replacement or repair, 11 proposed, and 4 not yet completed from the previous UWIR. Since that time, one new monitoring point has been completed and one has been removed from the network.

For the first time, the UWIR 2019 includes the requirement to sample water chemistry from production wells. At the time of the UWIR 2019, this network included 141 existing production wells and 16 wells proposed in planned development areas. Since that time, five existing wells have been removed due to operational limitations on sampling from the identified wells.

5.5 Associated water extraction

In addition to the monitoring of groundwater pressure and chemistry, tenure holders are required to report the volume of associated water produced by CSG wells. For the UWIR 2019, water volumes were available for around 6,000 production wells in 2018. Since that time, OGIA has received data for an additional 760 wells. Note that some of the production wells may not report any volume because either they may not be in production at the time or they may be producing negligible amount. A total volume of 54,000 ML was produced from CSG wells in 2019.

Recent discussions with industry have highlighted challenges in measuring water extraction when wells transition into the production phase. During the initial development phase, discharge is dominated by water (see Figure 2-4, UWIR 2019). As the reservoir is depressurised and wells transition into the production phase, discharge is progressively dominated by gas, resulting in typically more recorded than actual volume. OGIA is currently investigating and verifying measurement methods applied by individual tenure holders.

5.6 Data availability

Responsible tenure holders also provide monitoring data to OGIA every six months, in April and October each year. This includes a network implementation report, water monitoring report and monitoring point construction information. OGIA reviews each data submission for completeness and technical accuracy. Within three months of each submission, data is publically available on the Groundwater Database (GWDB) and the Queensland Globe.

5.7 Update on trends in groundwater pressure

To support the preparation of the UWIR 2019, a detailed analysis of groundwater pressure trends in aquifers adjacent to the Walloon Coal Measures was completed to assess the influence of CSG

groundwater extraction on groundwater pressure. The key findings presented in the UWIR were as follows:

- There is widespread CSG impact in the Walloon Coal Measures, up to 100 m in the upper part of the formation and up to 250 m in the lower part.
- In the overlying Springbok Sandstone, groundwater pressure trends are mixed (both raising and declining), although there is evidence of CSG impacts at some locations.
- In the underlying Hutton Sandstone, pronounced declining trends are observed, but these are likely due to increasing non-CSG water use.
- In the Precipice Sandstone, reinjection has led to rising groundwater pressure trends in the northern parts of the Surat Basin.

Since the UWIR 2019, additional monitoring data has been collected by industry and a preliminary analysis of this information has been completed by OGIA. In parallel, OGIA is developing and testing new methods for analysing groundwater pressure trends, with the primary objective of separating the influence of CSG impact signals from background trends. This research work is in progress and final outcomes are likely to be available in mid-2021, for inclusion in the UWIR 2021.

In the interim, an update to the findings presented in the UWIR, based on ongoing analysis of the monitoring data, are summarised as follows:

- Consistent with the UWIR 2019, CSG impacts in the Walloon Coal Measures are largely restricted to the gas fields themselves and the immediately surrounding areas. More significant declines are observed in the lower parts of the Walloon Coal Measures.
- Groundwater pressures in the Springbok Sandstone continue to show variable – both rising and declining – trends across the formation. At most locations, the observed trends are consistent with those reported in the UWIR 2019 and show minimal departure from background trends.
- Declining groundwater pressure trends continue to be observed across the Hutton Sandstone. However, the magnitude and rate of decline varies spatially, with more significant declines observed between Miles and Dalby. At two locations – Daandine-121 (RN 160350A) and Glenburnie-18 (RN 160941B) – an increased rate of decline is observed over the last 12 months.
- In the Condamine Alluvium, groundwater pressures continue to show stable to minor declining trends across the groundwater system. Consistent with the UWIR 2019, observed trends continue to correlate reasonably well with longer-term dry and wet periods and it is unlikely that observed trends relate to CSG water extraction in the Walloon Coal Measures.
- In the Precipice Sandstone, observed groundwater pressure trends continue to show a consistent response to Origin’s reinjection scheme, particular in areas north of Roma and Miles. Since late 2017, reinjection rates reduced from around 550 to 400 ML per month. Over the recent period, this change is expressed as a stabilisation of previously increasing trends and slight declines at monitoring locations further from the reinjection locations.

