NEW HOPE GROUP

GROUNDWATER MANAGEMENT AND MONITORING PLAN

New Acland Coal Mine Stage 3 Project

OCTOBER 2020

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1. Introduction

1.1. Background

This Groundwater Management and Monitoring Plan (GMMP) has been prepared to address the predicted impacts on groundwater at and surrounding the site of the proposed Stage 3 Expansion of New Acland Coal Mine (Project), south and west of New Acland Coal Pty Ltd's (NAC) current mining operation. It sets out the groundwater monitoring program for the Project and the associated groundwater impact triggers that will invoke further assessment and groundwater impact management. The GMMP is designed to enable compliance with the Project's Commonwealth and State regulatory requirements for groundwater management. The GMMP will be administered as a specialised environmental management plan for the Project's mining operations.

Groundwater management for the Project has received approval conditions from Queensland Coordinator General (CG), Queensland Department of Environment and Science (DES) and the Commonwealth Department of Environment and Energy (DEE).

Therefore, the GMMP has currently been prepared in accordance with:

- imposed condition 10 of the Queensland Coordinator-General (CG)'s imposed conditions on the Project as outlined within the CG's December 2014 Evaluation Report for the Project;
- the relevant Environmental Authority EPML00335713 (EA) (dated 12 March 2019) conditions for the Project; and
- the relevant conditions within the Commonwealth EPBC Act Approval (in particular condition 13) for the Project (EPBC 2007/3423), including the requirements detailed within the following supporting documents to that Approval:
  - IESC advice statement 2015-073; and
  - IESC advice statement 2016-081.

The Project is still awaiting approval of its Associated Water Licence (AWL) and new MLs 50232 and 700002. Following grant of these additional primary approvals, this GMMP will be subject to amendment and finalisation as necessary to address the AWL's requirements. In addition, NAC will seek amendment of the Project's EA to ensure it properly incorporates the implementation of this GMMP.

1.2. Objectives

The objectives of this GMMP are to:

- provide a monitoring regime to detect, identify and characterise the Project's impacts to groundwater;
- act as a guidance tool for Site operational personnel during operation of the Project;
- provide groundwater impact triggers for incorporation into the Project's EA;
- provide operational protocols for impact investigation, management and mitigation should impacts to groundwater occur during the Project's operation;
- outline a review and improvement process for the Project's groundwater model;
- provide robust data from which to inform the review and improvement process for the Project's groundwater model; and
- ensure compliance with the Project's approval conditions.

1.3. Document Structure

The GMMP is structured as follows.

- Section 2: describes the hydrogeologic setting of the Project.
- Section 3: describes the groundwater model for the Project and its predicted impacts on groundwater from the Project's operations.
- Section 4: describes the groundwater monitoring program for the Project site including monitoring locations, monitoring frequency, and the parameters to be recorded/analysed.
- Section 5: sets out the Quality Assurance and Quality Control procedures for the Project's groundwater monitoring program.
- Section 6: presents the baseline groundwater conditions for the Project based on monitoring data collected in the groundwater monitoring program to date.
- Section 7: sets out the groundwater impact triggers and protocols for investigating, and if required, mitigating the impacts on groundwater from the Project's operations.
- Section 8: describes the process of continual review and improvement of the GMMP to ensure it continues to meet its objectives.

1.4. Relevant Conditions

The current Project approval conditions relevant to this GMMP are detailed in **Table 1.**

Table 1 Project conditions relevant to this GMMP[1]

Approval	Condition Number	Details[2]
Coordinator - General's December 2014 Report	10 (imposed)	Groundwater Management and Monitoring Program (a) A Groundwater Management and Monitoring Program must be developed and certified by an appropriately qualified person which addresses all phases of the mining operation approved under the project's environmental authority ('project's EA'). (b) The groundwater management and monitoring program must be provided to the administering authority for the *Water Act 2000* for approval in accordance with the requirements of the baseline monitoring program in relevant conditions of the project's EA. (c) The groundwater management and monitoring program must be developed to ensure that the plan meets the following objectives: (i) validation of groundwater numerical model (including review of boundary and recharge conditions) to refine and confirm accuracy of groundwater impacts predicted; (ii) groundwater level monitoring in all identified geological units present across and adjacent to the mine site to confirm existing groundwater flow patterns and monitor drawdown impacts;[3]

[1] This GMMP is the "groundwater management and monitoring program" referred to in the Coordinator-General's conditions and Draft EA and the "Groundwater Management and Monitoring Plan" referred to in the EPBC approval conditions referenced in this table.
[2] Footnotes have been included in this table, where relevant, to cross reference specific requirements of the conditions against the sections of this GMMP addressing those specific requirements. More general obligations have not been cross referenced given that they are addressed more generally by this GMMP.
[3] Refer to section 4 of this GMMP.

		(iii) estimation of groundwater inflow to mine workings and surface water ingress to groundwater from flooding events using the groundwater model;[4] (iv) monitoring in any identified source aquifers for alternative water supplies, relevant to any approval issued under the *Water Act 2000* for the project;[5] (v) monitoring of geological units throughout all phases of project life including for the period post-closure as required by the administering authority for the *Water Act 2000*; (vi) identifying monitoring bores that will be replaced due to mining activities; and[6] (vii) to ensure all potential groundwater impacts from mine dewatering and mine water and waste storage facilities (artificial recharge) are identified, mitigated and monitored. (d) A copy of the approved groundwater management and monitoring program is to be provided to the Commonwealth Department of the Environment and Energy.
Coordinator - General's December 2014 Report	11 (imposed)	Monitoring Program Review (a) The groundwater management and monitoring program required under condition 10 must be reviewed by an appropriately qualified person in conjunction with the Groundwater Model Review (Condition 12, below) with a report provided on the outcome of the review to the administering authority within two years from the issuing of the project's EA and mining lease/s required for the project; and then no later than 1 July every 3 years following. The review must include: (i) an assessment of the outcome of the groundwater management and monitoring program against the objectives in the project's EA (ii) a review of the adequacy of the monitoring locations, frequencies and groundwater quality triggers specified in the project's EA (iii) a review of the adequacy of the groundwater monitoring program to support the requirements outlined in Condition 12.
Coordinator - General's December 2014 Report	12 (imposed)	Groundwater model review (a) The numerical model in the report titled 'Groundwater Model Technical addendum' - New Acland Coal Stage 3 Project (AEIS, 2014) must be reviewed to incorporate groundwater monitoring data and measured mine dewatering volumes from the groundwater management and monitoring program in the project's EA. (b) The review must be conducted within 2 years of commencement of any mining activities associated with any mine box cut excavation for the project and at least every 3 years thereafter, or at other intervals specified by the administering authority for the Water Act 2000 in writing, if the observed groundwater levels are not consistent with those predicted by the latest version of the groundwater model. (c) The review must provide a revised numerical groundwater model outlined in condition 12a), which incorporates additional relevant data associated with the Oakey Creek alluvial aquifer. The revised model must include:

[4] Refer to section 8.1 of this GMMP.
[5] Refer to section 4 of this GMMP.
[6] There are no such bores located within the mining footprint. Bores close to the mining footprint are identified in section 8.4.

		(i) review of the hydrogeological conceptualisation used in the previous model (ii) an update of the predicted impacts (iii) revised water balance model (iv) review of assumptions used in the previous model (v) predictions of changes in groundwater levels for a range of scenarios (vi) information about any changes made since the previous model, including data changes (vii) a report outlining the justification for the refined model and the outputs of the refined model (viii) an evaluation of the accuracy of the predicted changes in groundwater levels and recommended actions to improve the accuracy of model predictions (d) A report outlining the findings and any recommendations from the review under condition 12, must be completed by an appropriately qualified person and submitted to the administering authority for approval no later than 3 months after the commencement of the review. (e) A copy of the approved report relating to conditions 11 and 12 is to be provided to the Commonwealth Department of the Environment and Energy.
EA	D2	All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.
EA	D3	Groundwater quality and levels must be monitored at the locations and frequencies defined in Table D1 - Groundwater monitoring locations and frequency for quality characteristics identified in Table D2 - Groundwater quality triggers and limits.[7]
EA	D4	Groundwater levels when measured at the monitoring locations specified in Table D1 - Groundwater monitoring locations and frequency must not exceed the groundwater level trigger change thresholds specified in Table D3 - Groundwater level monitoring.
EA	D5	If quality characteristics of groundwater from compliance bores identified in Table D1 - Groundwater monitoring locations and frequency exceed any of the trigger levels stated in Table D2 - Groundwater quality triggers and limits or exceed any of the groundwater level trigger threshold stated in Table D3 - Groundwater level monitoring, the holder of this environmental authority must compare the compliance monitoring bore results to the reference bore results and complete an investigation in accordance with the ANZECC and ARMCANZ 2000.
EA	D6	Results of monitoring of groundwater from compliance bores identified in Table D1 - Groundwater monitoring locations and frequency must not exceed any of the limits defined in Table D2 - Groundwater quality triggers and limits.
EA	D7	The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.
EA	D8	The approved Groundwater Management and Monitoring Program required by Imposed Condition 10, in Appendix 1, of the CG's report must be provided, to the administering authority, within 20 business days of it being approved.

[7] Refer to section 4 of this GMMP.

EA	D9	In addition to the requirements of Imposed Condition 10 in Appendix 1 of the CG's report, a plan must be developed and certified by an appropriately qualified person to meet the following objectives: a) identification of groundwater drawdown level thresholds for monitoring the impacts to Groundwater Dependant Ecosystems; and b) collection and analysis of data that identifies natural groundwater level trends for identification of water level impact to authorised water users from the mining operation as required by Schedule 3, recommended Condition 1 in Appendix 3 of the CG's report. The plan must be provided to the administering authority in conjunction with submission of the approved program in Condition D8.
EA	D10	The environmental authority holder must provide the approved report required by Imposed Condition 11 , in Appendix 1, of the CG's report, to the administering authority, within 20 business days of it being approved.
EA	D11	The plan required under Condition D9 must be reviewed by an appropriately qualified person in accordance with the requirements of Imposed Condition 11 in Appendix 1 of the CG's report, and be provided to the administering authority in conjunction with the submission of the approved report in Condition D10.
EA	D12	The environmental authority holder must provide the approved report required by Imposed Condition 12, in Appendix 1, of the CG's report, to the administering authority, within 20 business days of it being approved.
EA	D13	As a component of the second and subsequent reviews of the New Acland Coal numerical groundwater model the environmental authority holder must provide an approved (under Water Act 2000) report outlining the impact on the Oakey Creek Alluvial aquifer, to the administering authority. The report should: a) Establish any identified impact associated with mining activities, if any, on the Oakey Creek Alluvial aquifer; b) Include an assessment of natural and potential pumping based water level variation caused by non-mining authorised users, in the Oakey Creek Alluvial aquifer; c) Outline any requirements for additional modelling or monitoring required; d) If the investigation under Condition D13 a) concludes that there is an identified impact on the Oakey Creek Alluvial aquifer as a result of mining activities, the environmental authority holder must determine the volumetric impact associated with the identified impact; and e) If the impact is determined to be the result of mining activities, the environmental authority may be required to construct additional monitoring bores. Additional monitoring bores are to be incorporated in the Groundwater Monitoring and Management Plan required by Condition D8.
EA	D14	The environmental authority holder must determine the long term impact of the take of water from the Main Range Volcanics aquifer and incorporate this into the 2nd review of the New Acland Coal numerical groundwater model pursuant to Conditions D8 - D12.
EA	D15	A groundwater monitoring network must be maintained. The network must: a) be installed and maintained by a person possessing appropriate qualifications and experience in the fields of hydrogeology and

		groundwater monitoring program design to be able to competently make recommendations about these matters; b) be constructed in accordance with methods prescribed in either the latest edition of the Agriculture and Resource Management Council of Australia and New Zealand manual titled 'Minimum Construction Requirements for Water Bores in Australia' or the 'Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland', whichever applies; and c) include a sufficient number of 'bores of compliance' that are located at an appropriate distance from potential sources of impact from mining activities and provides the following:[8] (i) representative groundwater samples from the uppermost aquifer; and (ii) background water quality in hydraulically up-gradient or background bore(s) that have not been affected by any mining activities to groundwater's; and (iii) the quality of groundwater downgradient of any potential source of contamination including groundwater passing the relevant bore(s) of compliance.
EPBC Approval 2007/3423	9	The approval holder must undertake management and monitoring of water resources in accordance with: i. the Environmental Authority issued for the project under the Environmental Protection Act 1994 (Qld); and ii. the requirements of any conditions regarding groundwater to be impose by the authority responsible for administering the Water Act 2000 (Qld).
EPBC Approval 2007/3423	12	The approval holder must submit a Groundwater Management and Monitoring Plan (GMMP) to the Minister for written approval. Mining activities must not commence until the GMMP has been approved by the Minister in writing. The approval holder must implement the approved GMMP.
EPBC Approval 2007/3423	13	The GMMP must include: i. details of a groundwater monitoring network to measure impacts to groundwater quality and drawdown as a result of the action, including: a. control monitoring sites;[9] b. details of the physical groundwater conditions, analytes, contaminants and physico-chemical properties to be monitored;[10] c. sufficient bores to determine the lateral extent of groundwater drawdown and flow direction and monitor potential impacts on groundwater resources and the effect of faulting on groundwater drawdown; and[11] d. a rationale for the design of the monitoring network with respect to the nature of potential impacts;[12] ii. baseline monitoring to determine existing groundwater quality within the project area, particularly adjacent to the location of the proposed pits;[13] iii. baseline monitoring data including a detailed bore census and investigation of bores in the area likely to be impacted;[14]

[8] Refer to section 4 of this GMMP.
[9] Refer to section 4 of this GMMP.
[10] Refer to section 4 of this GMMP.
[11] Refer to section 4 of this GMMP.
[12] Refer to section 4 of this GMMP.
[13] Refer to section 4 of this GMMP.
[14] Refer to section 6 of this GMMP.

		iv. details of the location of monitoring bores to use as early warning indicators of groundwater drawdown propagation;[15] v. threshold triggers for early warning monitoring bores based on modelled impacts to water resources;[16] vi. groundwater drawdown limits for impacts to the Oakey Creek Alluvium and Tertiary Basalt Aquifers;[17] vii. measures and timeframes to report and verify any exceedance of threshold triggers or drawdown limits to the Department;[18] viii. a process to submit additional mitigation measures including a review of the appropriateness of the existing threshold triggers to the Department for approval in the event a threshold trigger is exceeded;[19] ix. an outline of the proposed methodology to assess groundwater connectivity between each hydrogeological unit using nested bore arrays;[20] x. mechanisms for addressing the impacts of the action to groundwater resources, including details of measures for impacts to water bores and offsets for the Oakey Creek Alluvium and Tertiary Basalt Aquifers;[21] xi. a timeframe for when the measures and offsets for impacts to groundwater resources will be implemented;[22] xii. a timeframe for a regular review of the GMMP in accordance with the requirements of the conditions to be imposed by the authority responsible for administering the Water Act 2000, and subsequent updates of the GMMP, including to incorporate the outcomes of the groundwater model reviews (condition 16 of this notice); and[23] xiii. address the groundwater management measures outlined in the IESC advice.[24]
EPBC Approval 2007/3423	13A	If monitoring reports, based on threshold triggers for early warning monitoring bores, indicate that a groundwater drawdown limit will be substantially exceeded, the Minister may: i. require the approval holder to suspend mining operations; or ii. suspend or revoke an approval under section 144 and section 145 of the EPBC Act. To avoid any doubt, this condition does not limit the application of section 144 or section 145 of the EPBC Act, if the Minister believes that the action will have a significant impact that was not identified in assessing the action.
EPBC Approval 2007/3423	14	The Minister may submit the GMMP to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) or other independent expert for review before making a decision on whether to approve it under condition 12.
EPBC Approval 2007/3423	15	The GMMP, including any revisions of the GMMP, must be peer reviewed by a suitably qualified expert before the GMMP is submitted for approval. A peer review must be submitted to the Minister together with the GMMP and a statement from the suitably qualified expert stating that they carried out the peer review and accept the findings and the content of the GMMP.

[15] Refer to section 4 of this GMMP.
[16] Refer to section 7.1 of this GMMP.
[17] Refer to section 7.1 of this GMMP.
[18] Refer to section 7.2 of this GMMP.
[19] Refer to section 7.2 of this GMMP.
[20] Refer to section 4 of this GMMP.
[21] Refer to section 7.3.3 of this GMMP.
[22] Refer to section 7.3.3 of this GMMP.
[23] Refer to section 8 of this GMMP.
[24] This GMMP.

EPBC Approval 2007/3423	16	The approval holder must undertake groundwater model reviews in accordance with the requirements of the conditions imposed by the Queensland Coordinator-General under section 54B of the State Development and Public Works Organisation Act 1971. The reviews must address all matters raised in the December 2015 and 2016 IESC advice in regards to groundwater modelling. In addition, groundwater model reviews must be undertaken by a suitably qualified expert and must include: i. validation of the existence and nature of faulting and its potential effect on the predicted lateral extent of groundwater drawdown; ii. updated groundwater resource user abstraction data; iii. a review of predicted volumetric impacts to a groundwater resource; and iv. ongoing model evaluation including comparison between observed and modelled heads for each formation, across pre-mining, operations, postmining and long term phases.
EPBC Approval 2007/3423	17	The approval holder must make groundwater monitoring and modelling data available to the Department and Queensland Government authorities (if requested) for inclusion in any cumulative impact assessment, regional water balance model and/or bioregional assessment.
IESC Advice December 2016	10a	Install or adopt existing groundwater monitoring bores to use as indicators of early warning of drawdown propagation. Early-warning bores should be suitably located between the proposed project and an environmental/economic objective or asset. Early-warning bores could also be used to validate the groundwater model's drawdown predictions.[25]
IESC Advice December 2016	10b	An outline of the proposed methodology to assess groundwater connectivity between each hydrogeological unit using nested bore arrays (to support identification of impact to overlying and underlying hydrogeological units).[26]
IESC Advice December 2016	10c	A methodology to undertake groundwater quality monitoring to determine existing groundwater conditions within the proposed project area with a particular focus on the region in the immediate vicinity of where the proposed open cut pits are to be located. These data should be gathered prior to and during the early stages of mining and could build on any existing groundwater quality monitoring that occurs at the existing New Acland operation.[27]
IESC Advice December 2016	10d	Details of the proposed ongoing groundwater monitoring, including identification of physical groundwater conditions, analytes, contaminants and physico-chemical properties to be monitored.
IESC Advice December 2016	10e	An outline of the ongoing fault hydrogeological studies to be undertaken as mining progresses.

[25] Refer to section 4 of this GMMP.
[26] Refer to section 4 of this GMMP.
[27] Refer to section 4 of this GMMP.

2. Project Setting

This section describes the Project's hydrogeological setting, largely sourced from the conceptual hydrogeological model report for the Project (SLR, 2018a; **Appendix A**). Full technical detail supporting the following summary of the Project's hydrogeological setting can be found in that report.

The conceptual hydrogeological model for the Project is presented as **Figure 1**, and is summarised below.

2.1. Location, Topography and Surface Drainage

The Project Area is located in the Clarence-Moreton Basin of Southeast Queensland, and within the southeastern-most extent of the Surat Cumulative Management Area (CMA). The broader region is topographically dominated by the Great Dividing Range to the northeast east and southeast, the plains and gently sloping terrain of the Darling Downs in the area of the Mine, and the relatively flat Condamine River Valley to the far west. The region has a subtropical climate characterised by hot, humid summers and mild to cool winters, with annual rainfall dominated by the warmer summer months. However, in the topographically elevated areas at the northeast, east and southeast the climate tends to trend towards a more temperate classification due to orographic effects associated with the Great Dividing Range. Long term climate trends indicate that the region has generally been wetter than average prior to 1990 and drier than average since around 1990, with the drier period punctuated by short very wet periods.

The surface drainage systems of the region are generally westwards draining creeks across most of the area, originating in the Great Dividing Range and flowing into the Condamine River Valley. The main drainage features include Oakey Creek in the south of the Project Area, Lagoon Creek in the Project Area (a tributary to Oakey Creek that flows south-westwards across the Project Area), and Myall Creek to the north. The creeks are typically ephemeral in nature and do not have significant baseflow components associated with groundwater. However, discharge of treated Toowoomba wastewater into a tributary of Oakey Creek means that to the southwest of the Project Area, Oakey Creek has a constant flow and is likely to act as a groundwater recharge source (i.e. a losing stream) to the underlying alluvium.

2.2. Geological Setting

2.2.1. General

The western Clarence-Moreton Basin is considered to be an eastern hydrogeological extension to the Surat Basin, with the Walloon Coal Measures continuous between the Surat and Clarence-Moreton basins.

The stratigraphy of the Project Area consists of Jurassic-aged sedimentary rocks which dip in a southwesterly direction and of which the Walloon Coal Measures is the youngest. The Jurassic formations have been either partly eroded, or exposed, over much of the Study Area. Overlying the Jurassic formations in places are Cenozoic aged Main Range Volcanics rocks (typically basalt), and Cenozoic aged accumulations of unconsolidated and semi-consolidated alluvial sediments adjacent modern watercourses. Underlying the Walloon Coal Measures are the fine sandstones, siltstones and mudstones of the Durabilla Formation, which are then in turn underlain by the relatively thick Marburg Sandstone unit, considered equivalent to and continuous with the Hutton Sandstone of the Surat Basin. The Marburg Sandstone is underlain by the Evergreen Formation and the Helidon Sandstone, which both lie at significant depth in relation to the Project.

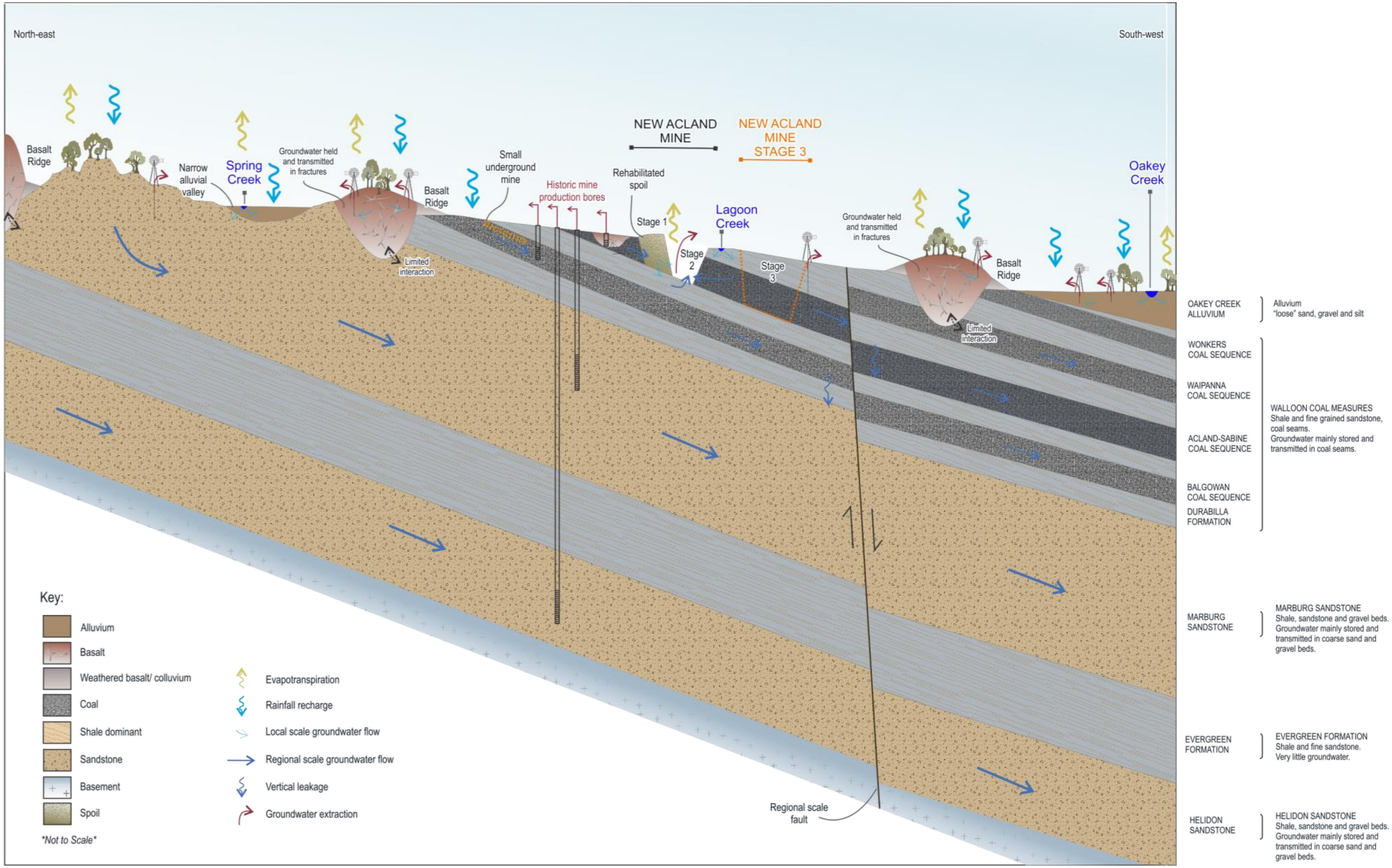


Figure 1 Conceptual Hydrogeological Model

Structural geological faulting is well known in the Project Area and surrounds from a number of studies as well as extensive NAC drilling data. Many of the fault structures in the Jurassic aged geological units have formed and are spatially controlled by the reactivation of deeper faulting in the older underlying basement rock. The most common structures present are steeply dipping (60-80°) normal faults, with two major northwest-southeast trending faults with throws of up to 50 m present at the Mine.