6 Implementation of the Spring Impact Management Strategy

6.1 Overview of the UWIR 2019 Spring Impact Management Strategy

The Spring Impact Management Strategy (SIMS) in the UWIR 2019 identified springs that may be at risk due to underlying aquifers being affected by CSG water extraction. The criteria for identifying potentially affected springs are conservative – springs overlying aquifers with predicted long-term pressure impacts of 0.2 metres or more are identified as potentially affected.

In addition to these known spring sites, OGIA completed a desktop assessment in 2017 to identify potentially gaining watercourse springs. In the UWIR 2019, the SIMS identifies some of these reaches for field verification by a responsible tenure holder (Table I-4, UWIR 2019).

Based on the predictions of impacts and a follow-up risk assessment, six groups of springs were identified for mitigation actions. For those springs, the UWIR 2019 requires the responsible tenure holder – Santos – to develop a plan and actions to mitigate predicted impacts.

As noted in Chapter 2, there have been changes to the cumulative industry development profile since the UWIR 2019. These changes have resulted in alterations to the magnitude and timing of predicted impacts as described in Chapter 3; however, they do not significantly change the situation with regard to predicted impacts at the majority of spring locations.

6.2 Update on spring monitoring

The UWIR 2019 includes a risk assessment for springs and specifies a monitoring program for nine spring complexes and eleven watercourse springs that are at higher risk of being affected. Responsibility for implementing the monitoring program is assigned to individual tenure holders.

The objectives of spring monitoring are to understand the natural variability in spring discharge and to better understand the source aquifers that feed the springs at some locations. This understanding will ensure that any future impacts from CSG water extraction are correctly identified.

The recently available wetland mapping at spring vents indicates generally drier conditions. This broadly correlates with a period of lower-than-average mean monthly rainfall and potentially an increase in non-groundwater-related stressors on the wetlands. However, at some locations, background trends in groundwater pressure in the springs' source aquifers show consistent minor declines in groundwater pressure. In parallel, the recently available stream gauging information from Hutton Creek and the Dawson River suggests a minor reduction in groundwater discharge to stream. This may also be related to the recent period of lower-than-average mean monthly rainfall. OGIA will further investigate these trends to determine the primary influences on the observed trends.

6.3 Update on watercourse validation

In the UWIR 2019, the SIMS identifies some reaches for field verification and assigns responsible tenure holders (Table I-4, UWIR 2019). Field verification is expected to include a dry season longitudinal survey of the reaches to determine if groundwater is discharging to surface and to identify source aquifers. The UWIR 2019 suggests field methods including surface water chemistry analysis, stream gauging, and measurement of water levels and chemistry in nearby water bores.

Responsible tenure holders are required to provide OGIA with a *watercourse spring investigation report* within 12 months of the approval of the UWIR. OGIA will review the outcomes from these investigations and specify new tenure holder obligations where appropriate. A number of tenure holders have received 12 month extensions from DES in relation to this obligation. Outcomes from these investigations will be incorporated into the impact assessment for the UWIR 2021.

6.4 Update on spring impact mitigation

The UWIR 2019 identified a spring mitigation strategy to prevent, minimise or mitigate the impact of P&G water extraction on springs. Based on the predictions of impacts and a follow-up risk assessment, six groups of springs were identified for mitigation actions.

Four of the six spring groups (Springrock, 311/Yebna 2, Lonely Eddie and Lucky Last) were assigned to Santos to prepare and submit a Spring Impact Mitigation Plan (SIMP) for approval by DES. Following further consideration, however, DES determined that the SIMP should instead be endorsed by OGIA, prior to submission to DES. Upon receipt of the endorsed SIMP, DES will provide a direction to OGIA to include the endorsed SIMP in the UWIR through an appropriate mechanism.

Consistent with this determination, OGIA has been reviewing the technical content and effectiveness of the SIMP submitted by Santos. Following ongoing discussions and feedback from OGIA, two iterations of the SIMP have been submitted, with a third iteration underway. While the SIMP is yet to be finalised, current progress in relation to mitigation actions at the four spring groups assigned to Santos is summarised below.