2.2.2. Walloon Coal Measures

The Walloon Coal Measures comprise a series of coal seam packages separated by intervals of thicker interburden. In the Project Area and immediate surrounds, these coal seam packages include (from youngest to oldest):

- the Waipanna Coal Sequence which outcrops to a minor extent in the southwest of the Project Area;
- the Acland Coal Sequence which forms the surficial coal sequence over much of the Project Area and is the primary coal resource targeted by NAC's mining activities; and
- the Balgowan Coal Sequence.

Each coal sequence typically is comprised of between 25 and 50m of interbedded thin coal seams, siltstones and fine sandstones, and separated from the next coal sequence by around 25 to 35 m of non-coal siltstone, mudstone and fine sandstone interburden.

2.3. Hydrogeological Setting

2.3.1. Aquifer Identification

Studies specific to the Surat CMA and supported by the Department of Natural Resources, Mines and Energy (DNRME) groundwater bore database analysis and NAC's own groundwater investigation and monitoring programs across the Mine and Project Area, indicate that the Cenozoic alluvium and Main Range Volcanics as well as the Marburg Sandstone and Helidon Sandstone form the major aquifers of the region. The alluvium and Main Range Volcanics aquifers are largely absent within and adjacent the Project Area. However, the alluvial aquifer becomes significant both to the north and south of the Project Area associated with major surface water drainage features (Myall and Oakey Creeks, respectively), and the Main Range Volcanics aquifer becomes prevalent northwest and west of the Project Area. Alluvium to the immediate north of the Project is associated with Spring and Cain Creeks, tributaries of Myall Creek. It should be noted that the same alluvial aquifer is associated with both Cain Creek and Spring Creek, given that Spring Creek flows into and becomes Cain Creek just to the northwest of the Project, which in turn flows into Myall Creek further downstream (northwest) of Cain Creek.

Various studies and NAC investigations show that the individual coal sequences of the Walloon Coal Measures form discreet aquifers in their own right, separated by non-coal aquitard-forming interburden rocks. This concept is supported by drilling data, water level and water quality data from adjacent monitoring bores, and aquifer pumping test analysis.

As well as groundwater within the coal sequences being constrained to the coal seams, the groundwater resources of the alluvium, Main Range Volcanics and Marburg Sandstone appear to be constrained within more permeable zones/horizons of those geologic units, with the less-permeable zones having aquitard-like properties in their own right. For this reason, it is expected that horizontal permeabilities of the major aquifers of the Project Area and surrounds are significantly greater than vertical permeabilities.

The hydrogeological classifications of the various units present at and surrounding the Project are shown in **Table 2**.

Table 2 Hydrostratigraphy of the Project Area and Surrounds

Geologic Unit		Dominant Hydrostratigraphic Classification
Alluvium		Aquifer (in coarser grained horizons)
Main Range Volcanics		Aquifer (where vesicular or fractured)
Walloon Coal Measures	Waipanna Coal Sequence	Aquifer (coal seams)
	Interburden	Aquitard
	Acland Coal Sequence	Aquifer (coal seams)
	Interburden	Aquitard
	Balgowan Coal Sequence	Aquifer (coal seams)
Durabilla Formation		Aquitard
Marburg Sandstone		Aquifer
Evergreen Formation		Aquitard
Helidon Sandstone		Aquifer

2.3.2. Groundwater Recharge

The Project is located in a general rainfall-sourced groundwater recharge area for many aquifers in the Surat CMA. Calculated recharge rates generally range from 1.3 mm/yr to 6.7 mm/yr, with highest recharge rates in the Main Range Volcanics and lowest recharge rates for the Walloon Coal Measures. The calculated recharge rates for the alluvium and Marburg Sandstone aquifers were 4.1 and 4.5 mm/yr, respectively.

2.3.3. Groundwater Levels and Flow Paths

Potentiometric surface mapping across the broader region generally shows similar trends between all aquifers, with west-southwest hydraulic gradients and flow directions, consistent with topographic trends for the consolidated aquifers and surface water drainage patterns for the alluvial aquifers. Both potentiometric surface mapping and hydrograph analysis show significant influence of groundwater extraction and climatic trends across the region, particularly for the alluvial and Main Range Volcanics aquifers.

Analysis of groundwater levels from adjacent monitoring bores in the Project Area and surrounds shows that in general, there are downwards vertical gradients across all aquifers. Additionally, the analysis shows there is generally significant separation of Main Range Volcanics groundwater levels from the deeper recorded groundwater levels in underlying aquifers, suggesting limited hydraulic connection between the Main Range Volcanics and the underlying units. The concept of hydraulic separation of the Main Range Volcanics from the underlying aquifers is also supported by hydrochemical data. One set of nested NAC monitoring bores to the southeast of the Mine shows an upwards hydraulic gradient to the Oakey Creek Alluvium.

2.3.4. Hydrogeological Role of Faults

Investigations into the hydrologic function of major faults at the Mine and within the Project Area have shown that the faults act as partial barriers to horizontal groundwater flow, significantly restricting horizontal groundwater movement across the alignment of the faults. This is evident from both specific pumping tests targeting particular faults, as well as observations made from within the Mine pits and at monitoring bores adjacent the Mine. In the Walloon Coal Measures, as groundwater flow is dominantly within the 25 to 50 m thick coal sequences, it is likely that the amount of vertical throw of individual faults has a significant role to play in the degree of restriction the fault provides to horizontal groundwater flow. Within the Project Area, the MDL_01 Fault in the southwest (see **Figure 14**) has been shown in specific hydrogeological investigations to have sufficient throw to completely disrupt the lateral continuity of the coal sequences, and as a result act as a partial barrier to groundwater flow during groundwater extraction from one side of the fault (see Appendix C of SLR, 2018a; **Appendix A**).

There is little anecdotal evidence of significant groundwater inflows to the Mine pits when faults are intersected. However, intersection of the major F5 Fault within the South Pit of the Mine in 2013 was observed to be coincident with groundwater drawdown at nearby Mine monitoring bores and temporary visual evidence of minor groundwater inflows to the pit from the vicinity of the fault (SLR, 2018a; **Appendix A**). Observations of fault hydrogeological behaviour immediately following this event are primarily based upon visual analysis of the fault within the active mine pit, where it has been subject to considerable mining-related stresses such as blasting and earthworks prior to the observations being made. These stresses have a large potential for disrupting the fault properties from their in-situ nature within the immediate surrounds of the disturbance. Therefore, observation made within the disturbance area, after the disturbance has occurred, must be considered within the context of it being a stressed system and not in situ.

Correlation of the timing of water level drawdown at monitoring bore 81P, which is located on the southern side of the F5 fault, with mining breaking through the F5 fault from the north in 2013, supports the concept that the F5 fault forms a barrier to groundwater flow across (perpendicular to) the fault, limiting groundwater drawdown propagation from mining activities on the north side of the F5 fault from monitoring bores on the south side of the F5 fault. If the F5 fault acted as a conduit for groundwater flow along the fault alignment, groundwater level drawdown should have propagated from the mine pit to monitoring bore 81P prior to mining breaking through the fault, as a result of the drawdown created by earlier mining. However, such drawdown did not occur until after the fault had been breached by the mine workings. The drawdown propagation to bore 81P after breaching of the fault is entirely consistent with the expected drawdown propagation within a coal seam aquifer once that seam is intersected by the mine pit, and as such, the fault itself does not need to act as a conduit for groundwater to explain the groundwater level response at bore 81P.

2.3.5. Regional Groundwater Use

The groundwater resources within and surrounding the Project Area are prescribed under the *Water Act 2000* subordinate legislation – the *Water Regulation 2016* and several Water Plans (the Water Plan (Condamine and Balonne) 2004, and the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017). Under the *Water Regulation 2016* and the Water Plans, three Groundwater Management Areas (GMAs) have been declared in the Study Area, and within these GMAs a water licence is generally required to take underground water, with the exception of Stock and Domestic usage which is exempt from licensing. The GMAs in the Study Area include:

- Oakey Creek GMA, covering the Oakey Creek Alluvium aquifer;
- Condamine and Balonne GMA, covering the Main Range Volcanics (Upper Condamine basalts) aquifer within and surrounding the Project Area; and
- Eastern Downs GMA, covering the Walloon Coal Measures, Marburg Sandstone and Helidon Sandstone aquifers within and surrounding the Project Area.

The groundwater resources surrounding the Project Area in general can be considered to be highly developed, especially the shallowest aquifer at any given location. The DNRME registered bore database (GWDB) reports a relatively dense distribution of third party groundwater bores across the majority of region surrounding the Project Area (**Figure 2**), mostly classified as being for Stock and Domestic use. There are also over 46,800 ML/year in nominal entitlements for non-Stock and Domestic usage in the vicinity of the Project Area. However, NAC's surveys of landholders in the vicinity of the Mine and the Project Area show that actual usage may be somewhat less than the allocated volumes, with actual usage reported to NAC by both surveyed landholders and DNRME being approximately 13% of the usage estimated for the region in the most relevant previous studies (i.e. OGIA, 2016).

2.4. Mining History

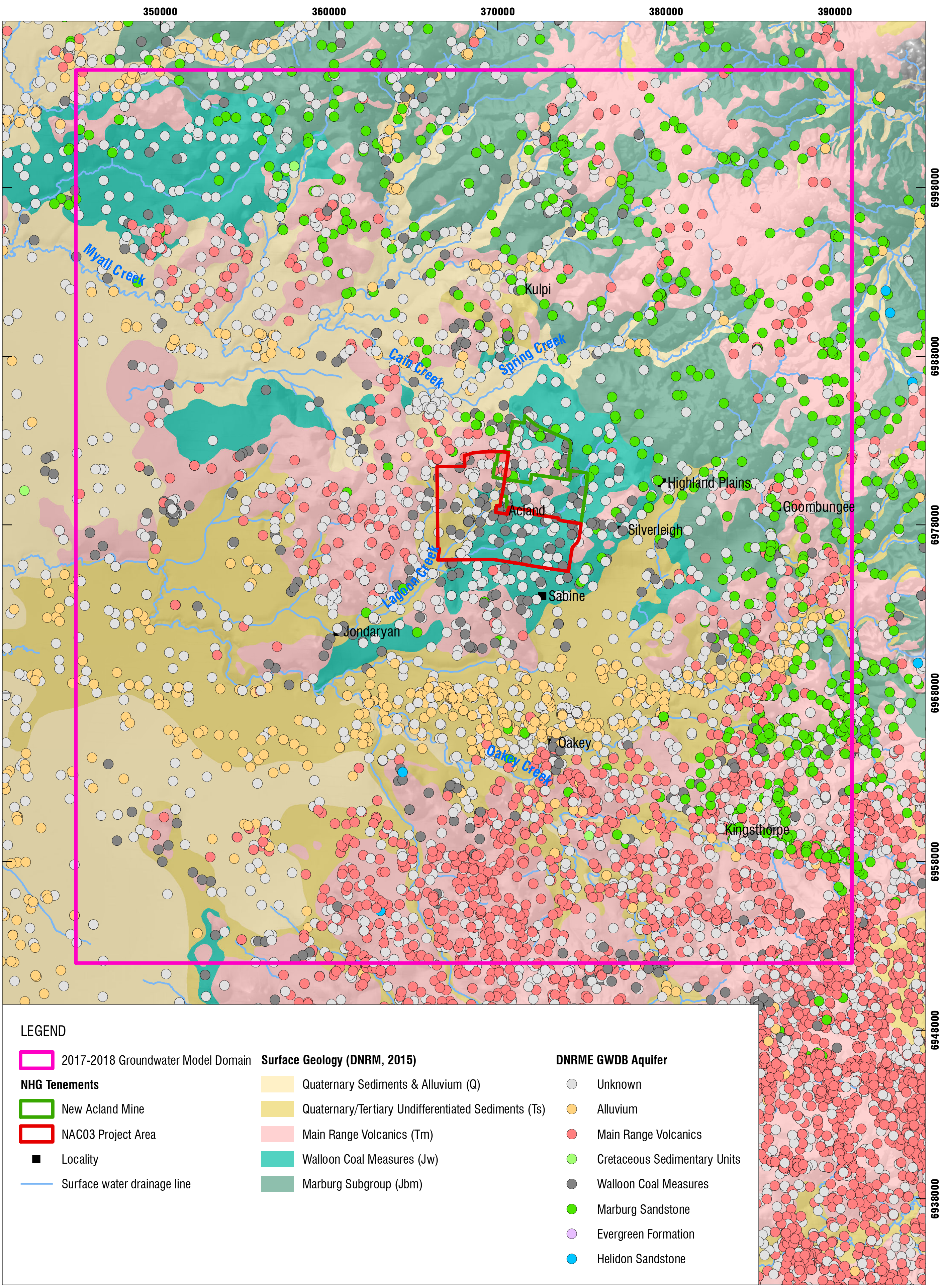
The Project Area has a long history of coal mining, with several underground coal mines within and adjacent to the Project Area in operation from the early 20th century until the 1980's. These mines were of relatively small scale and generally worked single seams or seam groups of up to 1.5 m thickness within the Acland Coal Sequence or Balgowan Coal Sequence of the Walloon Coal Measures.

NAC commenced operation in 2002 in the north of ML 50170, and has generally proceeded in a southwesterly direction down-dip in the targeted Acland Coal Sequence. The Mine progressively rehabilitates (i.e. backfill with spoil, contour the landform and replant native vegetation) the exhausted pits as mining progresses, such that a significant portion of historical Mine pits are now rehabilitated.

2.4.1. Mine Water Supply Bore Usage

NAC's water supply for coal washing was sourced from groundwater bores at the Mine prior to commissioning of the Wetella recycled wastewater pipeline in 2009. Between 2003 and 2011, the Mine generally extracted between 50 and 150 ML/month from a combination of the Main Range Volcanics, Walloon Coal Measures, Marburg Sandstone and the Helidon Sandstone, with this usage significantly declining since the commissioning of the Wetella recycled wastewater pipeline. Since 2011, usage has generally amounted to between 0.7 and 1.6 ML/month for potable supply from only the Main Range Volcanics aquifer as well as sporadic usage associated with maintenance of the borefields for emergency water supply. The current usage of the Main Range Volcanics aquifer potable supply is anticipated to continue into the future.

The New Hope Group (NHG) (through NAC and Acland Pastoral Co; APC) continues to hold 1,624 ML/year in formal groundwater entitlements authorised by DNRME related to the historic Mine groundwater supply as well as authorisations related to agricultural activities across the Main Range Volcanics, Walloon Coal Measures, Marburg Sandstone and the Helidon Sandstone aquifers as detailed in **Table 3**. Also shown in **Table 3** are the details of other authorisations held by the NHG for properties within and adjacent the Project Area.



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GROUNDWATER MANAGEMENT AND MONITORING PLAN

DNRME GWDB REGISTERED BORES

FIGURE 2

Table 3 DNRME Water Allocation Licenses held by NAC and APC

Aquifer	Licence Nº	Total Allocated Volume (ML/a)	Authorised Purpose
Oakey Creek Alluvium	52926R	27	Irrigation
Main Range Volcanics	189547	160	Industrial
	405222	40	Industrial; Irrigation
	21926R	2	Stock Intensive
Walloon Coal Measures	407784	271	Industrial
	567920	30	Industrial; Stock Intensive
	61110R	30	Stock Intensive
	175721	28	Industrial
	61627R	16	Irrigation; Stock Intensive
	100334	14	Irrigation
	87679R	12	Stock Intensive
	17490R	2	Stock Intensive
Marburg Sandstone	174733	271	Industrial; Stock Intensive
	107083R	6	Stock Intensive
	94009R	5	Stock Intensive
Helidon Sandstone	406524	710	Industrial

2.4.2. Mine Pit Inflows

Groundwater inflows from the Walloon Coal Measures to the Mine's working pits have been observed to be relatively small since the start of the Mine. Active dewatering prior to mining and/or significant water management infrastructure are not required to manage these inflows. The groundwater inflow volumes captured by the Mine's pits are managed through in-pit sumps and occasional pumping to water carts for re-use at the Mine for dust suppression purposes. A GoldSim water balance model developed for the conceptual hydrogeological model report (SLR, 2018a; **Appendix A**) resulted in estimated groundwater inflows to the Mine over the 2013 to 2015 period ranging from 650 to 875 ML/year (1.8 to 2.4 ML/day).

2.4.3. Groundwater System Response to Mining

Groundwater monitoring adjacent the Mine as part of the existing Stage 1 and 2 EA requirements as well as other general Mine groundwater monitoring has shown varying responses to mining activities to date.

Most monitoring bores on the western side of the Mine show some degree of response to Mine water supply extraction prior to commissioning of the Wetalla recycled wastewater pipeline in 2009, especially those monitoring bores installed in the Marburg Sandstone. However, since 2010, cessation of Mine water supply extraction has resulted in groundwater levels in the Marburg Sandstone gradually recovering to be now close to pre-mining levels. Similar to the Marburg Sandstone, monitoring bores in the Main Range Volcanics and Walloon Coal Measures on the western side of the Mine show a clear drawdown response to Mine water supply extraction between 2002 and 2010, followed by recovery to pre-mining conditions after 2010, with a particular recovery of groundwater levels in response to a very wet climatic event in late 2010/early 2011.

Mine monitoring bores in the Walloon Coal Measures aquifers show some drawdown response to mining, particularly in the southeast of the Mine area. However, in general these drawdowns are of lesser magnitude and extent than drawdowns associated with historical water supply extraction at the Mine. Different responses to mining are seen between the mined Acland Coal Sequence and the underlying non-mined Balgowan Coal Sequence, supporting the concept of a degree of hydraulic separation between the coal sequences. It is also apparent that there is significant recovery of groundwater levels in the Walloon Coal Measures aquifers as well as the rehabilitated spoil-filled mined out areas, as mining has moved further south.

Further discussion of existing monitoring data trends in site monitoring bores (both Stage 1 and 2 Mine bores and Stage 3 Project bores) is provided in **Appendix D**.

3. Predicted Groundwater Impacts

3.1. Impacts on Groundwater Levels

This section describes the Project's groundwater model, and the model's predicted impacts from the Project's operations on the groundwater system.

3.1.1. Groundwater Model Development

Project EIS and AEIS Model

NAC prepared and submitted an Environmental Impact Statement (EIS) for the Project in 2013 and a follow-up Additional Information to the EIS (AEIS) in 2014. The EIS and AEIS included details of the Project's groundwater impact assessment and associated modelling. The EIS and AEIS groundwater model was developed based on the conceptual understanding and data availability at the time. Where information was not available, the model was developed using conservative assumptions on the basis of literature, as is consistent with the Australian Groundwater Modelling Guidelines. It was recognised at the time of the EIS and AEIS that this would result in conservative predictions from the numerical model, i.e. the potential for over estimation of groundwater impacts arising from the Project.

The EIS and AEIS numerical groundwater model for the Project underwent significant review by multiple independent peer reviewers, Commonwealth and State (QLD) agencies, and community stakeholders as part of the EIS, AEIS, Commonwealth EPBC referral (including multiple reviews by the IESC) and QLD Land Court proceedings. Numerous changes or improvements have been made to the model as a result of the various suggestions and comments included in these reviews. The most significant comments from the QLD State Governmental reviews with respect to the groundwater modelling were incorporated in the Queensland Coordinator-General Imposed Conditions (December 2014) with groundwater conditions also incorporated into the Project's EA. The most significant comments from the Commonwealth EPBC referral were incorporated as conditions in the Project EPBC Act approval (2007/3423). A number of key groundwater modelling issues were raised as part of Land Court proceedings. In general, there were similar comments provided across the independent peer review, QLD Land Court, and Commonwealth and State agency review processes.

2018 Model

In the AEIS, NAC made commitments to address the information gaps and update the groundwater model shortly thereafter. As outlined in the 2017-2018 conceptual hydrogeological model report for the Project (SLR, 2018a), since the AEIS, NAC has accordingly implemented a large number of groundwater studies which had the ultimate aim of addressing these gaps and providing additional information from which to update the Project's groundwater model. In accordance with its commitments as well as the various regulatory approval conditions and proceedings of the Queensland Land Court, NAC commenced the process to update Project groundwater model during late 2016. The model was finalised in December 2018 and is reported in SLR (2018b).

The 2018 update of the Project groundwater model sought to incorporate the findings of the revised conceptual model report (SLR, 2018a) as well as, where appropriate, the recommendations and approval conditions identified above.

The overall objectives of the revised groundwater modelling were to:

- provide an updated numerical model that reflects, and is constrained by, the updated conceptual hydrogeologic model;

- provide an increase in confidence in estimates of predicted groundwater impacts associated with the New Acland Stage 3 Project (NAC03); and
- incorporate, where relevant, comments, approval conditions, and recommendations raised by third parties including NAC's independent peer reviewers.

Models often require continuous revisions and updates as more information becomes available and\or when different questions are asked of it. The 2018 revision of the model, and the subsequent revised predictions, should be viewed as an evolution of the understanding of the system as more studies and information become available.

Full details of the model development, model calibration, predicted impacts on groundwater over the life of the Project are presented in the 2018 modelling report (SLR, 2018b).

3.1.2. Model Predictions

3.1.2.1. Overview

As excavation of the Project's active mine pits proceeds below the water table within the Walloon Coal Measures, groundwater will discharge into the pits which target the Acland Coal Sequence. This dewatering of the Acland Coal Sequence aquifer will result in the lowering of groundwater levels in the aquifer in the immediate vicinity of the Project site. Groundwater levels in the other aquifers around the Project site may also be affected by dewatering the Acland Coal Sequence due to mining induced through-flow and leakage of groundwater from these aquifers to the Acland Coal Sequence. Furthermore, the northern-most extent of the Manning Vale West pit will directly intersect the edge of the Main Range Volcanics unit and as a result, it is predicted that there may be direct groundwater impacts to this aquifer.

Mining is planned to advance in a general north to south direction for the Project, generally down-dip in the Walloon Coal Measures. The active mine pits will be excavated as a progressive series of strips that advance across the Acland Coal Sequence aquifer (resource area). As each active mine pit advances through the development of a new strip, the previous strip is progressively backfilled with mined material and rehabilitated.

Impacts on groundwater levels will vary spatially over time as the mined area migrates down-dip across the Project site. The model predicts the greatest impacts on groundwater levels surrounding the Project will occur around the end of mining. This corresponds to the Life of Mine Plan when the deepest areas of working will result in the most widespread drawdown.

The results of the 2018 numerical groundwater model for the Project are documented in SLR (2018b). The following outlines the key outcomes of the 2018 model. Discussion in the following sections makes reference to the 5^{th}, 50^{th} (median) and 95^{th} percentile predictions for the 2018 model. These percentiles represent the uncertainty associated with the model predictions as outlined in **Table 4** below.

Table 4 Outline of the Presentation of Model Predictive Uncertainty

Prediction Percentile	Probability of Equalling or Exceeding the Model Prediction	Narrative Descriptor[1]	Description[1]
5th	95%	Very Likely	Likely to occur even in extreme conditions
50th	50%	About as likely as not	About an equal chance of occurring as not
95th	5%	Very unlikely	Not likely to occur even in extreme conditions

1. As per Table 2 of the draft *IESC Explanatory Note, Uncertainty Analysis in Groundwater Modelling* (IESC, 2018)

3.1.2.2. Predicted Mine Pit Inflows

Total combined predicted groundwater inflows to the Project's three pits are provided in **Figure 3** (see also **Figure 4** for a plan showing each pit location). As shown, median predicted pit inflows range from 11 to 482 ML/a over the life of Stage 3, peaking during year 9 of the Project. The inflow peak during year 9 corresponds to the Willeroo pit intersecting historical abandoned underground coal mine workings, and in reality these inflows would be managed by dewatering the workings prior to the pit intersecting them.

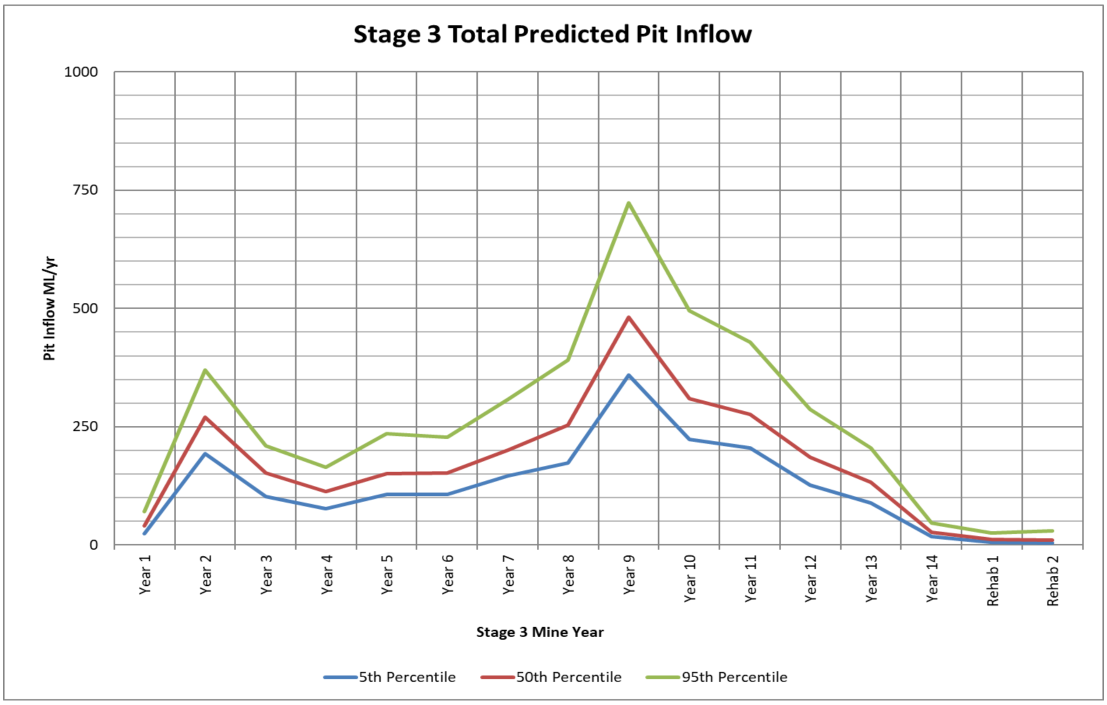


Figure 3 Predicted Mine Pit Inflows

Direct groundwater inflows to the Project's three pits will occur from the Acland Coal Sequence, and also from the Main Range Volcanics in the case of the northern part of the Manning Vale West pit (see **Figure 5**). These inflows will cause direct groundwater drawdown in these aquifers. These direct groundwater drawdowns are also predicted to propagate to other hydrostratigraphic units through induced vertical leakage. This leakage causes changes in groundwater storage volumes within each hydrostratigraphic unit, which are represented as changes in storage for each unit within the numerical groundwater model as shown in **Table 5** below.

Table 5 Modelled Change in Storage over the Life of Project[1] (ML)

Hydrogeologic Unit	5th Percentile	50th Percentile	95th Percentile
Alluvium	-232	-430	-808
Main Range Volcanics	-215	-1,276	-1,776
Walloon Coal Measures[2,3]	-1,433	-2,275	-3,324
Marburg Sandstone	-22	-34	-52
Total	**-1,902**	**-4,015**	**-5,960**

Notes: 1. 14 years of mining plus two years post-mining rehabilitation period
2. Includes all model layers that form the Walloon Coal Measures
3. Includes the effect of enhanced recharge over Mine pits and rehabilitated spoil

3.1.2.3. Predicted Drawdown

Detailed groundwater drawdown maps resulting from the 2018 groundwater model predictions are presented in the Project's 2018 numerical groundwater model report (SLR, 2018b). The maps presented in that report present predicted groundwater drawdowns at multiple time periods during the life of the Project, and for both the median and 95th percentile model results for each aquifer in and surrounding the Project Area. Given that this process has resulted in the generation of over 200 drawdown prediction maps, for the purposes of this GMMP, maps have been generated to show the extent of predicted drawdown for each aquifer at the end of Stage 3 mining (i.e. when the groundwater drawdown spatial extent is assumed to be at its peak and the Project's pits are at their deepest).

Chapter 3 of the *Water Act 2000* provides the framework for managing impacts on underground water that are associated with resource operations including coal seam gas (CSG) and mining activities. This underground water management framework ensures that a bore owner is not disadvantaged by such operations. The framework includes bore trigger thresholds to effectively identify areas where bore owners may be at risk. The bore trigger threshold is defined as, for an aquifer, a decline in the water level in the aquifer that is (relevantly):

- a 5 m decline for consolidated aquifers (being an aquifer consisting predominantly of consolidated sediment, such as sandstone); or
- a 2 m decline for unconsolidated aquifers (being an aquifer other than a consolidated aquifer, such as shallow alluvial aquifers).

In accordance with Chapter 3 of the *Water Act 2000*, the 2 m trigger threshold applies to the unconsolidated alluvial aquifers surrounding the Project Area. In addition, although the Main Range Volcanics would be considered a consolidated aquifer, NAC considers that the 2 m trigger threshold is also appropriate for this aquifer, which based on experience gathered through various hydrogeological programs associated with the Project, can be somewhat limited in thickness and degree of saturation, and therefore has limited available drawdown for third party use, compared to deeper consolidated aquifers (i.e. Walloon Coal Measures or Marburg Sandstone). As outlined in Chapter 3 of the *Water Act 2000*, the 5 m trigger threshold is appropriate for consideration of drawdown impacts associated with the Walloon Coal Measures and Marburg Sandstone aquifers, which are typically significantly thicker, deeper and also typically possess significantly larger degrees of available drawdown.

Also shown on the maps presented herein are the location of known third party (i.e. non-NAC) bores for the relevant aquifers, whose locations are either confirmed by NAC via the Project's Bore Baseline Assessment Program (BAP), or indicative and based on DNRME and OGIA recorded locations in the case of properties yet to be subject to surveys in the BAP at June 2017.

Predicted Impacts on the Alluvial Aquifer

The 2018 groundwater model does not predict any groundwater drawdown of 2 m or more for the alluvium, in either the 50th percentile (median) or 95th percentile case (**Figure** 4).

Predicted Impacts on the Main Range Volcanics Aquifer

The 2018 groundwater model predicts that the extent of groundwater drawdown of 2 m or greater for the Main Range Volcanics is limited to the area of the aquifer within and immediately adjacent the north of the Project Area, for both the 50th percentile (median) and 95th percentile model cases (**Figure 5**). There is comparatively little difference between the 50th percentile and 95th percentile 2 m drawdown extents.

It should be noted that the vast majority of the land area subject to groundwater drawdown of 2 m or greater for the Main Range Volcanics in the 2018 groundwater model is owned by NAC through its APC subsidiary, with impacts to private users restricted to four bores on one private property at the northwestern most part of the 2 m drawdown extent. This property and the four associated bores have previously been subject to a bore baseline assessment under the NAC03 BAP as shown in **Figure 5**.

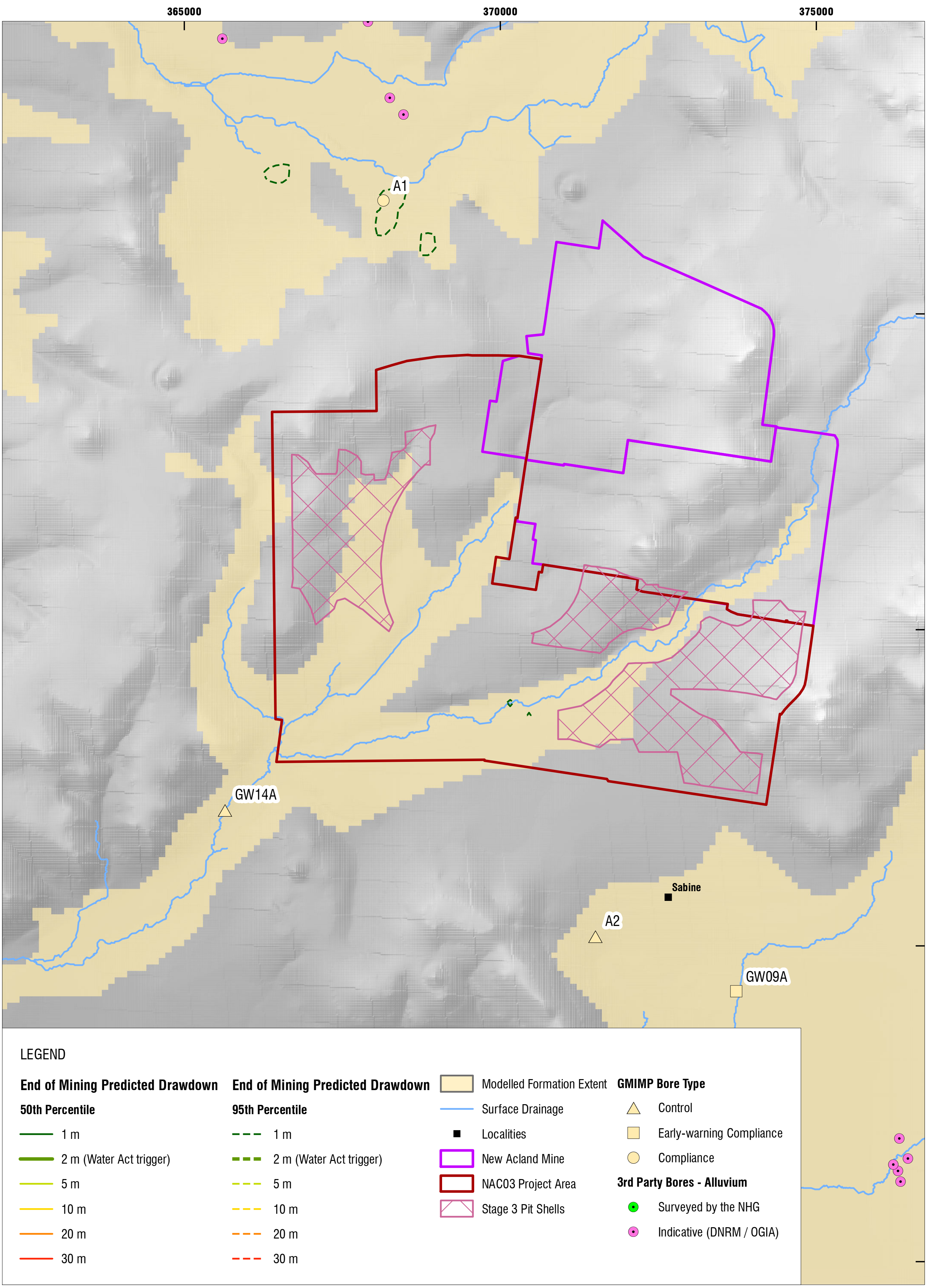
Predicted Impacts on the Acland Coal Sequence Aquifer

The Acland Coal Sequence forms the target coal resource of the Project and is therefore subject to direct mining impacts, and accordingly would be expected to show the largest groundwater impacts for all the hydrostratigraphic units in the Project Area and surrounds.

The 2018 groundwater model predicts that the extent of groundwater drawdown of 5 m or greater for the Acland Coal Sequence extends to approximately 5 km southwest of the Project Area for the 50th percentile (median) model case, and a further 2 km for the 95th percentile case (**Figure 6** and **Figure** 7). Impacts of groundwater drawdown of 5 m or greater on third party bores are summarised as:

- 5 bores for the 50th percentile (median) case, of which all have already been subject to a bore baseline assessment under the NAC03 BAP as shown in **Figure 6** and **Figure** 7; and
- a further 7 bores for the 95th percentile case, of which 2 have already been subject to a bore baseline assessment under the NAC03 BAP.

As shown in **Figure 6** and **Figure** 7, most third party bores in the Acland Coal Sequence are located close together near the edge of the geological unit's extent (i.e. near the outcrop) and the large majority of the aquifer subject to groundwater drawdown of 5 m or greater is devoid of bores accessing the Acland Coal Sequence. This circumstance is due to the fact that the Acland Coal Sequence becomes buried by additional Walloon Coal Measures units to the west and southwest of the Project Area, as well as the Main Range Volcanics and the Oakey Creek Alluvium (SLR, 2018a). Since third party bores typically target the shallowest available groundwater resource, the Acland Coal Sequence for the most part does not form the primary water supply aquifer for third parties away from the areas where the unit is at outcrop.



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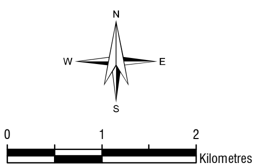

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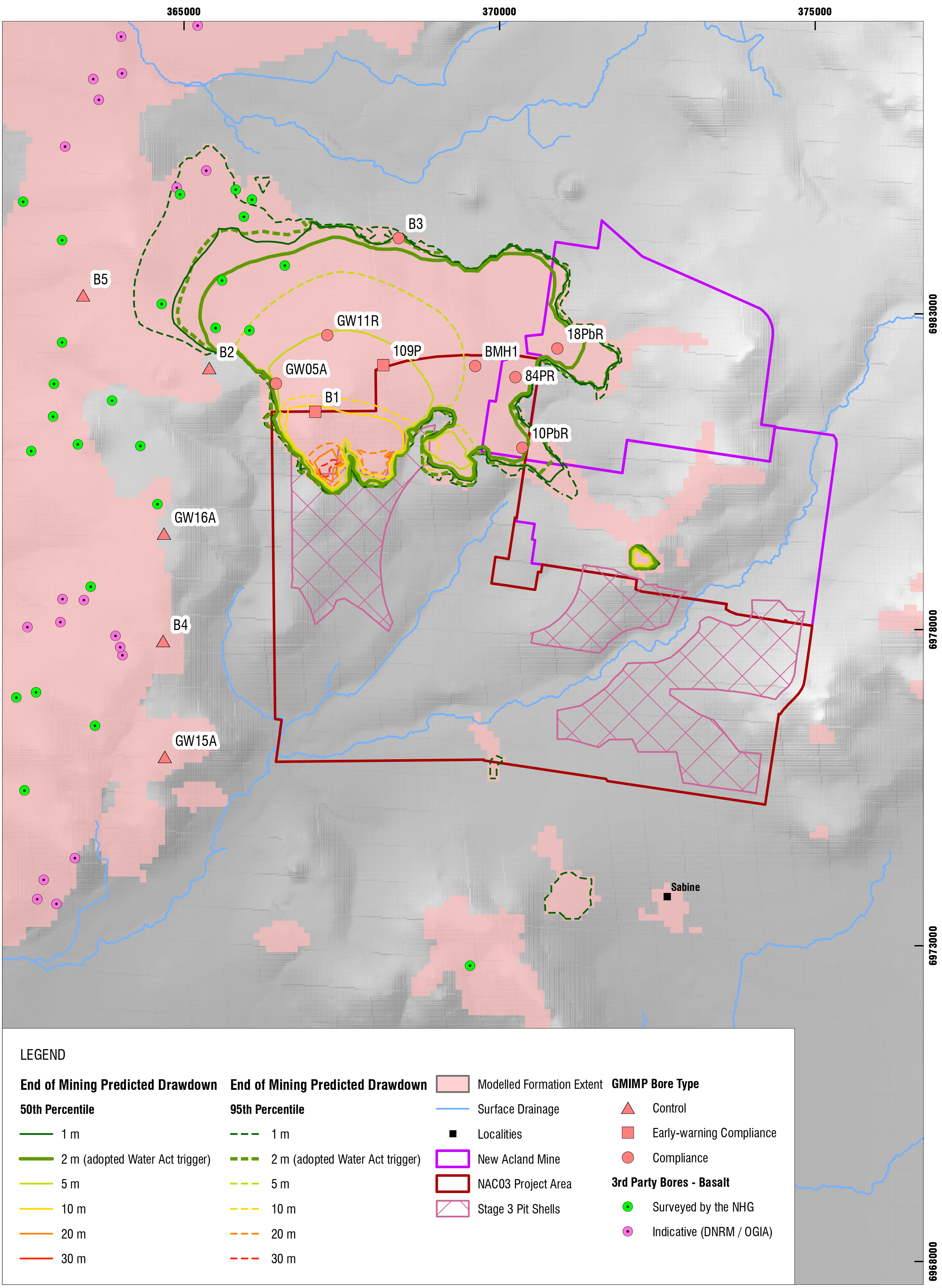
GROUNDWATER MANAGEMENT AND MONITORING PLAN

ALLUVIUM PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 4



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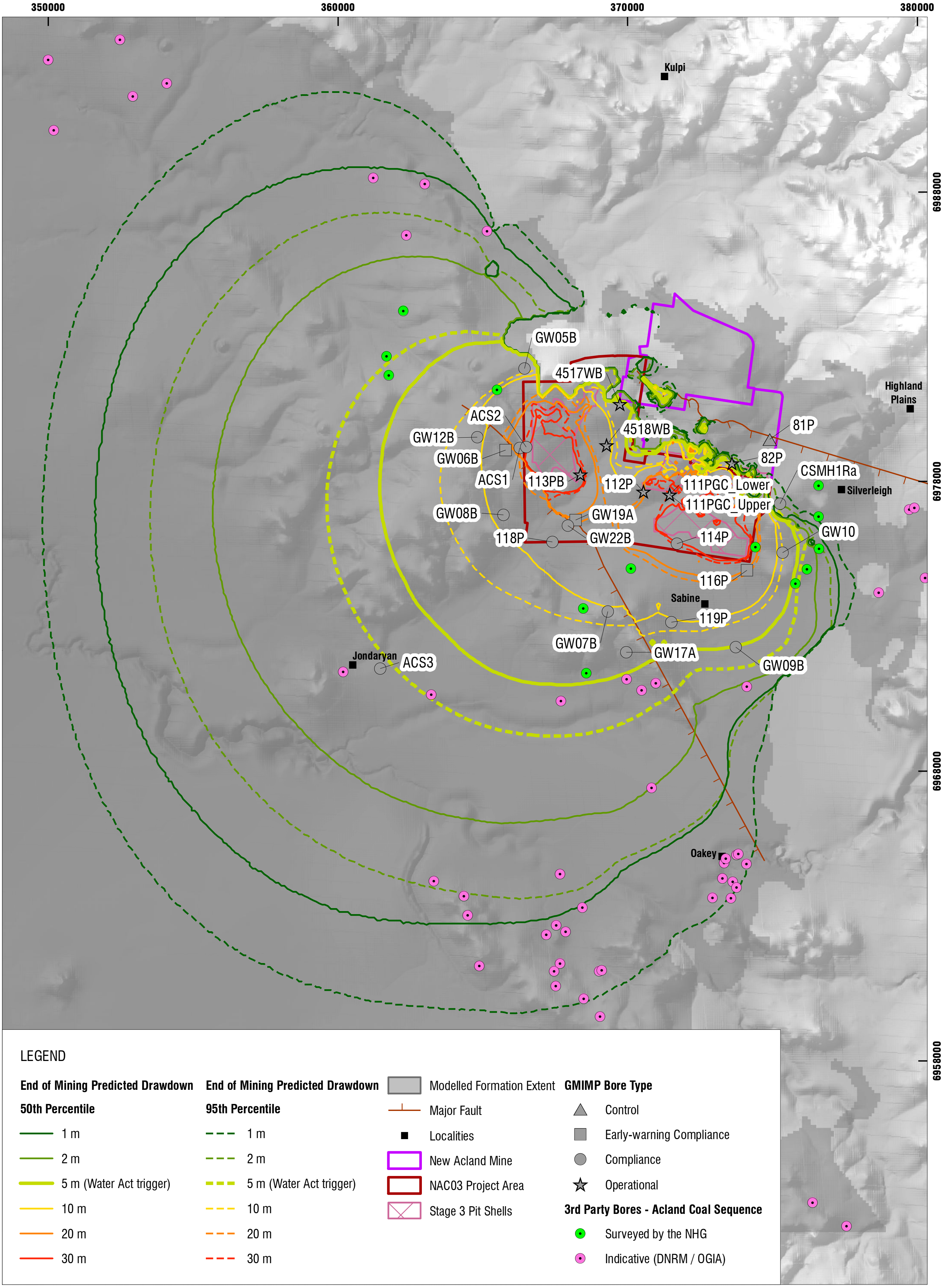
GROUNDWATER MANAGEMENT AND MONITORING PLAN

MAIN RANGE VOLCANICS PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 5



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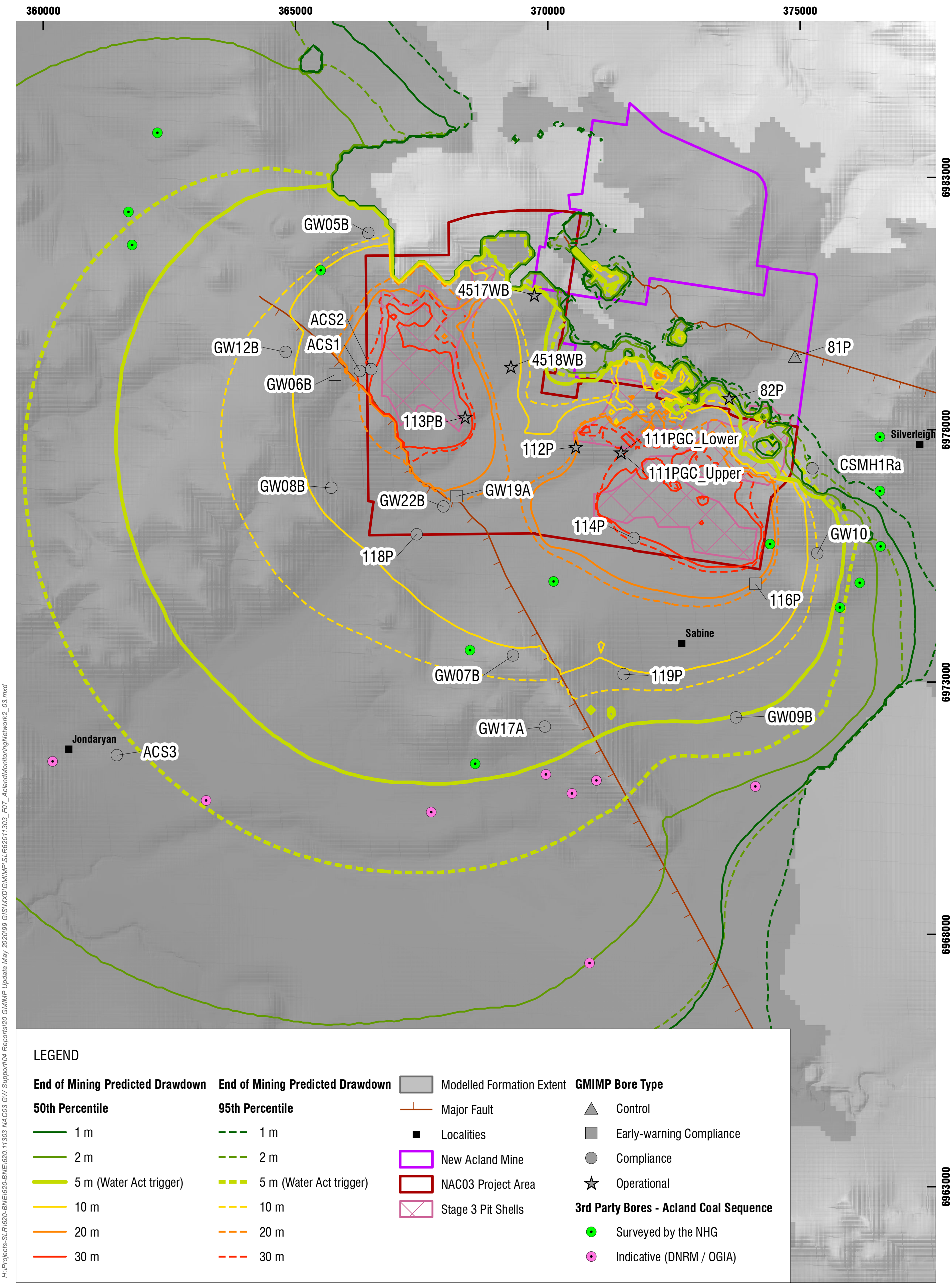
GROUNDWATER MANAGEMENT AND MONITORING PLAN

ACLAND COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 6



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GROUNDWATER MANAGEMENT AND MONITORING PLAN

ACLAND COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 7

Predicted Impacts on other Walloon Coal Measures Aquifers

The 2018 groundwater model predicts that the extent of groundwater drawdown of 5 m or greater for the Waipanna Coal Sequence is limited to several very small areas within the western and southeastern parts of the Project Area (**Figure 8**). Outside of the Project Area, there is only a minor occurrence of groundwater drawdown of 5 m or greater for the 95th percentile case to the west. There are no third party bores accessing the Waipanna Coal Sequence within any of the areas predicted to be subject to groundwater drawdown of 5 m or greater.