Santos is proposing three parallel streams of work as part of the SIMP:

1. **Mitigation actions** that would bring the residual risk to ‘low’ based on the current risk profile and predictions identified in the UWIR, unless there is evidence to suggest that the risk profile is different to that identified in the UWIR. Mitigation actions would be triggered by the likelihood of CSG impacts occurring at early warning indicator sites. Actions would then be implemented within one to two years of this determination.
2. **Trigger monitoring and reporting** based on OGIA’s ongoing assessment of trends in groundwater pressure monitoring data. Santos will undertake monitoring and provide data to OGIA. OGIA will undertake a yearly assessment of this monitoring data to identify the likelihood of CGS impacts occurring at early warning indicator sites, and notify the outcome to Santos and DES to trigger actions.
3. **Ongoing investigations** at a number of spring groups to further improve knowledge about impact pathways and springs response to those impacts. These investigations will occur in parallel with the mitigation actions and trigger monitoring.

A specific update for each of the four spring groups is provided below.

Springrock

The risk assigned for this group in the UWIR 2019 is assigned high. Santos has contemplated that the risk to Hutton Creek W216 is likely to be lower, but further work is required to support this conclusion. In parallel, Santos has committed to implementing a flow augmentation scheme by extracting water from a nearby Precipice Sandstone aquifer. The action will be triggered within two and one years, respectively, of confirmation of CSG impacts at early warning monitoring locations.

311/Yebna 2

The unmitigated risk for this group in the UWIR 2019 ranges from medium to high. Santos is also contemplating a lower risk for this site, subject to some further investigations. In the meantime, the proposed mitigation actions are based on the UWIR 2019 risk profile. Two mutually exclusive actions are proposed:

- offset of drawdown from Origin's reinjection scheme in early stages until around 2030, followed by the retirement of Santos's groundwater extraction licence
- stock control measures to improve wetland resilience to impact.

Since the reinjection by Origin is already occurring, no further trigger is required for immediate actions; however, Santos will submit a firm agreement to retire groundwater extraction from a nearby location before the end of 2021, so that this action can be triggered within a year of the reinjection scheme ceasing operation or failing.

Lucky Last

At this spring group, the unmitigated risk is medium, but Santos contemplates a lower risk. OGIA recognises that there is some ambiguity around the impact pathway for this spring, and the implications on predicted impacts. OGIA is investigating the matter further with recently acquired electro-magnetic data. Until the results from the investigations are available and the risk profile is revised, Santos's mitigation actions are based on the current risk.

Similar to Spring Group 311, two mutually exclusive actions are proposed:

- offset of drawdown from retiring landholder groundwater extraction.
- stock control measures to improve wetland resilience to impact.

The action to offset drawdown will be triggered within one to two years, of confirmation of CSG impacts at specific monitoring locations. These monitoring locations are based on early warning indicators so that actions can be implemented ahead of actual impacts occurring at the spring site. Santos is also committed to providing evidence of an agreement with the landholder by the end of 2021.

Lonely Eddie

This was assessed as high risk in the UWIR 2019; however, investigations since that time show that the local source aquifer is not connected to the aquifer from which CSG-related drawdown is predicted. Based on the information provided, OGIA concurs that the risk to this spring group is low and that no further actions are required at this stage.

Horse Creek

This spring group was assigned to QGC, but the UWIR 2019 did not require a mitigation plan at this stage, because of some uncertainty relating to the connectivity of Horse Creek with impacted aquifers, and an ongoing investigation by QGC.

QGC is finalising its investigations at this location; however, preliminary information provided by QGC to OGIA indicates that this creek is disconnected from groundwater. While OGIA will await the final report, it is likely that a mitigation plan will not be required at this location.

Cockatoo Creek

The risk in the UWIR 2019 was assessed as medium and no responsible tenure holder was identified. At this location, reinjection by Origin into the Precipice Sandstone is predicted to reduce impacts to less than the 0.2 metre trigger threshold. OGIA has committed to undertake further investigations.