The 2018 groundwater model predicts that there will be some drawdown equal to or exceeding the 5 m Water Act drawdown trigger threshold for the Balgowan Coal Sequence (for the 95th percentile case). However, it is mainly limited to the mining lease area. There are no third party bores that have predicted drawdown exceeding the 5 metre drawdown threshold (**Figure 9**). As shown on **Figure 9**, third party use of the Balgowan Coal Sequence aquifer for water supply is also quite limited.

Predicted Impacts on the Marburg Sandstone Aquifer

The 2018 groundwater model does not predict any groundwater drawdown of 5 m or greater for the Marburg Sandstone for any of the model cases (**Figure 9**). As shown on **Figure 9**, third party use of the Marburg Sandstone aquifer for water supply is limited, and focussed to the areas north and east of the Project where the aquifer lies at shallower depths.

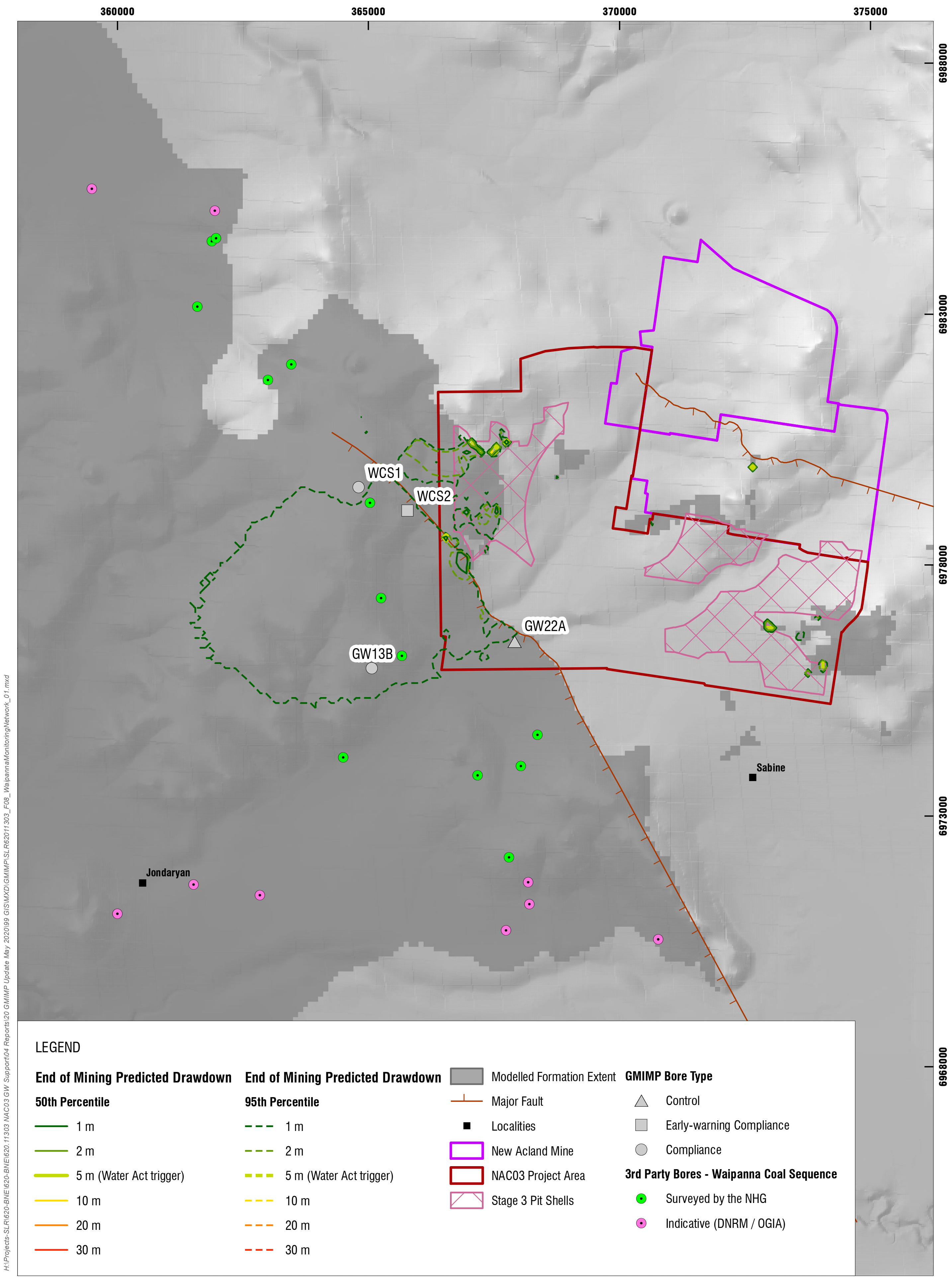
Predicted Impacts on the Helidon Sandstone Aquifer

The Helidon Sandstone aquifer is not represented in the groundwater model as it lies some 200 m below the base of the Marburg Sandstone aquifer, and separating these two units is the relatively low permeability Evergreen Formation. Therefore, the Project is not anticipated to have any impact on the Helidon Sandstone aquifer. NAC's bore abstraction from this aquifer has substantially reduced prior to the Project's implementation, resulting in the recovery of groundwater levels and the alleviation of some resource pressure on this GAB aquifer.

3.1.2.4. Predicted Post Mining Impacts

The Project's 2018 groundwater model included an assessment of the long term post-mining impacts associated with the Project's final voids (depressed landforms). The assessment coupled the Project's 2018 groundwater model with a water balance model that included the surface water hydrology associated with the voids, in order to more robustly simulate the long term void behaviour. The results of that final void study were reported in SLR (2018b) and are summarised as follows.

- All three voids are predicted to form long term persistent lakes that have generally stabilised within 20 years from the cessation of mining. Void lake water levels would generally fluctuate by +/- 5 m post-mining, due to the effect of rainfall (and therefore runoff) variability. The Manning Vale East and Willeroo voids are predicted to form lakes with maximum depths of approximately 10 to 12 m, whilst the Manning Vale West void is predicted to form the deepest void lake at approximately 30 m maximum depth. This prediction is primarily due to the base of that void being lower in elevation than the other two voids.
- All three voids are predicted to form groundwater sinks in the long term. Groundwater inflow rates into the voids from the rehabilitated spoil that surrounds the void lakes is predicted in the long term to be 0.11 ML/day for the Manning Vale West void, 0.01 ML/day for the Manning Vale East void, and 0.08 ML/day for the Willeroo Void. These predicted inflows are driven by evaporation from the void lakes.



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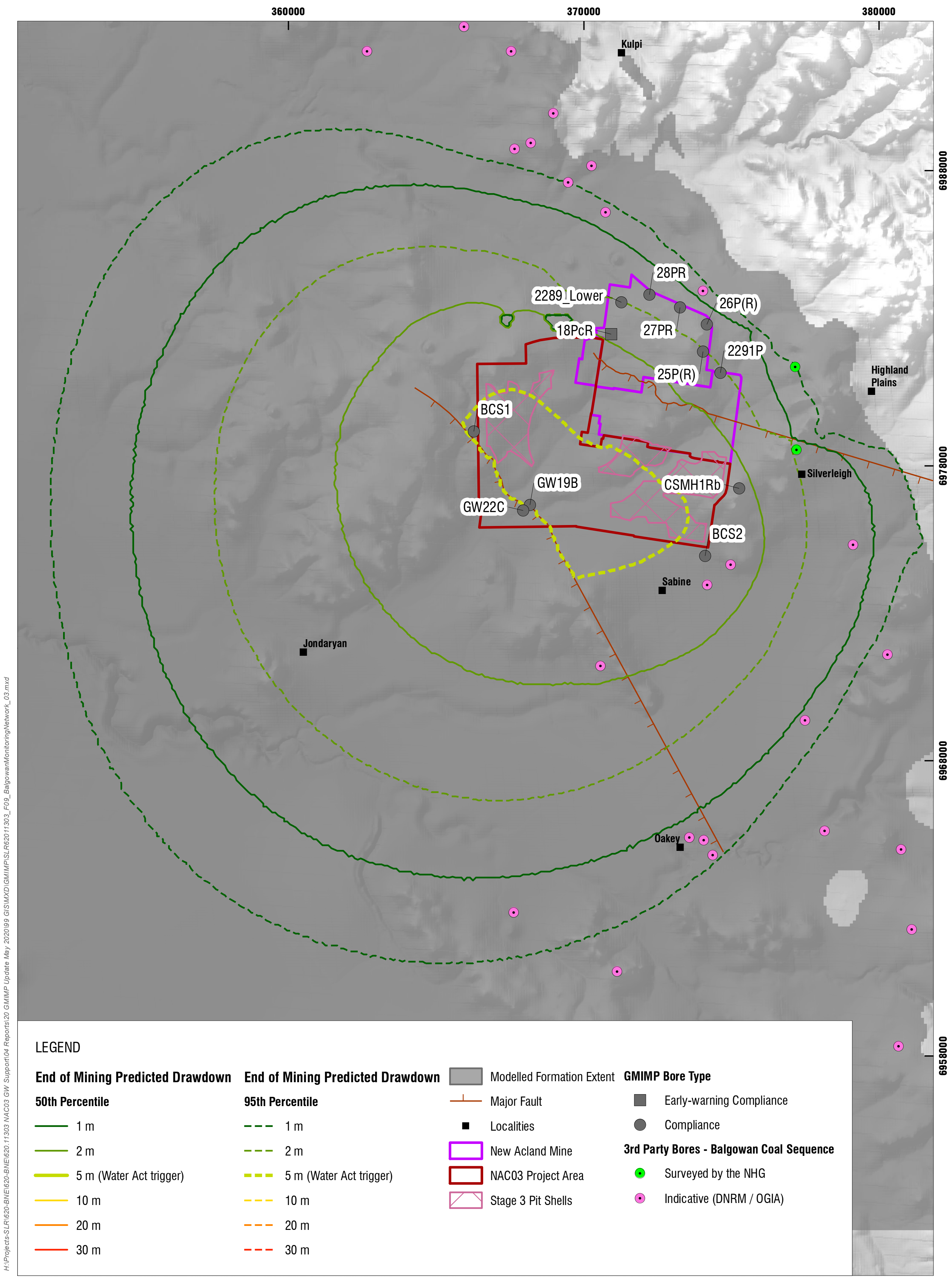
GROUNDWATER MANAGEMENT AND MONITORING PLAN

WAIPANNA COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 8



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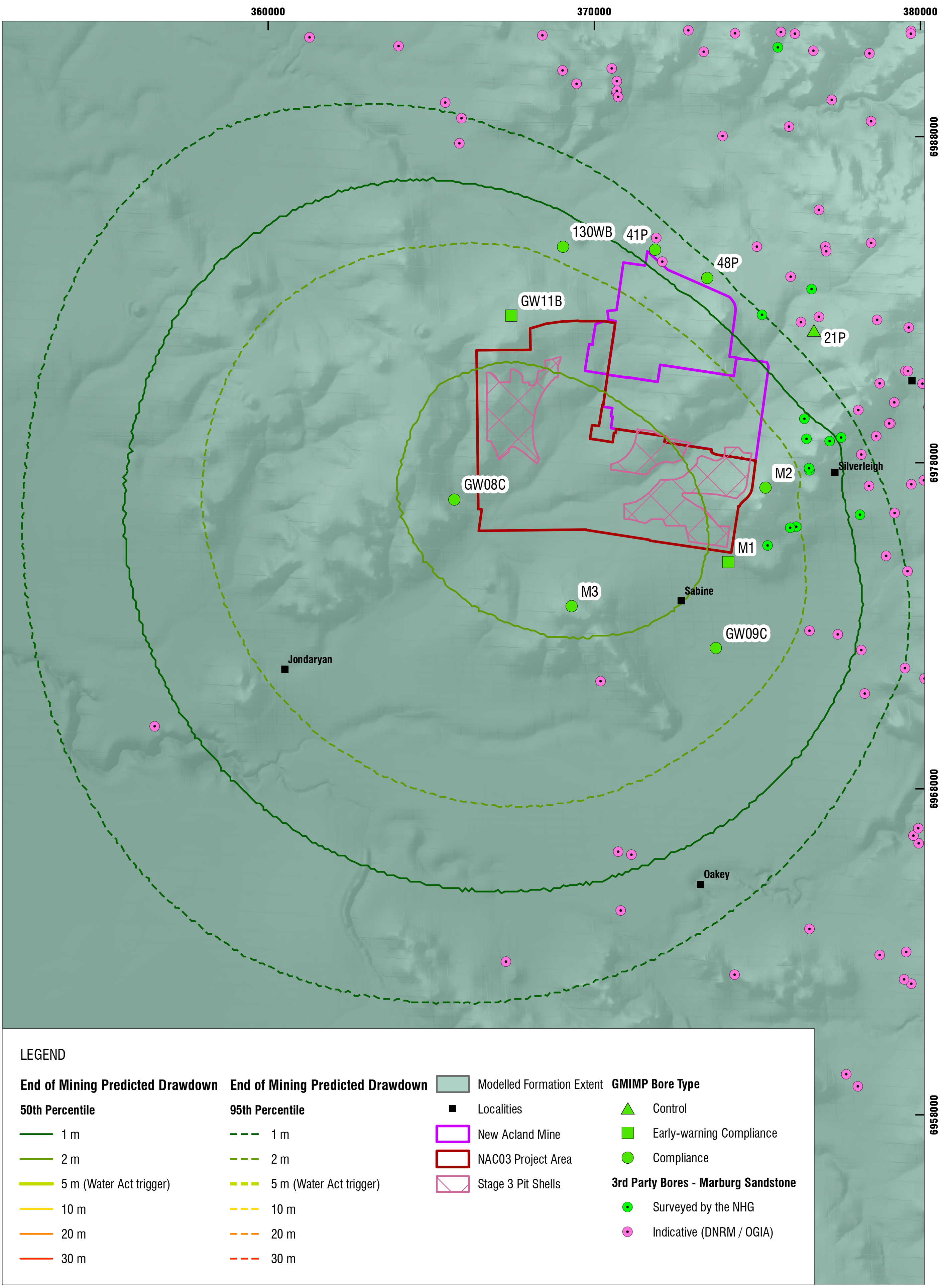
GROUNDWATER MANAGEMENT AND MONITORING PLAN

BALGOWAN COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 9



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Projection:	AGD 1984 AMG Zone 56

N W E S

0 1 2 3 4 5 Kilometres

NEW ACLAND STAGE 3 PROJECT

GROUNDWATER MANAGEMENT AND MONITORING PLAN

MARBURG SANDSTONE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 10

- The Manning Vale East void is also predicted to have a small loss of void water that infiltrates to the groundwater system, at a rate of 0.006 ML/day post closure. This water is modelled to be captured by the other two voids as part of their groundwater inflow flux.
- Runoff and rainfall capture accounts for between 87% and 97% of the predicted water inflow to the post-mining voids. Evaporation from the void lakes is predicted to be the only form of water loss from the Manning Vale West and Willeroo void lakes, whilst infiltration to the local groundwater system (in addition to evaporation) accounts for just over 2% of the total predicted water lost from the Manning Vale East void.
- No long term groundwater drawdown exceeding the relevant *Water Act 2000* bore trigger thresholds for the alluvium, Balgowan Coal Sequence or Marburg Sandstone aquifers is predicted. Furthermore, the model only predicts a very limited extent of drawdown exceeding the relevant *Water Act 2000* bore trigger threshold for the Waipanna Coal Sequence. However, the model does predict drawdown exceeding the relevant bore trigger thresholds outside of the Project's mine leases in the long term for both the Main Range Volcanics and the Acland Coal Sequence. Although, the number of third party bores captured within the extent of bore trigger threshold drawdown is limited to three bores in the Acland Coal Sequence and one bore in the Main Range Volcanics, all of which would have already been subject to drawdown impacts during the Project's active mining phase.

3.2. Impacts on Groundwater Quality

3.2.1. During Mining

Groundwater drawdown associated with the Project's mine pits has the potential to result in groundwater chemistry changes through the induced movement of groundwater towards those pits, particularly in the Acland Coal Sequence aquifer. Where existing groundwater quality is naturally variable in an aquifer, this induced movement has the potential to move water of differing quality into other areas. It is important to recognise such groundwater chemistry changes may be either negative (where poorer quality groundwater is mobilised into areas with naturally better quality groundwater) or positive (where better quality groundwater is mobilised into areas with naturally poorer quality groundwater). These processes have been documented as occurring in some Acland Coal Sequence monitoring bores adjacent the existing Mine's operations as part of routine reviews of the Mine's existing EA groundwater monitoring program. The results of these reviews have indicated that any groundwater chemistry changes are both spatially isolated and temporally short lived, and likely related to hydrogeologic and hydrochemical compartmentalisation of the Acland Coal Sequence aquifer, rather than induced changes in fluxes between aquifers. Any groundwater quality changes that have been detected to date as a result of the existing Mine operations return towards background levels relatively quickly. Therefore, consistent with the results of monitoring of Mining operations that have been underway since 2002, the groundwater quality in the vicinity of the Project is not anticipated to be significantly affected in the long term as a result of mining activities.

As described in the conceptual hydrogeological model report for the Project (SLR, 2018a), there is relatively little difference in natural groundwater chemistry between the different hydrostratigraphic units in the Acland region, and a generally broad spread of water chemical types for any one aquifer unit. Therefore, any changes in groundwater fluxes between units as a result of the Project are considered unlikely to manifest as significant changes in groundwater quality. Furthermore, given that groundwater drawdown and induced groundwater movement in all aquifers besides the Acland Coal Sequence is very limited, the potential for impacts on water quality within all aquifers other than the Acland Coal Sequence from the Project's mining activity is considered negligible.

Groundwater quality will continue to be monitored throughout the life of the Project under this GMMP to identify trends and assess whether impacts are occurring over time.

3.2.2. Post Mining

As part of the 2018 groundwater model development for the Project, the coupled groundwater/surface water model for the final voids was also used to assess the salt balance associated with the voids as a means of assessing any long term water quality (salinity) risks. As reported in SLR (2018b), the results indicate as follows.

- Salinities in the void lakes are predicted to generally increase over time primarily as a result of evaporation from the void lakes, with cyclical fluctuations in the longer term due to the effect of rainfall (and therefore runoff) variability based off the historic rainfall record.
- The Manning Vale East void lake salinity stabilises at approximately 10,000 to 12,000 mg/L in the long term.
- The Manning Vale West and Willeroo void lake salinities reach approximately 20,000 to 25,000 mg/L in the long term.

The lower predicted lake salinity in the Manning Vale East void as compared to the Manning Vale West and Willeroo void lakes is considered to be a result of the reduced groundwater inflow volume to the Manning Vale East void in comparison to the other two voids. This leads to the predicted salinity in the Manning Vale East void lake increasing in concentration at a lower rate than the Manning Vale West or Willeroo void lakes.

Since all three void lakes are predicted to form groundwater sinks in the long term at rates of between 0.01 and 0.11 ML/day (refer **Section 3.1.2**), the voids will continue to collect groundwater post-mining, and therefore, any local changes to the quality of groundwater that might occur as a result of mining are unlikely to migrate away from the residual voids.

From an acid rock drainage perspective, it is unlikely that any water captured in the Project's final voids will become acidic from oxidation of pyrites in the Walloon Coal Measures aquifer because of the neutralising effect of the surrounding sediments which are naturally alkaline. To date, NAC has not experienced any occurrences of acid rock drainage at the Mine.

4. Groundwater Monitoring Program

4.1. Overview

The groundwater monitoring program for the Project combines the current monitoring program for the existing Mine with an extended network of monitoring bores within and surrounding the Project Area. Data collected from the groundwater monitoring program will:

- ensure compliance with the requirements of the Project's EA, AWL and EPBC approvals;
- be collated into six monthly and annual reviews of groundwater monitoring;
- be used in the continued development and refinement of groundwater impact assessment criteria and investigation triggers;
- enable verification and refinement of the groundwater modelling predictions from the Project's revised groundwater model (SLR, 2018b);
- enable assessment of the long term influence of the MDL_01 Fault on groundwater drawdown propagation arising from operation of the Project; and
- be collated into a database that will be made available to the administering authorities on request or as required by approval conditions.

4.2. Monitoring Bore Types

The various relevant Project approval conditions (see **Section 1.4**) require the Project monitoring network to consist of several monitoring bore types with different purposes and condition compliance protocols. The Project's different monitoring bore types are outlined below.

4.2.1. Compliance Bores

Compliance bores are monitoring bores located on a perimeter surrounding the Project, outside of its mining footprint. These bores will have groundwater level and groundwater quality trigger limits established in the Project's EA that if breached will enact an investigation into the potential for environmental harm.

4.2.2. Early-warning Compliance Bores

Early-warning Compliance bores are monitoring bores located between the Project's mining pits and the Project's regular Compliance bores and/or Control bores. The bore locations are designed to detect unanticipated impacts prior to a trigger breach at an outer Compliance or Control bore. Early-warning Compliance bores will have a two-stage trigger system as follows:

- Groundwater level threshold triggers that are established only for the purposes of this GMMP. These threshold triggers are set at levels that are not considered to indicate potential environmental harm but will trigger an investigation and increased monitoring.
- Groundwater level and groundwater quality trigger limits have/will be established in both this GMMP and the Project's EA similar to Compliance bores, that if breached will enact an investigation into the potential for environmental harm.

Early-warning Compliance bores have threshold triggers (see **Section 7**) that would activate prior to a breach of a limit trigger at an outer Compliance or Control bore. Early-warning and Compliance/Control bore pairs are identified in **Section 4.3.4**.

4.2.3. Control Bores

Control monitoring bores are a subset of the Compliance monitoring bores, that are located outside of the Project's likely groundwater impact zone, for the purpose of comparison with potentially impacted areas.

For the purpose of this GMMP, the likely groundwater impact zone as it relates to the selection of Control bores is defined as the areas inside the predicted 95th percentile 1 m drawdown contour for each aquifer (see **Section 3.1** and **Table 4**). The 95th percentile 1 m drawdown contour was chosen as the threshold for determining the likely extent of impacts of the Project on the basis of:

- Table 2 of the *IESC Information Guidelines Explanatory Note: Uncertainty analysis—Guidance for groundwater modelling within a risk management framework* (Middlemis H and Peeters LJM, 2018), whereby a predictive percentile range of greater than 90% is presented as having a descriptor of being very unlikely that the outcome is larger than this value; and
- Mining induced drawdown of less than 1 m is unlikely to be able to be distinguished from groundwater level declines caused by non-mining factors such as climatic trends and/or third party bore extraction.

4.2.4. Operational Bores

Operational bores are monitoring bores that are located within the general area of the Project's mining footprint. These bores will not have groundwater level or quality triggers established, but are designed primarily to provide data from which to refine the Project's numerical groundwater model as part of the three-yearly review and improvement process.

4.3. Monitoring Network Details

4.3.1. 2019-20 Bore Integrity Review

Following an investigation commissioned by NAC in 2019 into the construction of Mine EA and GMMP Compliance monitoring bore 18Pc (Balgowan Coal Sequence) and it's paired non-EA bore 18Pb (Main Range Volcanics), it was found that the 18Pc bore was connected within its annulus across both the Main Range Volcanics and the Balgowan Coal Sequence (SLR, 2020a). The two bores were subsequently decommissioned, and two replacement bores (18PbR in the Main Range Volcanics and 18PcR in the Balgowan Coal Sequence) installed in compliance with the *Minimum Construction Guidelines for Water Bores in Australia*. Following the 18Pb/18Pc integrity investigation, NAC commissioned an additional investigation into the bore integrity of the entire monitoring network that was completed in mid-2020 (Geochemical Scientific, 2020). The additional investigation identified further potential integrity issues with the following five EA and GMMP monitoring bores installed in the early 2000's: 10Pb and 84P in the Main Range Volcanics, CSMH1 in the Acland Coal Sequence, and 27P and 28P in the Balgowan Coal Sequence. It is important to note that the integrity investigation of the broader monitoring network completed subsequent to the 18Pb/18Pc investigation did not identify any further potential for inter-aquifer connectivity as a result of poor historic bore construction practices, rather, all further potential integrity issues identified relate to the potential risk of surface water infiltration to the bore via the bore annulus due to poor surface sealing.

These potential bore integrity issues were identified as having the potential to compromise the water quality and water level monitoring data as not being representative of the intended hydrogeologic units being monitored. A review was undertaken to assess the potential implications that the integrity issues may have on the 2018 groundwater modelling predictions as used to define the Project's potential impacts in this GMMP (SLR, 2020b). The review included identifying whether the water level data from the potentially compromised bores had been used in the calibration of the model, and if so then determining the relative importance of the data on the overall calibration. A comparison of the water level data for the compromised bores with bores located nearby was also completed to determine any significant differences in the data.

The review found that data for bores 18Pb and 18Pc were not used in the calibration of the model. Concerns over the construction of the remaining five compromised bores were identified during the 2018 modelling work and as such the water level data from these bores were given lower calibration weightings. Comparison of the data to proximal uncompromised bores also found no obvious errors in water level records. The review concluded that the analysis of the data for all five bores used in the calibration of the 2018 groundwater model does not indicate significant groundwater level measurement errors nor discrepancies with surrounding measurements, and there are no concerns regarding the model calibration or any of the calibration realisations used in the 2018 model predictions.

Whilst the review determined that the integrity issues would likely not adversely affect the 2018 modelling work, it was determined from a monitoring perspective that the compromised bores need to be replaced to ensure future water quality and water level data collected is representative of the intended monitoring geologic unit. For monitoring purposes it was recommended that all seven bores should be replaced to ensure that the water level and water quality data is representative of the intended geological unit. As noted above, 18Pb and 18Pc were decommissioned and replaced in early 2020, and furthermore NAC is committed to decommissioning and replacing the other five bores in late 2020. This GMMP has been updated to reflect this.

4.3.2. General

Table 6 summarises the complete set of bores that will be monitored, monitoring parameters, and frequency. The groundwater monitoring program combines the 10 existing Mine EA monitoring bores and 5 replacement Mine EA monitoring bores together with an additional 56 bores in and around the Project Area. Full bore location and construction details are provided in **Appendix B** and **Figure 4** through **Figure 10** present locality plans by aquifer.

Monitoring bore locations have been chosen based on model drawdown predictions, presence of aquifers and receptors of interest, and regulatory agency feedback. The monitoring program has been established prior to the commencement of the Project's mining schedule to ensure there is sufficient baseline information on groundwater levels and quality for all bores.

Table 6 Groundwater Monitoring Schedule[28]

Monitoring Bore	Easting (AGD84)	Northing (AGD84)	Aquifer	Bore Type#	Parameter and Monitoring Frequency*
Bores currently monitored as part of the Mine's EA					
10PbR	370359$	6980886$	Main Range Volcanics	Compliance	Groundwater levels: at a **monthly** or more frequent interval. Groundwater quality: **six monthly** for bores with baseline\background criteria already established, or **three monthly** for bores yet to have baseline\background criteria established, to include: Laboratory analysis: Al, As, Ba, Ca, Se, Cl, Cu, Fe, Fe^{2-}, NO3, NO2, NH3, TKN, K, Mg, Mn, Na, SO4, HCO3, H2S, TDS Field Parameters: pH, EC, Temp, DO, ORP.
84PR	370250$	6982000$	Main Range Volcanics	Compliance	
BMH1	369610	6982175	Main Range Volcanics	Compliance	
81P	374898	6979454	Acland Coal Sequence	Control	
82P	373592	6978628	Acland Coal Sequence	Operational	
CSMH1Ra	375246$	6977235$	Acland Coal Sequence	Compliance	
4517WB	369728	6980670	Acland Coal Sequence	Operational	
4518WB	369265	6979250	Acland Coal Sequence	Operational	
18PcR	370909	6982457	Balgowan Coal Sequence	Early-warning Compliance	
2289_Lower	371266	6983544	Balgowan Coal Sequence	Compliance	
2291P	374622	6981151	Balgowan Coal Sequence	Compliance	
25P(R)	374036	6981873	Balgowan Coal Sequence	Compliance	
26P(R)	374158	6982791	Balgowan Coal Sequence	Compliance	
27PR	373255$	6983368$	Balgowan Coal Sequence	Compliance	
28PR	372222$	6983791$	Balgowan Coal Sequence	Compliance	

[28] This table has been updated from the table contained in the EA (which will need to be updated to reflect this table). The EA tables are based on the AEIS model results, nominal recommended drilling locations and were developed prior to receipt of the EPBC Approval conditions. This revised table is updated from the EA based on the 2018 model results, actual GMMP drilling program locations, replacement of several Stage 2 EA bores since the AEIS, and to incorporate EPBC Approval conditions and IESC feedback.

Monitoring Bore	Easting (AGD84)	Northing (AGD84)	Aquifer	Bore Type[#]	Parameter and Monitoring Frequency[*]
Additional bores incorporated into the Project's monitoring program					
GW09A	373727	6972284	Oakey Creek Alluvium	Early-warning Compliance	<u>Groundwater levels</u>: at a **monthly** or more frequent interval. <u>Groundwater quality</u>: **six monthly** for bores with baseline\background criteria already established, or **three monthly** for bores yet to have baseline\background criteria established, to include: Laboratory analysis: Al, As, Ba, Ca, Se, Cl, Cu, Fe, Fe^{2-}, NO3, NO2, NH3, TKN, K, Mg, Mn, Na, SO4, HCO3, H2S, TDS Field Parameters: pH, EC, Temp, DO, ORP.
GW14A	365642	6975147	Lagoon Creek Alluvium / Weathered Walloon Coal Measures	Control	
A1	368150[$]	6984800[$]	Cain Creek Alluvium	Compliance	
A2	371500[$]	6973150[$]	Oakey Creek Alluvium	Control	
18PbR	370913	6982451	Main Range Volcanics	Compliance	
109P	368154	6982193	Main Range Volcanics	Early-warning Compliance	
GW05A	366453	6981899	Main Range Volcanics	Compliance	
GW15A	364697	6975990	Main Range Volcanics	Control	
GW16A	364684	6979526	Main Range Volcanics	Control	
GW11R	367268	6982663	Main Range Volcanics	Compliance	
B1	367080[$]	6981450[$]	Main Range Volcanics	Early-warning Compliance	
B2	365400[$]	6982150[$]	Main Range Volcanics	Control	
B3	368400[$]	6984200[$]	Main Range Volcanics	Compliance	
B4	364670[$]	6977830[$]	Main Range Volcanics	Control	
B5	363400[$]	6983300[$]	Main Range Volcanics	Control	
GW13B	365063	6975946	Waipanna Coal Sequence	Compliance	

Monitoring Bore	Easting (AGD84)	Northing (AGD84)	Aquifer	Bore Type#	Parameter and Monitoring Frequency*
GW22A	367911	6976483	Waipanna Coal Sequence	Control	<u>Groundwater levels</u>: at a **monthly** or more frequent interval. <u>Groundwater quality</u>: **six monthly** for bores with baseline\background criteria already established, or **three monthly** for bores yet to have baseline\background criteria established, to include: Laboratory analysis: Al, As, Ba, Ca, Se, Cl, Cu, Fe, Fe^{2-}, NO3, NO2, NH3, TKN, K, Mg, Mn, Na, SO4, HCO3, H2S, TDS Field Parameters: pH, EC, Temp, DO, ORP.
WCS1	364800$	6979550$	Waipanna Coal Sequence	Compliance	
WCS2	365780$	6979090$	Waipanna Coal Sequence	Early-warning Compliance	
111PGC_Lower	371444	6977553	Acland Coal Sequence (lower)	Operational	
111PGC_Upper	371445	6977552	Acland Coal Sequence (upper)	Operational	
112P	370545	6977658	Acland Coal Sequence	Operational	
113PB	368353	6978250	Acland Coal Sequence	Operational	
114P	371698	6975854	Acland Coal Sequence	Compliance	
116P	374114	6974946	Acland Coal Sequence	Early-warning Compliance	
118P	367400	6975927	Acland Coal Sequence	Compliance	
119P	371501	6973152	Acland Coal Sequence	Compliance	
GW05B	366437	6981901	Acland Coal Sequence	Compliance	
GW06B	365780	6979090	Acland Coal Sequence	Early-warning Compliance	
GW07B	369309	6973527	Acland Coal Sequence	Compliance	
GW08B	365704	6976849	Acland Coal Sequence	Compliance	
GW09B	373729	6972297	Acland Coal Sequence	Compliance	
GW10	375336	6975551	Acland Coal Sequence	Compliance	

Monitoring Bore	Easting (AGD84)	Northing (AGD84)	Aquifer	Bore Type#	Parameter and Monitoring Frequency*
GW12B	364802	6979539	Acland Coal Sequence	Compliance	Groundwater levels: at a **monthly** or more frequent interval. Groundwater quality: **six monthly** for bores with baseline\background criteria already established, or **three monthly** for bores yet to have baseline\background criteria established, to include: Laboratory analysis: Al, As, Ba, Ca, Se, Cl, Cu, Fe, Fe^{2-}, NO3, NO2, NH3, TKN, K, Mg, Mn, Na, SO4, HCO3, H2S, TDS Field Parameters: pH, EC, Temp, DO, ORP.
GW17A	369940	6972116	Acland Coal Sequence	Compliance	
GW19A	368190	6976681	Acland Coal Sequence	Early-warning Compliance	
GW22B	367928	6976481	Acland Coal Sequence	Compliance	
ACS1	366270$	6979160$	Acland Coal Sequence	Compliance	
ACS2	366500$	6979200$	Acland Coal Sequence	Compliance	
ACS3	361450$	6971550$	Acland Coal Sequence	Compliance	
GW19B	368181	6976676	Balgowan Coal Sequence	Compliance	
GW22C	367948	6976479	Balgowan Coal Sequence	Compliance	
BCS1	366270$	6979160$	Balgowan Coal Sequence	Compliance	
BCS2	374110$	6974950$	Balgowan Coal Sequence	Compliance	
CSMH1Rb	375250$	6977230$	Balgowan Coal Sequence	Compliance	
GW08C	365709	6976874	Marburg Sandstone	Compliance	
GW09C	373730	6972310	Marburg Sandstone	Compliance	
GW11B	367457	6982517	Marburg Sandstone	Early-warning Compliance	
M1	374110	6974950	Marburg Sandstone	Early-warning Compliance	
M2	375250	6977230	Marburg Sandstone	Compliance	
M3	369300	6973600	Marburg Sandstone	Compliance	
130WB	369039	6984626	Marburg Sandstone	Compliance	

Monitoring Bore	Easting (AGD84)	Northing (AGD84)	Aquifer	Bore Type#	Parameter and Monitoring Frequency*
21P	376733	6982068	Marburg Sandstone	Control	
41P	371862	6984535	Marburg Sandstone	Compliance	
48P	373467	6983670	Marburg Sandstone	Compliance	
3307_WB	372408	6982501	Rehabilitated Spoil	Operational	

$ Co-ordinates approximate; bore not yet installed.

See **Section 4.2**

* Aluminium (Al), Arsenic (As), Barium (Ba), Calcium (Ca), Selenium (Se), Chloride (Cl), Copper (Cu), Iron (Fe), Ferric Iron (Fe^{2+}), Nitrate (NO3), Nitrite (NO2), Ammonia (NH3), Total Kjeldahl Nitrogen (TKN), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na), Sulphate (SO4), Bicarbonate (HCO3), Hydrogen Sulphide (H2S), Total Dissolved Solids (TDS), Acidity/Alkalinity (pH), Electrical Conductivity (EC), Temperate (Temp), Dissolved Oxygen (DO), Oxidation Redox Potential (ORP);. See **Section 4.5.2.2**.

4.3.3. Control Bores

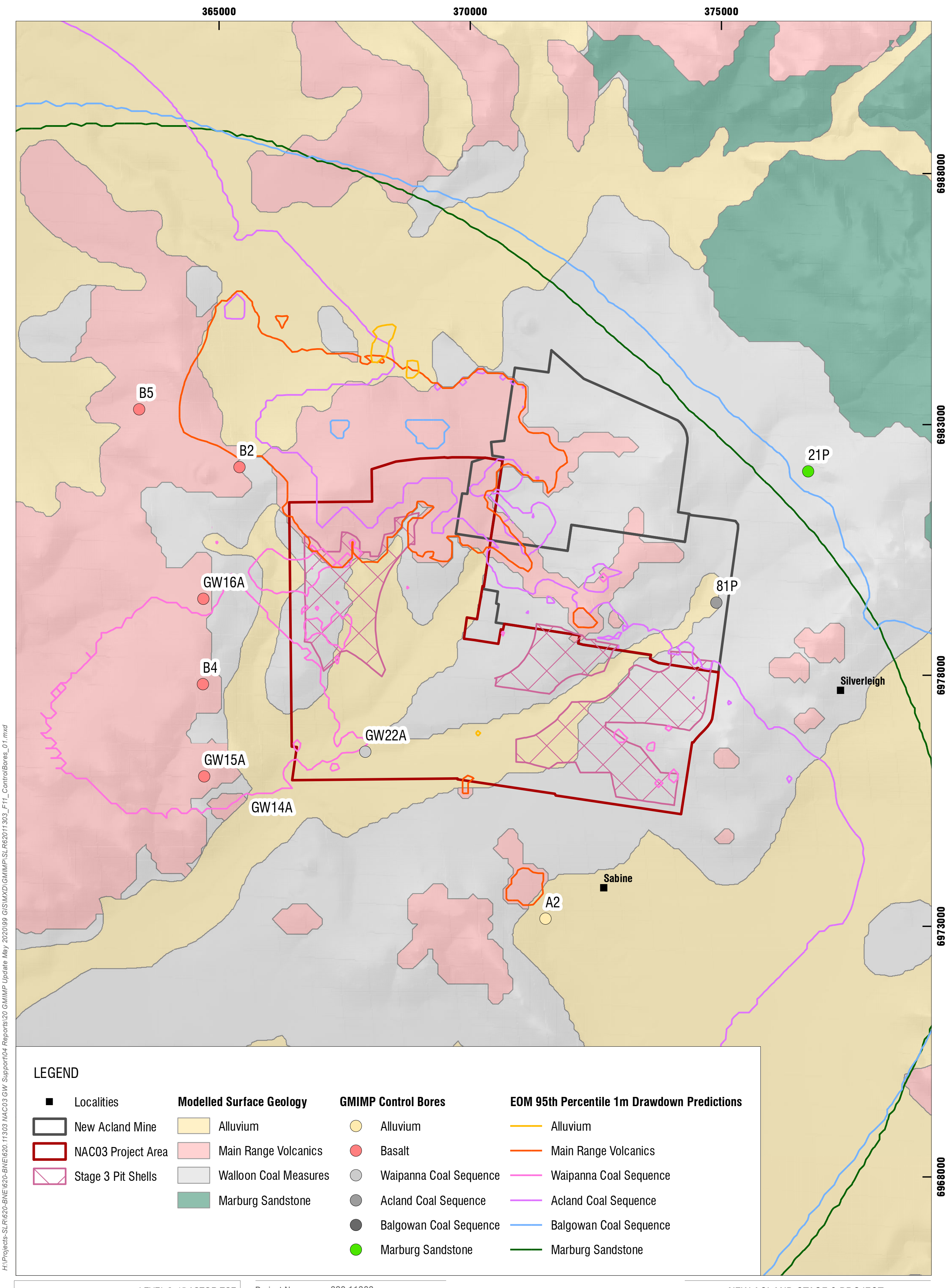
Table 7 and **Figure 11** identify the Project's Control monitoring sites, which are a subset of the bores identified in **Table 6**. Control monitoring sites are all located outside of the 95th percentile 1 m predicted drawdown contour relevant for each aquifer and have been identified for each of the key geologic units in and surrounding the Project Area.

Table 7 Control Monitoring Sites

Monitoring Bore	Aquifer
GW14A	Alluvium (Lagoon Creek)
A2	Alluvium (Oakey Creek)
GW15A	Main Range Volcanics
GW16A	Main Range Volcanics
B2	Main Range Volcanics
B4	Main Range Volcanics
B5	Main Range Volcanics
GW22A	Waipanna Coal Sequence
81P	Acland Coal Sequence
21P	Marburg Sandstone

The Control monitoring bores identified in **Table 7** and **Figure 11** include new bores proposed to be installed specifically for the purpose of providing Control monitoring sites (as opposed to repurposed existing monitoring bores) as follows.

- Bore A2 is proposed as a means to provide a Control monitoring site in the Oakey Creek Alluvium aquifer immediately south of the Project in the area, where that aquifer is close to the Project's boundary.
- Bore B2 is proposed as a means to provide a Control monitoring site in the Main Range Volcanics aquifer northwest of the Project, in the area of the aquifer that is associated with third party use closest to the Project but not within the Project's predicted impact zone northwest of the Project.
- Bore B4 is proposed as a means to provide a second Control monitoring site in the Main Range Volcanics aquifer west of the Project, in the area of the aquifer that is associated with third party use closest to the Project but outside the Project's predicted impact zone.
- Bore B5 is proposed as a means to provide a Control monitoring site in the Main Range Volcanics aquifer further northwest of the Project, in the area of the aquifer that is associated with third party use but beyond the Project's predicted impact zone northwest of the Project.



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NEW ACLAND STAGE 3 PROJECT

GROUNDWATER MANAGEMENT AND MONITORING PLAN

CONTROL BORES

FIGURE 11

4.3.4. Early-warning and Compliance/Control Bore Pairs

For each Early-warning Compliance bore, the monitoring network includes a Compliance or Control bore in the same aquifer and located at a further distance away from the Project boundaries, facilitating each Early-warning Compliance bore to have investigation triggers (see **Section 7**) that would activate prior to a breach of a trigger at an outer Compliance or Control bore. Early-warning and Compliance/Control bore pairs are identified in **Table 8** and **Figure 12**.

The location of each Early-warning Compliance bore has been chosen such that, where possible, drawdown will be measured at the Early-warning Compliance bore prior to the first three-yearly groundwater model update (see **Section 8.1**). For this purpose, the 50^{th} percentile 1 m drawdown prediction at Mine Year 3 was adopted as a means to identify suitable locations for the Early-warning Compliance bores (see **Figure 12**). However, it should be noted that there are several complicating factors, which are explained as follows.

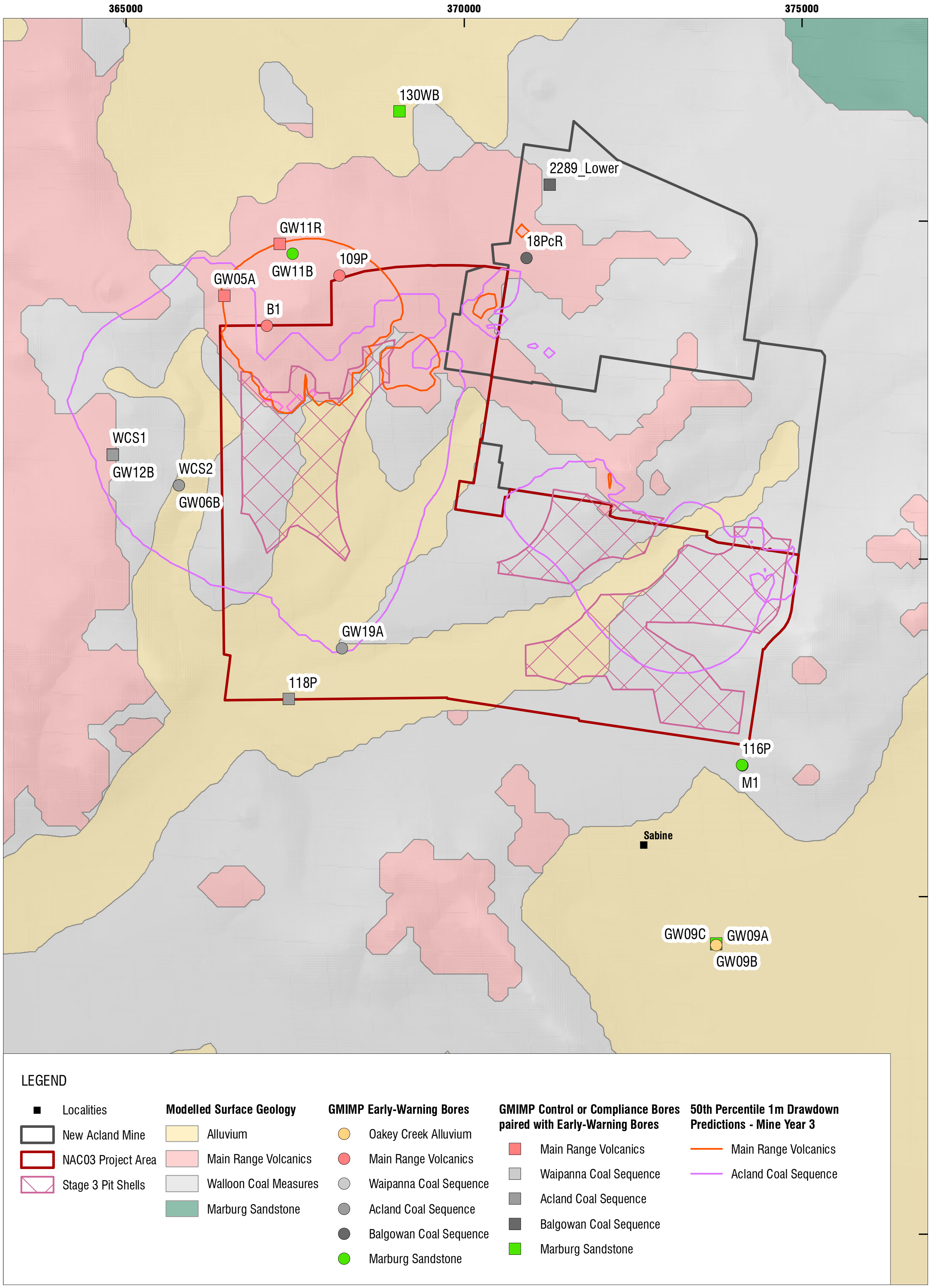
- Timing: At the time of the first three-yearly groundwater model update, groundwater model predictions indicate that measurable groundwater drawdown from the Project (considered to be greater than 0.5 m for this purpose) will not occur for any of the Alluvium, Waipanna Coal Sequence outside of the mining disturbance footprint, Balgowan Coal Sequence, or Marburg Sandstone.
- Groundwater System Recovery from Stage 1 and 2 Operations: For the Balgowan Coal Sequence and Marburg Sandstone aquifers, although groundwater drawdown arising from the Project is predicted (i.e. incremental Project-only drawdown), this is actually offset in the cumulative impacts model scenario (i.e. the model predictions that include the existing Mine operations) by recovery of groundwater levels related to the cessation of historic Mine-related groundwater pumping in 2010, as well as recovery of groundwater levels following the completion and rehabilitation of Stage 1 and 2 mining. Therefore, although groundwater drawdown arising from the Project is predicted for the Balgowan Coal Sequence and Marburg Sandstone, in a cumulative impact scenario (i.e. real-world) sense there is no predicted drawdown for those aquifers since groundwater levels are recovering overall (i.e. rising) and the drawdown from the Project is masked and therefore unmeasurable.
- Non-Mining Antecedent Trends: As described in the Project's conceptual hydrogeological model report (SLR, 2018b; **Appendix A**) and the baseline data statistical trend analysis (**Appendix E**), the groundwater system in the vicinity of the Project is subject to existing groundwater drawdown trends associated primarily with large volumes of third-party groundwater extraction and climatic variability.

Since measurable groundwater drawdown from the Project is not predicted to occur for any of the Alluvium, Waipanna Coal Sequence outside of the mining disturbance footprint, Balgowan Coal Sequence, or Marburg Sandstone at the time of the first three-yearly groundwater model update, the location of the Early-warning Compliance bores in these aquifers have been chosen from the existing/proposed network where the bores occur closest to the Project for each of those aquifers. This method results in the situation where any drawdown in those aquifers would be detected firstly at these Early-warning Compliance bores, before any other Compliance bore in the monitoring network for those aquifers.