The current investigations include a detailed evaluation of the Surat – Bowen Basin contact zone near Wandoan, which is the potential impact propagation pathway in this area. In parallel, 3D seismic data recently acquired by Origin will provide additional information on the Leichhardt-Burunga Fault and the lateral connectivity of the Precipice Sandstone in this area. This will provide the necessary information to improve the predictions of impact to this spring group in the UWIR 2021.

7 Update on research projects

7.1 Overview

OGIA is continuing to update and build knowledge about the regional groundwater flow system through its ongoing research programs, industry initiatives and research by other organisations.

Knowledge about the groundwater flow system continues to improve as data accumulates and is used to build knowledge through targeted research. The UWIR 2019 identified further research in the following key areas:

- **Groundwater flow modelling:** continued refinement of the current regional groundwater flow model and exploration of options to address challenges associated with modelling scale.
- **Trend analysis:** ongoing analysis of additional groundwater monitoring data to identify impacts associated with CSG development.
- **Hydrogeological conceptualisation:** further targeted assessment of the hydrogeological characteristics of geological faults (particularly the Horrane Fault), aquifer interconnectivity, regional groundwater flow patterns and groundwater flow in the Precipice Sandstone.
- **Data management:** verification of bore aquifer attribution, the location and status of water bores, and better public access to data and information.

Since the release of the UWIR 2019, a range of additional data sets have become available, particularly geological and formation properties data from additional CSG wells and groundwater monitoring data, established through the UWIR obligations as well industry's own monitoring initiatives. OGIA is now in the process of building knowledge from these additional data sets and has been progressing this research work, while in parallel integrating coal mining impacts in the Surat Basin following an amendment to the Surat CMA in January 2020.

A summary of the key research projects being implemented is provided below.

7.2 Update of the geological model

Since the release of the UWIR 2019 and the integration of coal developments, the primary geology focus has been to compile and process extensive data sets from Surat coal mines that include more than 18,000 coal bores, 5,000 stratigraphic markers and several mine geomodels. Logs from an additional 1,500 new petroleum wells have also been interpreted. This new data will continue to inform both conceptualisation and modelling projects.

The regional geological model, which underpins OGIA's groundwater flow model, has also been updated by including, for the first time, a geological subdivision of the Walloon Coal Measures (Upper Juandah, Lower Juandah and Taroom coal measures) based on all the available interpretations.

OGIA has also constructed sub-regional geological models both to assist with the conceptualisation around coal areas and to support the development of sub-regional cumulative groundwater impact models to represent a higher level of detail.

The extent for the Alluvium, Main Range Volcanics and other Cenozoic units has also been revised to produce higher confidence aquifer attribution where these units are present.

OGIA is also working on long-term improvements to its geological model, including the depth conversion of seismic data (through the University of Queensland (UQ)) and correlation of key

stratigraphic surfaces, which is likely to improve OGIA's geomodel in areas where data has previously been relatively scarce.

7.3 Hydrogeological conceptualisation

A range of activities are underway to improve hydrogeological conceptualisation and ongoing integration of new and improved knowledge with trend analysis and modelling. Some of the key activities include the following:

- Characterisation of the Springbok Sandstone contact with the Walloon Coal Measures to better understand the permeability structures within the Springbok Sandstone and improve prediction of impacts in this formation.
- Improved understanding of heterogeneity within the Hutton Sandstone, its hydrogeological characteristics and those of any potential connectivity features such as faulting – including further analysis of groundwater pressure trends and hydraulic gradients.
- Assessment of lateral and vertical connectivity of the Precipice Sandstone in target areas, to improve understanding of impact pathways for CSG and conventional oil and gas induced impacts. The focus is on areas in and around the Moonie wellfield and contact zones associated with the Peat field and the Hutton-Wallumbilla Fault. This will also incorporate more recent investigations by UQ and Origin.

7.4 Trends in groundwater pressure

As mentioned in section 5.7, OGIA is currently undertaking a detailed review of the available groundwater pressure and chemistry data for aquifers in the Surat CMA. The project is focused on investigating a range of potential causes for observed pressure declines in aquifers adjacent to CSG reservoirs – the Condamine Alluvium and the Hutton, Springbok and Precipice sandstones.