Table 8 Early-warning and Compliance/Control Monitoring Pairs

Early-warning Compliance Bore	Compliance or Control Bore	Aquifer
GW09A	A2	Alluvium (Oakey Creek)
B1	GW05A	Main Range Volcanics
109P	GW11R	Main Range Volcanics
WCS2	WCS1	Waipanna Coal Sequence
116P	GW09B	Acland Coal Sequence
GW06B	GW12B	Acland Coal Sequence
GW19A	118P	Acland Coal Sequence
18PcR	2289_Lower	Balgowan Coal Sequence
GW11B	130WB	Marburg Sandstone
M1	GW09C	Marburg Sandstone

Trigger thresholds applied to Early-warning Compliance bores are discussed in **Section 7.1.2**.



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NEW ACLAND STAGE 3 PROJECT

GROUNDWATER MANAGEMENT AND MONITORING PLAN

EARLY-WARNING COMPLIANCE BORES

FIGURE 12

4.3.5. Grouped Bores for Vertical Connectivity Monitoring

Monitoring bore locations include several sets of co-located bores, located in close proximity to each other, that will allow assessment of the response of different stacked (overlying) aquifers in and surrounding the Project area. **Table 9** and **Figure 13** identify the grouped vertical connectivity monitoring bores**,** which are a subset of the bores identified in **Table 6**.

These locations will allow ongoing assessment of the connectivity between the vertically stacked aquifers through the analysis of both water level and water quality characteristics (for example cluster or principal component analysis) and trends over time and comparison of those characteristics and trends between grouped bores. This form of vertical connectivity assessment has already been conducted using baseline data as discussed in **Appendix A, Appendix D** and **Appendix G**, and repeat of this analysis during execution of the Project will be incorporated in the ongoing review process outlined in **Section 8**.

The selection of each bore and bore grouping for vertical connectivity monitoring in the GMMP is made on the basis of:

- covering the stacked hydrogeologic units of interest; and/or
- prioritisation of sites with longer periods of record; and/or
- the highest 95th percentile cumulative model drawdown prediction over the life of the Project being of different magnitude at each bore in each grouping, as shown in **Table 9**.

Thus, departures from the model predictions for these bores would potentially indicate greater or reduced vertical connectivity between aquifers than originally assumed.

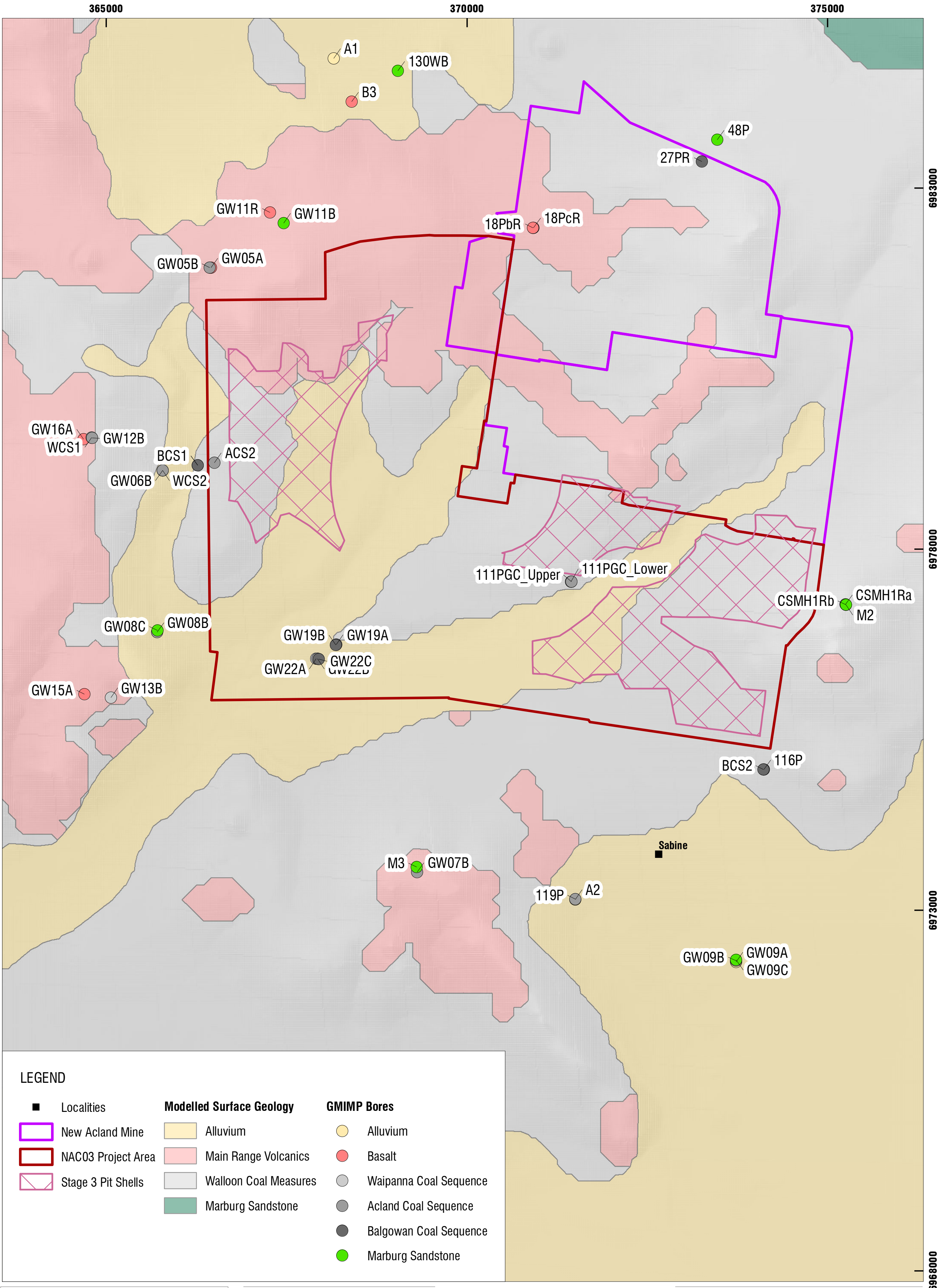
Table 9 Grouped Bore Installations for Vertical Connectivity Monitoring

Bore Grouping	Aquifers Monitored	Reference Level	95th Percentile Cumulative Drawdown Prediction	Location
A1 B3 130WB	Cain Creek Alluvium Main Range Volcanics Marburg Sandstone	TBC TBC TBC	1.6 m 2.3 m -0.1 m	North of the Project
GW05A GW05B	Main Range Volcanics Marburg Sandstone	454.8 mAHD 410.3 mAHD	7.2 m 10.5 m	Northwest of the Project
GW11R GW11B	Main Range Volcanics Marburg Sandstone	446.1 mAHD 408.1 mAHD	7.0 m 0.5 m	North of the Project
GW16A WCS1 GW12B	Main Range Volcanics Waipanna Coal Sequence Acland Coal Sequence	450.2 mAHD TBC 400.8 mAHD	-0.1 m 2.7 m 12.4 m	West of the Project downthrow of the MDL_01 Fault
18PbR 18PcR	Main Range Volcanics Balgowan Coal Sequence	443.0 408.5	4.57 m 0.37 m	North of the Project
WCS2 GW06B	Waipanna Coal Sequence Acland Coal Sequence	TBC 401.7 mAHD	4.1 m 16.3 m	West of the Project downthrow of the MDL_01 Fault

Bore Grouping	Aquifers Monitored	Reference Level	95th Percentile Cumulative Drawdown Prediction	Location
ACS1 BCS1	Acland Coal Sequence Balgowan Coal Sequence	TBC TBC	30.1 m 2.9 m	West of the Project upthrow of the MDL_01 Fault
GW08B GW08C	Acland Coal Sequence Marburg Sandstone	400.3 mAHD 334.5 mAHD	13.9 m 1.7 m	West of the Project
GW15A GW13B	Main Range Volcanics Waipanna Coal Sequence	419.6 mAHD 400.9 mAHD	0.0 m 4.1 m	Southwest of the Project
GW19A GW19B	Acland Coal Sequence Balgowan Coal Sequence	397.1 mAHD 393.5 mAHD	24.4 m 3.7 m	In the southwest of the Project Area upthrow of the MDL_01 Fault
GW22A GW22B GW22C	Waipanna Coal Sequence Acland Coal Sequence Balgowan Coal Sequence	392.7 mAHD 392.5 mAHD 391.7 mAHD	3.8 m 18.0 m 3.5 m	In the southwest of the Project Area downthrow of the MDL_01 Fault
GW07B M3	Acland Coal Sequence Marburg Sandstone	401.9 mAHD TBC	13.5 m 2.9 m	South of the Project
A2 119P	Oakey Creek Alluvium Acland Coal Sequence	TBC 392.0 mAHD	1.7 m 14.5 m	Southeast of the Project
GW09A GW09B GW09C	Oakey Creek Alluvium Acland Coal Sequence Marburg Sandstone	391.4 mAHD 392.2 mAHD 392.5 mAHD	5.8 m 9.3 m 3.6 m	Southeast of the Project
116P BCS2 M1	Acland Coal Sequence Balgowan Coal Sequence Marburg Sandstone	389.6 mAHD TBC TBC	23.8 m 4.3 m 4.6 m	Southeast of the Project
CSMH1Ra CSMH1Rb M2	Acland Coal Sequence Balgowan Coal Sequence Marburg Sandstone	TBC TBC TBC	3.5 m 3.7 m 4.5 m	East of the Project
27P 48P	Balgowan Coal Sequence Marburg Sandstone	443.0 mAHD 414.5 mAHD	0.1 m -0.5 m	North of the Project and the Mine

Since the grouped bores for vertical connectivity monitoring outlined in **Table 9** and **Figure 13** are a subset of the Project's Compliance, Early-warning Compliance and Control bores (see **Table 6**), they have groundwater impact triggers established for the purposes of this GMMP as described in **Section 7.1** and **Appendix I**. The approach to impact trigger development, particularly for groundwater levels, is based upon assessment of model drawdown predictions, and the model incorporates the current understanding of aquifer connectivity as described in the Project's conceptual hydrogeological model (SLR, 2018b;

Appendix A). Therefore, any greater than expected aquifer connectivity would manifest in a departure from model predictions and thus will likely result in a breach of a groundwater impact trigger outlined in **Section 7.1**. Furthermore, the Groundwater Impact Investigation Procedure outlined in **Section 7.2** will then be initiated in the event of any trigger breach related to greater than expected aquifer connectivity, and then possible mitigation measures as described in **Section 7.3** would apply. It is therefore considered that the current groundwater impact triggers and investigation procedure documented in **Section 7** are sufficient for the purposes of identifying and managing greater than expected connectivity between aquifers.



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NEW ACLAND STAGE 3 PROJECT

GROUNDWATER MANAGEMENT AND MONITORING PLAN

GROUPED BORE SITES

FIGURE 13

4.3.6. Fault Monitoring

The monitoring bore locations also include co-located bores designed to monitor the influence of the major "MDL_01" fault on groundwater drawdown propagation, as identified in **Table 10** and **Figure 14.** The MDL_01 Fault is the major sub-regional scale fault separating the Project from the downgradient hydrogeologic system as described in the Project's conceptual hydrogeological model (SLR, 2018b; **Appendix A**). These bores are designed to assist in providing monitoring data that would be utilised for developing an updated characterisation of whether the MDL_01 fault acts as a conduit or a barrier to groundwater flow at this location. These bores are a subset of the bores identified in **Table 6**.

Table 10 Grouped Bore Installations for Fault Monitoring

Bore Grouping	Aquifers Monitored	Location
GW16A WCS1 GW12B	Main Range Volcanics Waipanna Coal Sequence Acland Coal Sequence	West of the Project downthrow of the MDL_01 Fault
WCS2 GW06B	Waipanna Coal Sequence Acland Coal Sequence	West of the Project downthrow of the MDL_01 Fault
ACS1 BCS1	Acland Coal Sequence Balgowan Coal Sequence	West of the Project upthrow of the MDL_01 Fault
GW19A GW19B	Acland Coal Sequence Balgowan Coal Sequence	In the southwest of the Project Area upthrow of the MDL_01 Fault
GW22A GW22B GW22C	Waipanna Coal Sequence Acland Coal Sequence Balgowan Coal Sequence	In the southwest of the Project Area downthrow of the MDL_01 Fault

These bores will allow direct comparison of the hydrogeologic response of each coal sequence aquifer on either side of the fault as mining progresses, through the analysis of both water level and water quality trends over time (statistical and hydrograph analysis) and comparison of those trends across either side of the MDL_01 fault. This form of assessment will be incorporated in the ongoing review process outlined in **Section 8**. In the event that this assessment indicates greater than anticipated groundwater flow and drawdown associated with the fault, the ongoing review process outlined in **Section 8** would result in a review and if necessary an update of how faults are represented in the groundwater model as discussed in **Section 8.1.1**, expansion of the fault monitoring bore sets to include additional bores if required, or enacting of additional investigations such as those discussed in **Section 8.3.2**.

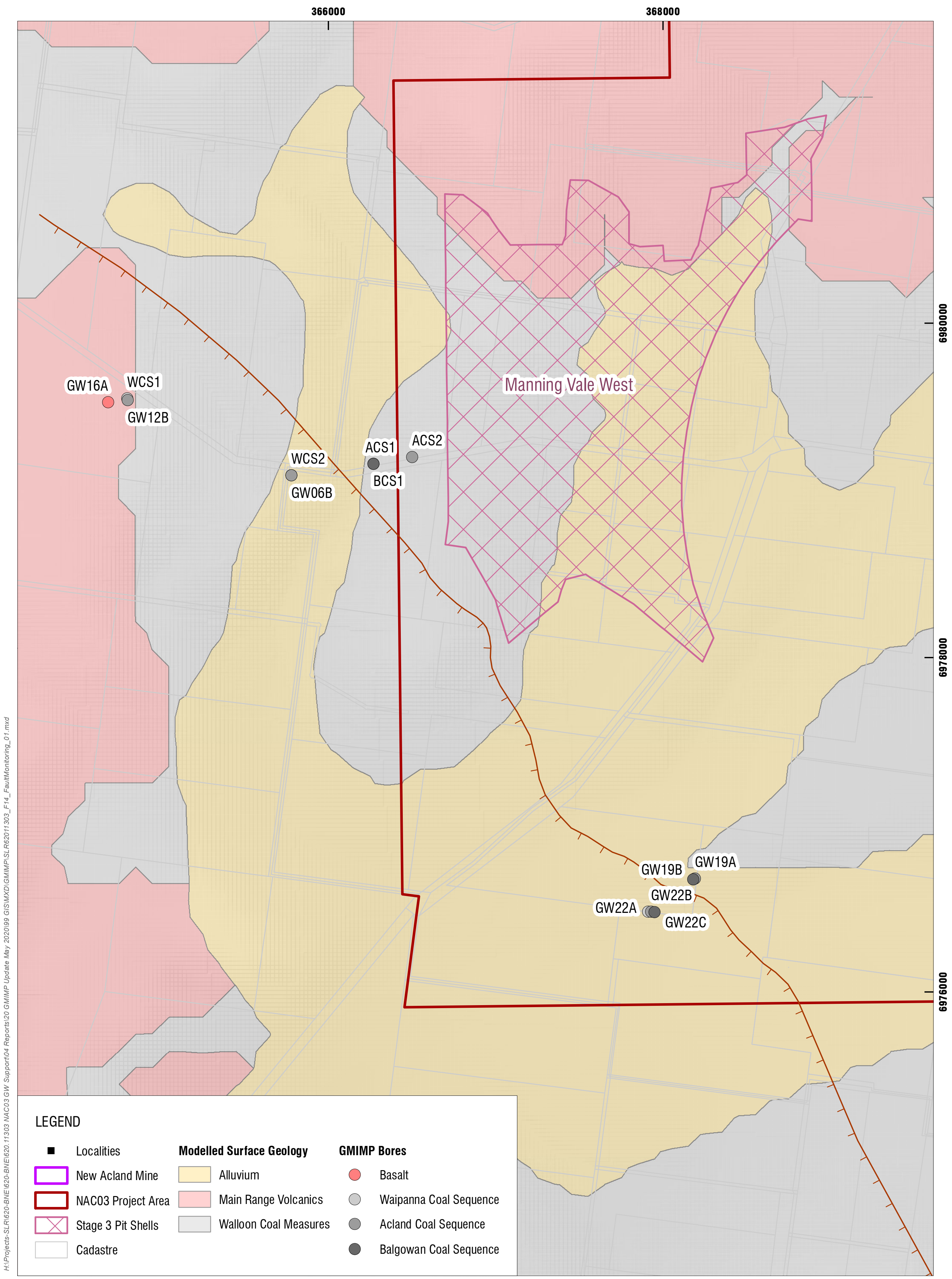
Fault monitoring bore trigger levels have also been established for the fault monitoring bores (**Appendix I**) based on modelled impact predictions. **Section 7** discusses the investigation procedure if these triggers are breached and potential mitigation measures that would be considered.

4.3.7. Revisions / Updates to the Monitoring Network

It is recognised that updates to a projects groundwater monitoring network are necessary from time to time. Reasons for this may include physical damage to a particular bore or it becoming otherwise compromised, or new information becoming available which changes the understanding of the system. As discussed in **Section 8**, the GMMP review and improvement process will identify where this is necessary, and sufficient rework of the underlying modelling and impacts assessment will be undertaken to ensure no net loss of integrity of the program or protection to the environmental values.

4.3.8. Groundwater Dependant Ecosystem Monitoring

As described in the Project's conceptual hydrogeological model report (SLR, 2018a, **Appendix A**), publicly mapped (BoM GDE Atlas) potential terrestrial Groundwater Dependant Ecosystems (GDEs) are located within proximity to the Project Area. However, a review of regional ecosystem mapping and aerial photographic analysis found that none of the actual vegetation communities that exist within these areas correspond to vegetation types that are known to be GDEs. That is, the species characteristic of the ecologically dominant layers within these communities are not phreatophytic and similar communities are known to occur where groundwater is not accessible. Furthermore, Oakey Creek and its upper tributary Cooby Creek to the south of the Project, as well as Myall Creek to the north, are identified as 'losing' streams, and therefore, are not likely to be associated with the surface expression of groundwater (i.e. having baseflow derived from groundwater) despite being mapped as potential surface expression GDEs in publicly available mapping. Consequently, it was not deemed valid or necessary to incorporate specific GDE monitoring into this GMMP.



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GROUNDWATER MANAGEMENT AND MONITORING PLAN

FAULT MONITORING SITES

FIGURE 14

4.3.9. Landholder Bores

Since 2015, NAC has been undertaking a landholder bore Baseline Assessment Program (BAP; SLR, 2015) to characterise each and every private bore located within the area predicted to be subject to groundwater drawdowns exceeding the relevant *Water Act 2000* bore trigger thresholds as a result of the Project. It is the intent of the BAP to provide the necessary information required for NAC to determine if any landholder bores might be unduly affected by operation of the Project so that NAC can proceed to developing make good agreements with those landholders. The BAP collects information such as bore construction, condition, usage, source aquifer, and water level and quality information.

Following the completion of this assessment program, and subject to further engagement with landholders, groundwater monitoring will be undertaken at selected landholder bores surrounding the Project site and documented in this GMMP following consultation and agreement with the relevant landholders.

The ongoing monitoring program at selected landholder bores commenced in 2017 and continues to be refined as the bore assessment program is completed.

Primarily the long term landholder bore monitoring program will include monitoring of groundwater levels and quality in order to assess potential impacts from mine operations. Landholder bores targeted for monitoring will primarily be those taking water from the coal measures and Main Range Volcanics but may include some bores in the Marburg Sandstone or alluvial aquifers. Landholder bores chosen for long term monitoring and documented in this GMMP will be selected on the basis of:

- aquifer of interest in relation to the Project's predicted impacts;
- confidence in bore construction;
- where possible, the absence of the influence of landholder groundwater pumping, or where specific details of the landholder pumping can be reliably obtained; and
- agreement with the landholder.

NAC will continue the process to finalise the confirmed long term landholder monitoring program for the Project upon completion of the BAP, and is committed to ensuring that this on-going monitoring program is established at the priority landholder locations around the Project (i.e. based on achieving legal agreement for long term access and monitoring activities with the participating landholders).

4.4. Post Mining

The Project's post mining period is specifically covered by the requirements for NAC to develop a Final Land Use and Rehabilitation Plan (FLURP) in accordance with the Project's EPBC Act approval conditions and a Progressive Rehabilitation and Closure Plan (PRCP) in accordance with State regulatory requirements.

The GMMP groundwater monitoring program for Project monitoring bores described in **Section 4.1** though **Section 4.3** above will continue unchanged in the post-mining period. This will also be documented in both the FLURP and the PRCP.

Post-mining monitoring will also include additional monitoring of each of the three Project final voids (depressed landforms, refer **Section 3.1.2.4**) as follows.

- Void Water Level
  - Monthly survey of the void lake water level consistent with the frequency of groundwater level monitoring at Project groundwater bores.
- Void Water Quality

+ 6-Monthly sampling of the void lake water quality consistent with the frequency and parameter suite (**Section 4.5.2.2**) for groundwater quality monitoring at Project groundwater bores.

In the post-mining period, the FLURP and PRCP will require that the GMMP Review and Improvement Process outlined in **Section 8** continues unchanged.

The GMMP will continue to be implemented during the post-mining period until such time as mining lease relinquishment is achieved, in accordance with relevant State and Commonwealth regulatory approvals associated with satisfactory completion of implementation of the FLURP and PRCP. These statutory obligations will include assessment and demonstration that the ongoing risk to groundwater associated with the final landform has been successfully managed and mitigated.

4.5. Monitoring Protocols

The groundwater monitoring network will:

- be installed and maintained under the supervision of a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters; and
- be constructed in accordance with methods prescribed in the latest edition of the 'Minimum Construction Requirements for Water Bores in Australia' by an appropriately qualified and licensed water bore driller; and
- where relevant, ensure compliance with the requirements of the 'Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland WSS/2016/3189 Version 1.02 (DNRME, 2017)'.

Groundwater monitoring will be undertaken by appropriately qualified personnel. Groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998. Further detail is provided in **Section 5**.

4.5.1. Groundwater Level Monitoring

Groundwater level monitoring will be undertaken using automated level loggers installed by appropriately qualified personnel in each Project monitoring bore. Logging intervals will be set to record a measurement every 6 hours, a time interval considered sufficient for adequate data capture given that modelling shows measurable mining related groundwater level impacts are predicted to occur over timescales of months to years. A barometric pressure logger will be installed at bore 112P in the central part of the Project Area (refer **Figure 7**) and the water level logger data will be barometric pressure corrected using the barometric pressure logger data prior to any analysis.

Loggers will be downloaded at least every three months. At the time of each download, a manual water level measurement will be recorded at each bore using a conventional groundwater level monitoring e-tape to confirm logger data accuracy. Any discrepancies observed in the automated monitoring data when compared to the manual measurements will be immediately investigated and where necessary the loggers reset or replaced to ensure data reliability.

Further detail is provided in **Section 5**.

4.5.2. Groundwater Quality Monitoring

4.5.2.1. General

Groundwater quality sampling will be undertaken on a 6-monthly basis for bores where baseline\background parameter concentrations and triggers have been established. For bores where water quality baseline\background parameter concentrations and triggers are not yet established, monitoring will occur at a 3-monthly frequency until a statistically sufficient dataset is collected from which to define baseline criteria and triggers in accordance with the DSITI (2017) groundwater quality assessment guideline.

Groundwater quality sampling will be undertaken in accordance with the protocols and QA/QC procedures outlined in:

- Australian Standard AS/NZS 5667.11:1998 Water quality – Sampling – Guidance on sampling of groundwaters;
- Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009); and
- Department of Environment and Heritage Protection (EHP) Monitoring and Sampling manual – Version 2 (September 2010).

Field measurement of water quality parameters will be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

Groundwater sample analysis will continue to be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA). The sample analysis will include duplicates and blanks consistent with industry standard QA/QC procedures.

Further detail is provided in **Section 5**.

4.5.2.2. Parameter Suite

As described in **Section 3.2**, potential impacts from the Project activities have been identified as primarily groundwater level drawdown as a result of mining. The Project's impact on groundwater level drawdown has the potential to result in groundwater quality changes. Groundwater quality changes may occur where groundwater level drawdown results in changes in aquifer potentiometric head gradients sufficient to cause significant alteration of groundwater flow systems that moves groundwaters of different quality into different areas of the hydrogeologic system. Furthermore, groundwater level drawdown also has the somewhat less likely potential to result in oxidation of the aquifer matrix that results in release of the matrix chemical constituents into groundwater, and this type of oxidation effect may also occur within overburden spoil dumps associated with the Project. Blasting activities also have the potential to release nitrogen compounds such as ammonia to groundwater. At a single monitoring bore location, these potential groundwater quality changes may manifest as one or a combination of:

- changes to groundwater salinity (measured as electrical conductivity (EC) or Total Dissolved Solids (TDS);
- changes to groundwater pH;
- modification of the ionic composition of the groundwater;
- changes to the concentration of metal and metalloids in groundwater (particularly if significant pH changes arise); and
- changes to the concentration of nitrogen compounds ('nutrients') in groundwater.

The groundwater quality parameter suite identified in **Table 6** therefore has been selected to detect these potential changes in groundwater following a comprehensive geochemical review of monitoring data collected since the commencement of mining (Geochemical Scientific, 2020). The groundwater quality parameter suite comprises:

- Physico-chemical Parameters
  - Salinity as EC (field measured) and TDS (laboratory)
  - pH (field measured)
  - Redox Potential (field measured for interpretive purposes only)
  - Dissolved Oxygen (field measured for interpretive purposes only)
  - Temperature (field measured for interpretive purposes only)
- Major Ions (laboratory)
  - Sodium (Na)
  - Calcium (Ca)
  - Potassium (K)
  - Magnesium (Mg)
  - Chloride (Cl)
  - Sulphate (SO4)
  - Bicarbonate (HCO3)
  - Carbonate (CO3)
- Metals and Metalloids (laboratory)
  - Aluminium (Al)
  - Arsenic (As)
  - Barium (Ba) (for interpretive purposes only)
  - Copper (Cu)
  - Fluorine (F)
  - Iron (F)
  - Ferrous Iron (Fe^{2+}) (for interpretive purposes only)
  - Manganese (Mn)
  - Selenium (Se)
- Nutrients (laboratory)
  - Nitrate (NO3)
  - Nitrite (NO2)
  - Ammonia (NH3) (for interpretive purposes only)
  - Total Kjeldahl Nitrogen (TKN) (for interpretive purposes only)
- Dissolved Gases (laboratory)
  - Hydrogen Sulphide (H2S) (for interpretive purposes only)

4.5.3. Groundwater Data Management

The data gathered from the groundwater monitoring program will be collated into a database managed by NAC Environmental Department site personnel. The data management system will include:

- a site plan showing sample locations;
- tabulated results of the monitoring compared with applicable background/trigger levels;
- all data collected during each monitoring round;
- a record of chain of custody of the samples from sampling through to analysis;
- laboratory analysis certificates;
- groundwater monitoring program reports, and
- a description of the procedures, methods and calculations used.

Further detail is provided in **Section 5**.

5. Quality Assurance / Quality Control

NAC recognises that robust QA/QC procedures are a critical component of the GMMP. QA/QC procedures adopted by NAC in the GMMP will include:

- Field based procedures for:
  - Equipment calibration;
  - Equipment decontamination;
  - Groundwater level measurement methods; and
  - Groundwater quality sampling methods.
- Groundwater quality laboratory-based procedures for:
  - Laboratory accreditation;
  - Sample analysis replication; and
  - Sample quality assurance.
- Data management and data quality assurance procedures.

5.1. Field Procedures

Field procedures have been developed to be compliant with:

- Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009);
- DES 2018. Monitoring and Sampling Manual: Environmental Protection (Water) Policy. Brisbane: Department of Environment and Science Government.
- Australian and New Zealand Standard AS/NZS 5667.1:1998 Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS5667).

5.1.1. Qualified Personnel

Groundwater monitoring will be undertaken by appropriately qualified personnel with experience in conducting groundwater monitoring and sampling programs in accordance with the above listed Guidelines.

5.1.2. Equipment Calibration

The field water quality (i.e. pH, EC, DO and Redox) meter used during the program implementation will be calibrated to the relevant calibration standard solutions daily, and prior to each day's work. Daily calibration records will be noted in a dedicated register and provided with the monitoring event report (see **Section 5.1.7**) for record keeping purposes.

5.1.3. Equipment Decontamination

All field equipment used in the execution of the GMMP monitoring programs will be thoroughly decontaminated before and after conducting any field measurements and sampling at each and every bore. This decontamination process includes the water level dip-meter probe and tape, field water quality meter, and water quality sample pumps and tubing.

5.1.4. Groundwater Level Measurements

5.1.4.1. Manual Measurements

Manual groundwater level measurements will be collected prior to any disturbance for groundwater quality sample collection at any bore.

Manual groundwater level measurements will be collected using an industry standard groundwater level e-tape. The e-tape will be checked for operational readiness before each use, including a test of the probe function prior to use in the field. Measurements of the groundwater level will be taken from the top of the PVC casing at each bore, a point permanently marked at the top of the PVC casing at each bore to provide repeatability and consistency between monitoring events.

5.1.4.2. Water Level Data Logger Downloads

As described in **Section 4.5.1**, groundwater level monitoring will also be undertaken using automated level loggers installed by appropriately qualified personnel in each Project monitoring bore and set to record at 6-hourly intervals. A barometric pressure logger will be installed at bore 112P in the central part of the Project Area (refer **Figure** 7) and the water level logger data will be barometric pressure corrected using the barometric pressure logger data prior to any analysis.

Loggers will be downloaded at least every three months. At the time of each download, a manual water level measurement will be recorded at each bore using a conventional groundwater level monitoring e-tape (refer **Section 5.1.4.1** above) to confirm logger data accuracy. Any discrepancies observed in the automated monitoring data when compared to the manual measurements will be immediately investigated and where necessary the loggers reset or replaced to provide further data reliability.

Following logger download, monitoring personnel will confirm that each logger is operating correctly, and the logger is re-set into each bore at the correct depth. Downloaded logger files will be provided with the other field documentation compiled at the conclusion of each monitoring event (see **Section 5.1.7**).

5.1.5. Groundwater Quality Sampling

5.1.5.1. Bore Purging Procedures

In accordance with the above listed Guidelines, appropriate groundwater sampling procedures require that stagnant water that has been standing in the bore casing be purged prior to collection of a groundwater sample, so that sample is representative of the groundwater within the aquifer screened by the bore. This is due to the fact that the stagnant water in the bore column can become physically and chemically altered from that held within the aquifer. The following purge methods will be adopted during the program depending on the characteristics of each bore being sampled (e.g. bore depth, water column height, and rate of inflow to the bore):

- Three bore volumes/parameter stabilisation via a conventional submersible purge pump; or
- Low-flow sampling using specialised low-flow sampling equipment.

In conventional bore purging prior to sampling, industry standards dictate that a minimum of three bore volumes of groundwater should be purged from the bore prior to sampling. However, NAC will monitor field water quality parameters of EC, pH, temperature, dissolved oxygen and redox during purging, and sampling will only be undertaken once parameters have also stabilised in addition to three bore volumes being purged.

5.1.5.2. Field Measurements

Recording of field water quality parameters (i.e. EC, pH, temperature, dissolved oxygen and redox) will be undertaken using appropriate field water quality equipment using a flow through cell, after bore purging is confirmed to be satisfactorily complete with parameter stabilisation confirmed. The equipment will be calibrated prior to use as outlined in **Section 5.1.2**.

5.1.5.3. General Sample Collection Procedures

Following confirmation of field parameter (EC, pH, temperature, dissolved oxygen and redox) stabilisation identifying representative aquifer water is being produced from the bore, groundwater samples will be collected from each bore in the monitoring program. Groundwater samples will be collected as follows.

- Only collected once parameter stabilisation has been confirmed.
- Collected in accordance with the relevant guidelines.
- Placed into laboratory supplied bottles containing the appropriate preservative solutions for the analyte suite to be tested.
- Clearly labelled with the Bore ID, sampling date/time and field personnel initials.
- Field filtered to 0.45 µm where relevant for particular bottles/analytes (e.g. dissolved metals).
- Placed onto ice in a cooler box with ice immediately after sampling for transfer to the analytical laboratory.

Following sampling, all equipment will be cleaned and decontaminated in preparation for moving to the next bore.

5.1.5.4. Sample Duplicates

Duplicate samples are used to check and provide consistency in laboratory analytical processes. Duplicate samples involve the collection of a second set of samples from a bore in an identical manner to the primary samples. The duplicate samples will be tested for the same analytical suite as the primary samples (see **Table 6**). Additionally, duplicate samples will be collected as "blind duplicates", where an alternate naming convention is adopted for the duplicates so that the analytical laboratory cannot match a duplicate sample to its relevant primary sample. The blind duplicate sample will be clearly matched to its relevant primary sample in the field documentation (see **Section 5.1.6**).

One duplicate sample will be collected for every 10 primary samples per monthly monitoring event.

5.1.5.5. Sample Blanks

Blank samples are used to identify if any possible sample contamination has occurred during the sample collection and storage/shipping process. Blank samples will be tested for the same analytical suite as the primary samples (see **Table 6**). Two types of sample blanks will be adopted in the program:

- Container blank.

Also known as a 'field blank'. Laboratory supplied ultra-pure water is placed into sample containers whilst in the field and stored/transported to the analytical laboratory in the same manner as the primary samples. The container blank testing is used to identify if any contamination of samples may have occurred as a result of the sample collection process or use of non-sterile sample containers.

One container blank will be collected per monitoring event.

- Equipment / rinsate blank.

Following field equipment cleaning/decontamination in the field, laboratory supplied ultra-pure water is poured over and through the field equipment and then placed into sample containers and stored/transported to the analytical laboratory in the same manner as the primary samples. The equipment blank testing is used to identify if any contamination of samples may have occurred as a result of insufficient equipment cleaning/decontamination processes.

One equipment blank will be collected per purging pump per event.

5.1.5.6. Storage and Chain of Custody

Groundwater sample bottles will be placed onto ice in a cooler box immediately after sampling for transfer to the analytical laboratory. Sample transfer will occur under industry standard Chain of Custody (CoC) protocols/documentation and within the relevant holding times for each parameter. Copies of each CoC form will be taken in the field prior to shipping the samples and the CoC forms will be included with the monitoring report (see **Section 5.1.7**) for record keeping purposes.

5.1.6. Field Documentation

NAC recognises that robust field documentation is a key component of field program execution. NAC will compile all field documentation at the conclusion of each monitoring event in conjunction with the monitoring report (see **Section 5.1.7**). A Field Sheet (field documentation) will be developed by the field team for use during the monitoring program at each bore being monitored. The Field Sheet will be used to record the following information.

- Identification of which bore is represented by the field sheet.
- Date and time of the resting standing water level measurement pre-purging/sampling.
- Date and time when purging commenced.
- Details of the purging method including pump/intake depth.
- Records of field water quality parameters during purging at routine time intervals.
- Colour and odour of purged water during purging at routine time intervals.
- Purge time, volume and standing water level during purging at routine time intervals.
- Observations of any degassing of water during purging.
- Sample collection date, time and ID, including the ID of any QA/QC (e.g. duplicate) samples taken.
- A daily Calibration Record for the field water quality meter.
- A Daily Report emailed to the NAC Environment Department project manager.
- A completed Chain of Custody (CoC) record for samples.
- A digital photographic record for each bore, containing:
    + The condition of the bore headworks and general surrounding area, and
    + The water sample at the time of sampling.

Each photograph will contain clear identification of the bore ID that is the subject of the photograph.

5.1.7. Reporting

Following each monitoring event, a factual Monitoring Report will be prepared for record keeping purposes. The Monitoring Report will contain the following information.

- Summary details regarding the dates of the field program covered by the report.
- Identification of staff who undertook the program and their relevant qualifications.
- Details of any monitoring restrictions encountered during the program.
- A summary table of measured standing water levels.
- A summary table of final field groundwater quality measurements.
- A summary of the water quality sampling.
- Details of sample QA/QC.
- Details regarding logger downloads.
- Appendices containing:
    - Laboratory analytical results sheets;
    - Field Sheets for each bore;
    - The daily Calibration Record for the field water quality meter;
    - Copies of the Chain of Custody (CoC) form(s); and
    - The photographic record for each bore.

5.2. Laboratory Procedures

5.2.1. Accreditation

Groundwater sample analysis will be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA).

5.2.2. Sample analysis replication and Sample quality assurance

The sample analysis will include duplicates and blanks collected in the field consistent with industry standard QA/QC procedures compliant with the relevant guidelines, as described in **Sections 5.1.5.4** and **5.1.5.5**.

Additionally, the NATA accredited laboratories will employ as standard practice an internal QA/QC program (intra-lab QC) that will include laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogates, at frequencies at or above those recommended in the NEPM (2013) guidelines.

The intra-lab QC testing regime is designed by each NATA accredited laboratory and may vary slightly between laboratories, however samples are typically analysed at the following frequencies.

- Method Blanks – one (1) analysed within each process lot of twenty (20) samples;
- 10% Laboratory Duplicates – two (2) analysed within each process lot of twenty (20) samples;
- Laboratory Control Samples – one (1) analysed within each process lot of twenty (20) samples; and

- 5% Matrix Spikes – one (1) analysed within each process lot of twenty (20) samples.

5.3. Data Management and Data Quality Assurance Procedures

5.3.1. Data Management and Storage

The data gathered from the GMMP's groundwater monitoring program will be collated into a dedicated electronic database managed by the NAC Environment Department. Data will be entered into the database no later than 24 hours after it is received by the NAC Environment Department. The database will be routinely backed up in accordance with NAC's electronic information backup procedures.

5.3.2. Data Quality Assurance

A multi-tier process for GMMP data quality assurance after data collection will be implemented as follows.

1. Within the dedicated electronic database managed by the NAC Environment Department, flags will be implemented to automatically identify data that breaches any of the groundwater level or groundwater quality triggers established in this GMMP (see **Section 7.1**) and thus automatically notify the NAC Environment Department personnel to enact the Groundwater Impact Investigation Procedure (see **Section 7.2**), the first step of which is to confirm the data validity.
2. The GMMP Annual Review (see **Section 8.2**) and Three Yearly Reviews (see **Section 8.3**) will include a thorough review of the groundwater monitoring database that will include identification of any spurious data through comparison with baseline data and statistical trend and outlier analysis in accordance with the procedures identified in DSITI (2017).
3. Any formal investigation into the potential for environmental harm enacted as a result of a trigger breach (see **Section 7.1**) followed by implementation of the Groundwater Impact Investigation Procedure (see **Section 7.2**), will include identification of any spurious data through comparison with baseline data and statistical trend and outlier analysis in accordance with the procedures identified in DSITI (2017).

Should any of the above result in identification of spurious data, the NAC Environment Department will implement an investigation into the source of the data error, including review of the data collection procedures (**Section 5.1**), and where relevant the laboratory procedures (**Section 5.2**), to identify the source of the error, where possible. Where the error source is conclusively identified, the procedures identified in this GMMP will be updated where necessary, to mitigate the error occurring again.

6. Baseline Groundwater Conditions

Routine groundwater monitoring at the Mine has been undertaken since 2002 for the Main Range Volcanics, Acland Coal Sequence and Balgowan Coal Sequence of the Walloon Coal Measures. Routine groundwater monitoring across and surrounding the Project Area has also been undertaken since 2013. The Project groundwater monitoring network was also significantly expanded during 2015 and 2016 to cover all aquifer units within and adjacent the Project Area, and routine groundwater monitoring has been undertaken continuously since installation of these new monitoring bores.

The baseline (pre-Stage 3) groundwater monitoring program for the Project has included the following actions:

- Monthly to bi-monthly manual measurement of standing water levels.
- Automated twice-daily measurement of standing water levels using electronic loggers.
- Six-monthly groundwater quality sampling.

The data collected to date allows the establishment of baseline groundwater conditions across the Project site. Although, it is considered that there remains insufficient data for the yet to be installed bores, and some of the recently established bores within and surrounding the Project Area, to establish groundwater level reference values and quality triggers using the DSITI (2017) guidelines at the present time.

Baseline groundwater conditions (levels and quality) on third party properties surrounding the Project have been established by NAC using a bore census since 2015 in accordance with the Project's Baseline Assessment Program (BAP; SLR, 2015), which was developed consistent with the then DEHP's Baseline Assessment Guideline. NAC remains committed to completing all required assessments at least three years prior to any predicted groundwater impact on any particular landholder property.

6.1. Groundwater Levels – NAC Monitoring Bores

6.1.1. General

A groundwater monitoring program at the Mine is currently undertaken in accordance with EA EPML00335713 for the current mining operation, and the Mine's current groundwater monitoring program is regulated by the DES. This monitoring has provided sufficient data to characterise temporal groundwater levels at the Mine since 2002, including characterisation of impacts from existing mining activities, and these are detailed in the regular groundwater monitoring reports prepared by independent consultants, SLR Consulting Australia Pty Ltd (SLR).

NAC has also commenced routine water level monitoring at other Project bores identified in **Table 6** that have already been installed as part of the Project. Baseline (pre-Stage 3) groundwater level data collected to date for each of the Project monitoring bores identified in **Table 6** is presented as **Appendix C**.

6.1.2. Discussion of Baseline Groundwater Levels

The results of the Project's baseline groundwater level monitoring in the first few years since bore installation and before implementation of the Project were detailed in the conceptual hydrogeological model report for the Project (SLR, 2018a, **Appendix A**). An update to this discussion is also provided as **Appendix D** of this GMMP.

6.1.3. Baseline Groundwater Level Reference Values

Reference groundwater level values have been established for the GMMP for each monitoring bore with sufficient baseline data, for the purposes of calculating groundwater drawdown during the Project as discussed in **Section 7.1.1**. Drawdown during the life of the Project will be calculated on a bore by bore basis, by subtracting the measured water level (in mAHD) for a bore at any point in time during the Project with the reference value for that bore. This simple calculation will occur automatically within the Project's groundwater monitoring database (see **Section 5.3.1**)

Reference values have been established based on statistical trend analysis of the complete baseline water level dataset collected at each bore prior to modelled impacts from Stage 3 mining, using the non-seasonal Mann-Kendall test. The statistical analysis has included a thorough QA/QC of the baseline dataset to filter data outliers (errors) using Tukey's method (1977). A manual outlier analysis was also conducted to confirm or correct the statistical outlier analysis. The results of the statistical trend and outlier analysis are provided in **Appendix E** and show that most bores are subject to existing water level trends, either positive (upward) or negative (downward). This supports the analysis and discussion of baseline groundwater levels provided in **Appendix D**. Previous analysis as reported in SLR (2018a) (**Appendix A**) indicates these existing trends are related to a combination of extensive regional third party groundwater extraction, climatic influences, and for monitoring bores close to the existing Mine, the effects of current and historic mining activities.

Since baseline groundwater level data for each Project monitoring bore is subject to existing trends, groundwater level reference values have been established as the average measured water level over the 12-month period between May 2019 and April 2020. This method takes into account both the pre-Project antecedent level trends as well as observed climatic-driven seasonal groundwater level variability.

A summary of the statistical trend analysis results as well as the reference groundwater level values for each bore are provided in **Table 11**.

Table 11 Groundwater Level Reference Values

Monitoring Bore	Aquifer	Bore Status at August 2020	Water Level Statistical Trend	Reference Value (mAHD)
GW09A	Oakey Creek Alluvium	Active	No Trend	391.4
GW14A	Lagoon Creek Alluvium / Weathered Walloon Coal Measures	Active	Downward	394.6
A1	Cain Creek Alluvium	Not Yet Installed	TBC	TBC
A2	Oakey Creek Alluvium	Not Yet Installed	TBC	TBC
10PR	Main Range Volcanics	Not Yet Installed	TBC	TBC
84PR	Main Range Volcanics	Not Yet Installed	TBC	TBC
18PbR	Main Range Volcanics	Active (recently installed)	Insufficient data	443.0
BMH1	Main Range Volcanics	Active	Downward	440.0
109P	Main Range Volcanics	Active	Downward	457.8

Monitoring Bore	Aquifer	Bore Status at August 2020	Water Level Statistical Trend	Reference Value (mAHD)
GW05A	Main Range Volcanics	Active	No Trend	454.8
GW15A	Main Range Volcanics	Active	Downward	419.6
GW16A	Main Range Volcanics	Active	Downward	450.2
GW11R	Main Range Volcanics	Active	Upward	446.1
B1	Main Range Volcanics	Not Yet Installed	TBC	TBC
B2	Main Range Volcanics	Not Yet Installed	TBC	TBC
B3	Main Range Volcanics	Not Yet Installed	TBC	TBC
B4	Main Range Volcanics	Not Yet Installed	TBC	TBC
B5	Main Range Volcanics	Not Yet Installed	TBC	TBC
GW13B	Waipanna Coal Sequence	Active	Downward	400.9
GW22A	Waipanna Coal Sequence	Active	Upward	392.7
WCS1	Waipanna Coal Sequence	Not Yet Installed	TBC	TBC
WCS2	Waipanna Coal Sequence	Not Yet Installed	TBC	TBC
81P	Acland Coal Sequence	Active	Downward	412.3
82P	Acland Coal Sequence	Active	Downward	420.8
CSMH1Ra	Acland Coal Sequence	Not Yet Installed	TBC	TBC
4517WB	Acland Coal Sequence	Active	No Trend	404.5
4518WB	Acland Coal Sequence	Active	Downward	409.0
111PGC_Lower	Acland Coal Sequence (lower)	Not Yet Active	Downward	TBC
111PGC_Upper	Acland Coal Sequence (upper)	Not Yet Active	Downward	TBC
112P	Acland Coal Sequence	Active	No Trend	399.2
113PB	Acland Coal Sequence	Active	Upward	408.8
114P	Acland Coal Sequence	Active	Upward	381.7
116P	Acland Coal Sequence	Active	Upward	389.6
118P	Acland Coal Sequence	Active	Downward	393.0
119P	Acland Coal Sequence	Active	Downward	392.0
GW05B	Acland Coal Sequence	Active	Upward	410.3
GW06B	Acland Coal Sequence	Active	Upward	401.7
GW07B	Acland Coal Sequence	Active	Upward	401.9

Monitoring Bore	Aquifer	Bore Status at August 2020	Water Level Statistical Trend	Reference Value (mAHD)
GW08B	Acland Coal Sequence	Active	Upward	400.3
GW09B	Acland Coal Sequence	Active	No Trend	392.2
GW10	Acland Coal Sequence	Active	Upward	402.8
GW12B	Acland Coal Sequence	Active	No Trend	400.8
GW17A	Acland Coal Sequence	Active	Downward	374.4
GW19A	Acland Coal Sequence	Active	Downward	397.1
GW22B	Acland Coal Sequence	Active	Upward	392.5
ACS1	Acland Coal Sequence	Not Yet Installed	TBC	TBC
ACS2	Acland Coal Sequence	Not Yet Installed	TBC	TBC
ACS3	Acland Coal Sequence	Not Yet Installed	TBC	TBC
18PcR	Balgowan Coal Sequence	Active (recently installed)	Insufficient data	408.5
2289_Lower	Balgowan Coal Sequence	Active	Upward	432.5
2291P	Balgowan Coal Sequence	Active	Upward	421.9
25P(R)	Balgowan Coal Sequence	Active	Upward	426.3
26P(R)	Balgowan Coal Sequence	Active	Upward	434.5
27PR	Balgowan Coal Sequence	Not Yet Installed	TBC	TBC
28PR	Balgowan Coal Sequence	Not Yet Installed	TBC	TBC
GW19B	Balgowan Coal Sequence	Active	Upward	393.5
GW22C	Balgowan Coal Sequence	Active	No Tend	391.7
BCS1	Balgowan Coal Sequence	Not Yet Installed	TBC	TBC
BCS2	Balgowan Coal Sequence	Not Yet Installed	TBC	TBC
CSMH1Rb	Balgowan Coal Sequence	Not Yet Installed	TBC	TBC
GW08C	Marburg Sandstone	Active	Downward	334.5
GW09C	Marburg Sandstone	Active	Downward	392.5
GW11B	Marburg Sandstone	Active	Upward	408.1
M1	Marburg Sandstone	Not Yet Installed	TBC	TBC
M2	Marburg Sandstone	Not Yet Installed	TBC	TBC
M3	Marburg Sandstone	Not Yet Installed	TBC	TBC
130WB	Marburg Sandstone	Not Yet Active	TBC	TBC

Monitoring Bore	Aquifer	Bore Status at August 2020	Water Level Statistical Trend	Reference Value (mAHD)
21P	Marburg Sandstone	Active	Downward	412.8
41P	Marburg Sandstone	Active	No Trend	415.9
48P	Marburg Sandstone	Active	Downward	414.5
3307_WB	Rehabilitated Spoil	Active	Upward	451.4

A reference water level value will be established for each monitoring bore where reference values are not already provided (i.e. listed as 'TBC') in **Table 11** prior to any modelled impacts from Stage 3 operations occurring at the bore. Reference values will be established on the basis of statistical analysis of the baseline water level dataset collected over a minimum period of 12 months prior to any modelled impacts from Stage 3 operations occurring at the bore.