As reported in the UWIR 2019, monitoring data is affected by a range of influences such as climatic factors, CSG stresses and non-CGS stresses. OGIA therefore used a multiple-lines-of-evidence approach in analysing trends for CSG impacts. Since the UWIR 2019, OGIA has been trialling other methods for a more sophisticated and quantitative approach for such analysis, utilising novel signal separation techniques. The work is currently underway and interim outcomes are expected to be available for the UWIR 2021.

7.5 Fault hydrogeology

Building on the revised conceptualisation of major fault systems completed as part of the geological modelling work (section 7.2), OGIA undertook a project aimed at first mapping and then understanding the likely hydrogeological behaviour of minor faults – as reported in the UWIR 2019.

Since the UWIR 2019, OGIA is conducting targeted projects aimed at improving the understanding around key faults in the basin, including development of a 3D geological model around the Horrane Fault and acquisition of airborne electro-magnetic (AEM) data around the Horrane Fault. This work is currently underway. In parallel, OGIA is also utilising newly collected AEM data from Geoscience Australia to update its understanding of the Hutton-Wallumbilla Fault.

7.6 Refinement of the non-CSG water use estimate

OGIA continues to refine the method used to estimate non-CSG water extraction from unmetered bores. The method considers property size, livestock-carrying capacity and the availability of other water supplies to estimate the groundwater demand. The method also differentiates between rural, urban and peri-urban properties.

This information is an important component of the regional water balance and a key input to the regional groundwater model. Since the UWIR 2019, OGIA has commissioned UQ to extend its metering project through a new collaboration until late 2023. Additional metering will be used to improve and refine the methods to estimate water use.

7.7 Improvements to groundwater flow modelling

OGIA is currently running three parallel streams of work for its ongoing improvement of groundwater flow modelling.

Regional groundwater model update

A number of targeted improvements are currently being implemented for an update to OGIA's regional groundwater model. These include both structural changes through the inclusion of the subdivision of the Walloon Coal Measures and adjustments to fault zones based on new geophysical data, as well as the inclusion of updated calibration data sets to capture the latest monitoring data in the Surat Basin.

Modelling of coal impacts

Work is also underway to develop a proof of concept for the modelling of cumulative impacts around coal mines in the Surat CMA. This work includes several components:

- development of novel methods to characterise and model near-surface groundwater systems
- representation of both CSG and coal stresses in the near surface
- development of new calibration and uncertainty methodologies

While this work is initially focused on coal mines, the methods developed here are likely to also bear relevance for future impact modelling in shallow CSG areas.

Next-gen groundwater modelling

In parallel with the above, OGIA is also exploring new ways to improve future modelling of groundwater impacts at specific receptors. The approach starts at the receptor and works backwards to conceptualise critical components that need to be captured by a model. The new approach will also aim to calibrate models directly to impact drawdown, where it can be determined from monitoring data. This will ensure the models are constrained by data pertinent to the predictions they are designed to make.

7.8 Assessment of impacts to environmental values

A legislative change in 2016 extended the scope of the UWIR to include a description of impacts on environmental values (EV) arising from the exercise of underground water rights. The UWIR 2019 included an assessment of impacts on EVs for the first time. Since then, OGIA has focused on improving this assessment with a particular focus on subsidence. OGIA's work is focused on the following elements:

- improving the methodology for the prediction and risk of subsidence
- improving knowledge about the potential consequences of subsidence, with a focus on farming systems in the Condamine Alluvium
- integrating the available monitoring information (on-ground and remotely sensed) to integrate into the overall assessment of impacts to EVs.

OGIA has also held meetings and a workshop with landholders to map out relevant issues, particularly the consequences of ground movement. Further work is underway and will be reported in the UWIR 2021.

7.9 Improvements to water bore data

Data and information collected during bore and baseline assessments provides a contemporary snapshot of information on water bores. In many cases, there is limited recent information available on these bores in the GWDB; there is therefore significant value in transitioning non-confidential information to the GWDB for a range of natural resource management purposes.

OGIA has commenced the data migration process with DRDMW. At this stage, bore location data has been updated on the GWDB. For other information, such as water level and water chemistry, OGIA is working with DRDMW. In parallel, OGIA is progressing an alternative avenue to make relevant bore and groundwater data available via the Open Data Portal.

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