6.2. Groundwater Quality – NAC Monitoring Bores

6.2.1. General

A groundwater monitoring program at the Mine is currently undertaken in accordance with EA EPML00335713 for the current mining operation, and the Mine's current groundwater monitoring program is regulated by the DES. This monitoring has provided sufficient data to define bore-specific baseline concentrations for the monitored parameters at the Mine's EA bores for the purposes of the current EA, and these are detailed in the regular EA compliance groundwater monitoring reports prepared by independent consultants.

NAC has also commenced routine water quality monitoring at bores identified in **Table 6** that have been installed as part of the Project but are not part of the existing Mine EA monitoring program. Baseline (pre-Stage 3) groundwater quality data collected to date for each of the Project monitoring bores identified in **Table 6** is presented as **Appendix G** (Discussion of Baseline Groundwater Quality).

The results of the Project's baseline groundwater quality monitoring in the first few years since bore installation and before implementation of the Project were detailed in the conceptual hydrogeological model report for the Project (SLR, 2018a, **Appendix A**). An update and expansion of this discussion is provided as **Appendix G** of this GMMP.

6.3. Landholder Bores

As outlined above, baseline groundwater conditions (levels and quality) on third party properties surrounding the Project have been established by NAC using a bore census that commenced during 2015 in accordance with the Project's BAP (SLR, 2015). The census was developed consistent with the then DEHP's Baseline Assessment Guideline. The results of the BAP implementation between 2015 and 2017 were outlined in the 2017-2018 conceptual groundwater model update (SLR, 2018a) and also incorporated in the 2018 Project numerical groundwater model update (SLR, 2018b). **Appendix H** presents a locality plan and tabulated data collected in the BAP program.

7. Groundwater Impact Triggers and Investigation Protocols

7.1. Groundwater Impact Criteria and Triggers

Groundwater monitoring will be undertaken for the Project in accordance with the groundwater monitoring program. Impact assessment criteria for groundwater levels and quality, where not already established in this GMMP, will be developed using statistical analysis of the baseline data and the predicted impacts presented in the latest version of the Project's groundwater model (SLR, 2018b).

Triggers will be used to determine if the groundwater impact investigation procedure should be initiated.

These triggers include:

- exceeding triggers in relevant conditions of the EA, AWL or EPBC approvals;
- substantial variance from the predicted groundwater drawdown effects presented in the latest version of the Project's groundwater model report (SLR, 2018b) or subsequent impact assessment updates; or
- when a legitimate complaint is received from a local landholder who is a groundwater user.

EPBC Approval 2007/3423 requires that this GMMP is approved by the Federal Minister for the Environment or the Federal Minister for the Environment's delegate, including the groundwater baseline, impact criteria and triggers identified herein. NAC will ensure the ministerial approval is achieved prior to the commencement of any Project mining activities in accordance with EPBC Approval 2007/3423.

7.1.1. Groundwater Level Reference Values

Prior to the occurrence of modelled impacts from the Project's mining activities at each monitoring bore, a reference water level value will be established for each monitoring bore where reference values are not already provided in **Section 6.1.3**. Reference values will be established on the basis of statistical analysis of the baseline water level dataset collected at each bore over a period of 12 months prior to modelled impacts occurring at the bore. The statistical analysis will include a thorough QA/QC of the baseline dataset to filter outliers.

Measured drawdown during the life of the Project will be calculated on a bore by bore basis, by comparing the measured water level for a bore at any point in time during the Project with the reference value for that bore.

7.1.2. Groundwater Level Drawdown Triggers

7.1.2.1. Monitoring Bores

The predictive results of the 2018 Project groundwater model (SLR, 2018b) have been utilised to develop bore specific water level drawdown triggers for each Project monitoring bore identified in the groundwater monitoring program (refer **Table 6**). The drawdown triggers have been based on the following criteria.

- Drawdown triggers have been calculated using the latest version of the Project groundwater model (SLR, 2018b), and using the cumulative impact predictions (as opposed to incremental Project-only predictions) so they are directly comparable to real-world measurements.

- Drawdown triggers are based on the difference between the predicted water level at the commencement of Stage 3 mining activities (time zero), and the minimum (lowest) predicted water level at any time during the life of the Project.
- Compliance and Control monitoring bores have been assigned a drawdown limit trigger value equal to the maximum 95th percentile model drawdown prediction at each bore over the life of the Project.
- Early-warning monitoring bores, as with Compliance and Control bores, have been assigned a drawdown limit trigger value equal to the maximum 95th percentile model drawdown prediction at each bore over the life of the Project.
- Additionally, Early-warning bores have been assigned an early warning drawdown threshold trigger value equal to the maximum 50th percentile model drawdown prediction at each bore for each year of the Project, allowing a time-based trigger assessment for these bores as mining progresses.
- Fault monitoring bores, which are a subset of the Project's Compliance, Early-warning Compliance and Control bores, have also been assigned drawdown threshold trigger value equal to the maximum 50th percentile model drawdown prediction at each bore for each year of the Project, allowing a time-based trigger assessment for these bores as mining progresses.
- Operational monitoring bores have not been assigned drawdown triggers since they are located within the general mining footprint, and therefore, are anticipated to be subject to relatively significant drawdown due to operation of the Project.

The groundwater level drawdown triggers have been developed with due consideration of the following complicating factors.

- <u>Groundwater System Recovery from Stage 1 and 2 Operations:</u>

  For the Balgowan Coal Sequence and Marburg Sandstone aquifers, although groundwater drawdown arising from the Project is predicted (i.e. incremental Project-only drawdown), this is actually offset in the cumulative impacts model scenario (i.e. the model predictions that include the existing Mine operations) by recovery of groundwater levels related to the cessation of historic Mine-related groundwater pumping in 2010, as well as recovery of groundwater levels following the completion and rehabilitation of Stage 1 and 2 mining. Therefore, although groundwater drawdown arising from the Project is predicted for the Balgowan Coal Sequence and Marburg Sandstone, in a cumulative impact scenario (i.e. real-world) sense there is no predicted drawdown for those aquifers since groundwater levels are recovering overall (i.e. rising) and the drawdown from the Project is masked and therefore unmeasurable. Drawdown triggers established in this GMMP therefore need to take these Stage 1 and Stage 2 related recovery trends into account and this is done by adopting the cumulative model predictions for trigger development.

- <u>Non-Mining Antecedent Trends</u>:

  As described in the Project's conceptual hydrogeological model report (SLR, 2018b; **Appendix A**), the groundwater system in the vicinity of the Project is subject to existing groundwater drawdown trends associated primarily with large volumes of third-party groundwater extraction. Therefore, ongoing drawdown will be measured in Project monitoring bores that is not related to the Project (i.e. greater than that predicted in either the incremental Project-only or cumulative model scenarios) and drawdown triggers established in this GMMP need to take these antecedent drawdown trends into account. This is done by the existing simulation of these trends in the Project's groundwater model.

Should the drawdown trigger at any bore be exceeded at any time over the life of the Project, it would result in implementation of the Project groundwater impact investigation procedure detailed in **Section 7.2** below.

The bore specific drawdown triggers for each Project monitoring bore identified in the groundwater monitoring program (refer **Table 6**) are presented in **Appendix I**.

It should be noted that the bore specific drawdown triggers presented in **Appendix I** incorporate the model's simulation of antecedent non-mining related trends such as regional third party groundwater extraction and climatic influences, so that the triggers can be accurately compared to real-world monitoring measurements during the lifespan of the Project. Thus some Control bores in the GMMP are assigned drawdown triggers that are greater than 1 m, where the influence from the Project is predicted to be less than 1 m (95^{th} percentile) but the combined influence of mining and non-mining trends is predicted to be greater than 1 m (95^{th} percentile).

7.1.2.2. Formation Wide Drawdown Limits for the Oakey Creek Alluvium and Main Range Volcanics Aquifers

In accordance with EPBC Act approval condition 13 (vi), formation wide groundwater drawdown limits for impacts to the Oakey Creek Alluvium and Main Range Volcanics ("Tertiary basalt") aquifers have been established in this GMMP. These limits are based on the maximum 95th percentile cumulative model drawdown prediction at any time during the life of the Project for each of these aquifers, at the location of the closest private property to the Project that overlies that aquifer. The drawdown limits are presented in **Table 12** and represent maximum drawdown beyond the influence of any antecedent trends included in the model, or external factors such as landholder pumping.

Table 12 Formation Wide Drawdown Limits

Aquifer	Drawdown Limit (m)
Oakey Creek Alluvium	0.5
Main Range Volcanics	8.7

7.1.3. Establishment of Water Quality Baseline Criteria

Prior to the occurrence of modelled impacts from the Project's mining activities at a particular monitoring bore, groundwater quality baseline criteria will be established for each bore where criteria are not already provided in **Section 6.2, Appendix F** and **Appendix G**. Baseline criteria will be established based on statistical analysis of the complete baseline water quality dataset collected over a minimum of 12 months at each bore prior to the occurrence of modelled impacts from Stage 3 mining occurring. Baseline criteria will be established in accordance with the methods outlined in DSITI (2017) as has already occurred for many Project bores as reported in **Appendix G**. The statistical analysis will include a thorough QA/QC of the baseline dataset to filter outliers.

For bores where baseline criteria cannot be established due to insufficient data ("TBA" in **Table 13**), it will be through the implementation of this GMMP that a dataset is collated that will allow a statistically appropriate baseline/background water quality assessment using the DSITI (2017) groundwater quality assessment guideline. NAC is committed to establishing baseline groundwater quality conditions for these newer bores in accordance with the DSITI (2017) guideline once a sufficient dataset has been obtained in accordance with this GMMP (discussed further in **Section 7.1.4**).

7.1.4. Groundwater Quality Trigger Values

Groundwater quality trigger values have been developed for each Project monitoring bore with sufficient data for each of the GMMP groundwater quality parameters (**Section 4.5.2.2**) as documented in **Appendix G**. As described therein, the methodology outlined in the DSITI (2017) groundwater quality assessment guideline was utilised in order to develop the triggers.

As documented in **Appendix G**, a two-tier trigger system has been developed consistent with DSITI (2017) and the DES (2017) Guideline – Model Mining Conditions. The two-tier trigger system is as follows.

1. **Parameter Triggers (PT)**

   The Parameter Trigger is based on the 80th percentile of the baseline data set for that parameter at a specific bore.

   A breach of the bore specific trigger is confirmed, and the investigation procedure activated if the Parameter Trigger is exceeded on any five (5) consecutive sampling occasions.

2. **Parameter Limits (PL)**

   Where the entire baseline dataset remains below the relevant ANZECC (2000) Environmental Values protection criteria for a water quality parameter at a specific bore, then the relevant ANZECC (2000) Environmental Values protection criteria has been adopted as a single Parameter Limit trigger value.

   Where the entire baseline dataset is above the relevant ANZECC (2000) Environmental Values protection criteria for a water quality parameter at a particular bore, the Parameter Limit is based on the 95th percentile of the baseline data set for that parameter at a particular bore.

   A breach of the bore specific trigger is confirmed, and the investigation procedure activated if the Parameter Limit is exceeded on any three (3) consecutive sampling occasions.

The groundwater quality trigger values are presented in **Table 13**.

For bores where water quality triggers are not yet established due to insufficient data ("TBA" in **Table 13**), it will be through the implementation of this GMMP that a dataset is collated that will allow a statistically appropriate baseline/background water quality assessment using the DSITI (2017) groundwater quality assessment guideline. NAC is committed to establishing baseline groundwater quality conditions for these newer bores in accordance with the DSITI (2017) guideline once a sufficient dataset has been obtained in accordance with this GMMP. As outlined in **Section 4.5.2**, for bores where water quality triggers are not yet established, monitoring will occur at an increased frequency (3-monthly) until a statistically sufficient dataset is collected from which to define baseline criteria and triggers, after which water quality monitoring will revert to the standard 6-monthly frequency once baseline criteria and triggers are established. Through the commitment to undertake an increased frequency of monitoring for these bores, NAC will ensure that a sufficient dataset has been obtained to establish baseline groundwater quality conditions and triggers in accordance with the DSITI (2017) guideline, prior to the occurrence of modelled groundwater drawdown impacts from Stage 3 mining activities.

Table 13 Groundwater Trigger Values

Bore ID	Aquifer	pH (lab) pH units		Electrical Conductivity (EC) µS/cm		Total Dissolved Solids (TDS) mg/L		Calcium mg/L		Sodium mg/L		Magnesium mg/L		Potassium mg/L		Chloride mg/L		Sulfate mg/L		Fluoride mg/L		Aluminium (dissolved) mg/L		Arsenic (dissolved) mg/L		Copper (dissolved) mg/L		Iron (dissolved) mg/L		Manganese (dissolved) mg/L		Selenium (dissolved) mg/L		Bicarbonate mg/L		Total Nitrogen mg/L	
		PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL
GW09A	Oakey Creek Alluvium	7.33-8.05	6.00-8.50	2814	2855	1688	4000	92.4	1000	349.6	460	96.4	98	2	5	732	750	23	1000	0.34	2	0.01	5	0.001	0.5	0.001	1	0.05	10	0.0046	10	0.01	0.02	513	521	2.2	30
GW14A	Lagoon Creek Alluvium / Weathered Walloon Coal Measures	To be determined once sufficient data available																																					
A1	Cain Creek Alluvium	To be determined once sufficient data available																																					
A2	Oakey Creek Alluvium	To be determined once sufficient data available																																					
10PbR	Main Range Volcanics	To be determined once sufficient data available																																					
84(R)	Main Range Volcanics	To be determined once sufficient data available																																					
18PbR	Main Range Volcanics	To be determined once sufficient data available																																					
BMH1	Main Range Volcanics	7.24-8.01	6.00-8.50	1408	1448	868	4000	90.4	1000	96.8	460	86	91.1	1.4	2.04	97	700	17	1000	0.3	2	0.02	5	0.001	0.5	0.002	1	0.05	10	0.0094	10	0.01	0.02	742	797	15.44	30
109P	Main Range Volcanics	8.01-8.53	6.00-8.63	549	597	347	4000	12	1000	116.8	460	1	2	2	2	22	700	10.8	1000	0.46	2	0.04	5	0.001	0.5	0.0054	1	0.05	10	0.0026	10	0.01	0.02	291	301	1.26	30
GW05A	Main Range Volcanics	7.09-7.93	6.00-8.50	1324	1363	797	4000	86.8	1000	135	460	62.8	65.35	1	1.04	67	700	16	1000	0.9	2	0.01	5	0.001	0.5	0.0011	1	0.05	10	0.001	10	0.01	0.02	717	728	18.92	30
GW15A	Main Range Volcanics	7.52-7.98	6.00-8.50	1908	1948	1154	4000	113	1000	190	460	74	79.75	14	14.35	416	700	33.8	1000	0.3	2	0.01	5	0.001	0.5	0.001	1	1.316	10	0.1648	10	0.01	0.02	531	542	0.2	30
GW16A	Main Range Volcanics	6.99-7.76	6.00-8.50	2070	2109	1356	4000	131.8	1000	168	460	92.4	93.35	10	10	435	700	19.4	1000	0.4	2	0.011	5	0.001	0.5	0.0011	1	0.092	10	0.0214	10	0.01	0.02	646	691	0.3	30
GW11R	Main Range Volcanics	8.00-8.30	6.00-8.50	1054	1395	606	4000	28	1000	184.6	460	4	6.4	2	2.87	229	700	52.8	1000	0.34	2	0.02	5	0.001	0.5	0.001	1	0.05	10	0.0404	10	0.01	0.02	187	283	0.14	30
B1	Main Range Volcanics	To be determined once sufficient data available																																					
B2	Main Range Volcanics	To be determined once sufficient data available																																					
B3	Main Range Volcanics	To be determined once sufficient data available																																					
B4	Main Range Volcanics	To be determined once sufficient data available																																					
B5	Main Range Volcanics	To be determined once sufficient data available																																					
GW13B	Waipanna Coal Sequence	8.39-8.56	6.00-8.69	885	904	524	4000	6	1000	213	460	2	2	2	2	66	700	0.5	1000	1	2	0.01	5	0.001	0.5	0.001	1	0.05	10	0.0044	10	0.01	0.02	447	470	0.2	30
GW22A	Waipanna Coal Sequence	To be determined once sufficient data available																																					
WCS1	Waipanna Coal Sequence	To be determined once sufficient data available																																					
WCS2	Waipanna Coal Sequence	To be determined once sufficient data available																																					
81P	Acland Coal Sequence	7.34-8.00	6.00-8.50	6412	6630	3918	4060	247.8	1000	986.6	1000	100	100	15	16	1770	1800	268	1000	0.1	2	0.048	5	0.001	0.5	0.0029	1	1.36	10	0.136	10	0.026	0.046	379	397	1.44	30
82P	Acland Coal Sequence	6.94-7.86	6.00-8.50	6084	7985	3700	5098	176.4	1000	915.4	1030	157	200.5	8	9	1424	1897	559.4	1000	0.5	2	0.018	5	0.001	0.5	0.0029	1	2.47	10	0.0708	10	0.016	0.027	836	906	1.16	30
CSMH1Ra	Acland Coal Sequence	To be determined once sufficient data available																																					
4517WB	Acland Coal Sequence	To be determined once sufficient data available																																					

Bore ID	Aquifer	pH (lab) pH units		Electrical Conductivity (EC) µS/cm		Total Dissolved Solids (TDS) mg/L		Calcium mg/L		Sodium mg/L		Magnesium mg/L		Potassium mg/L		Chloride mg/L		Sulfate mg/L		Fluoride mg/L		Aluminium (dissolved) mg/L		Arsenic (dissolved) mg/L		Copper (dissolved) mg/L		Iron (dissolved) mg/L		Manganese (dissolved) mg/L		Selenium (dissolved) mg/L		Bicarbonate mg/L		Total Nitrogen mg/L	
		PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL
4518WB	Acland Coal Sequence	To be determined once sufficient data available																																			
111PGC_Lower	Acland Coal Sequence (lower)	7.49-7.89	6.00-8.50	6822	6943	4540	4630	346	1000	902	938.5	179	187	10	13	1890	1950	307	1000	0.1	2	0.01	5	0.001	0.5	0.002	1	4.236	10	0.0336	10	0.01	0.02	609	620	2	30
111PGC_Upper	Acland Coal Sequence (upper)	7.47-7.92	6.00-8.50	6902	6967	4442	4762	323	1000	905	960.5	196	210.5	12	12.5	1800	1905	346	1000	0.1	2	0.01	5	0.001	0.5	0.003	1	3.968	10	0.0236	10	0.01	0.02	625	640	1.9	30
112P	Acland Coal Sequence	7.63-8.07	6.00-8.50	3364	3406	1928	4000	122.2	1000	537.2	549.2	46.4	47	6.4	7	810	828	160	1000	0.1	2	0.01	5	0.001	0.5	0.0034	1	0.05	10	0.137	10	0.01	0.02	524	536	4.14	30
113PB	Acland Coal Sequence	7.61-8.20	6.00-8.50	6450	6484	4104	4288	210.2	1000	878.2	916.8	191.4	193.75	5.4	6.7	1744	1791	355.4	1000	0.5	2	0.01	5	0.001	0.5	0.0007	1	2.38	10	0.0648	10	0.01	0.02	525	541	0.52	30
114P	Acland Coal Sequence	7.72-8.18	6.00-8.50	6420	6600	3688	4000	145.8	1000	1146	1186	44	48	8	9.4	1748	1812	235.2	1000	0.1	2	0.01	5	0.001	0.5	0.0046	1	1.206	10	0.0476	10	0.01	0.02	384	393	1.96	30
116P	Acland Coal Sequence	7.80-8.20	6.00-8.50	2978	3022	1672	4000	82.8	1000	539	551.3	29.8	30.45	5	5.45	735	744	55.6	1000	0.1	2	0.01	5	0.001	0.5	0.002	1	0.61	10	0.0268	10	0.01	0.02	519	525	1	30
118P	Acland Coal Sequence	7.18-7.81	6.00-8.50	17140	20120	12920	13920	670.2	1000	2546	2794.5	376.4	499.2	14.4	19.7	5742	6771	702	1000	0.1	2	0.01	5	0.001	0.5	0.0014	1	5.392	10	0.2662	10	0.01	0.02	331	350	2.96	30
119P	Acland Coal Sequence	7.89-8.42	6.00-8.50	2464	2625	1318	4000	39.2	1000	461.8	501	14	25.6	4	4.4	631	700	47.6	1000	0.1	2	0.01	5	0.001	0.5	0.0016	1	0.08	10	0.012	10	0.01	0.02	355	418	0.68	30
GW05B	Acland Coal Sequence	8.10-8.35	6.00-8.52	1082	1155	639	4000	23	1000	230.8	460	4	4	3	3	97	700	35.4	1000	0.2	2	0.01	5	0.001	0.5	0.001	1	0.05	10	0.008	10	0.01	0.02	512	550	0.2	30
GW06B	Acland Coal Sequence	8.64-8.79	6.00-8.87	1060	1080	623	4000	1.1	1000	241.2	460	0.5	0.5	0.5	0.61	153	700	0.5	1000	0.5	2	0.01	5	0.001	0.5	0.001	1	0.05	10	0.003	10	0.01	0.02	361	402	0.3	30
GW07B	Acland Coal Sequence	8.06-8.25	6.00-8.50	807	816	480	4000	16	1000	160.6	460	2	2.16	2	2.46	111	700	6	1000	0.1	2	0.01	5	0.001	0.5	0.0014	1	0.05	10	0.0076	10	0.01	0.02	303	313	0.2	30
GW08B	Acland Coal Sequence	8.62-8.80	6.00-8.90	1280	1307	785	4000	2	1000	311.6	460	0.5	1.03	0.5	1.29	84	700	2.2	1000	0.7	2	0.016	5	0.001	0.5	0.001	1	0.05	10	0.0022	10	0.01	0.02	628	687	0.3	30
GW09B	Acland Coal Sequence	7.44-8.08	6.00-8.50	2368	2421	1314	4000	60.8	1000	366.4	460	57.8	64.9	4	4.7	567	700	24	1000	0.6	2	0.01	5	0.001	0.5	0.001	1	0.69	10	0.009	10	0.01	0.02	621	645	0.46	30
GW10	Acland Coal Sequence	7.59-8.06	6.00-8.50	2974	3022	1696	4000	70.8	1000	540	566.8	14	15	5	5.35	830	852	17	1000	0.1	2	0.01	5	0.001	0.5	0.001	1	0.35	10	0.0104	10	0.01	0.02	320	328	1	30
GW12B	Acland Coal Sequence	8.56-8.75	6.00-8.88	1282	1375	739	4000	3	1000	280.2	460	0.5	0.57	2	2	188	700	11.6	1000	0.5	2	0.01	5	0.001	0.5	0.001	1	0.05	10	0.003	10	0.01	0.02	434	455	0.3	30
GW17A	Acland Coal Sequence	8.47-8.61	6.00-8.79	959	1001	539	4000	3	1000	209.8	460	0.5	0.5	1	1.35	195	700	0.5	1000	0.1	2	0.016	5	0.002	0.5	0.001	1	0.05	10	0.0074	10	0.01	0.02	292	326	0.2	30
GW19A	Acland Coal Sequence	To be determined once sufficient data available																																			
GW22B	Acland Coal Sequence	To be determined once sufficient data available																																			
ACS1	Acland Coal Sequence	To be determined once sufficient data available																																			
ACS2	Acland Coal Sequence	To be determined once sufficient data available																																			
ACS3	Acland Coal Sequence	To be determined once sufficient data available																																			
18PcR	Balgowan Coal Sequence	To be determined once sufficient data available																																			
2289_Lower	Balgowan Coal Sequence	7.53-7.85	6.00-8.50	4762	4789	3238	4000	253.6	1000	615.4	634.9	76.8	77.45	14	24.05	1354	1397	261.6	1000	0.1	2	0.01	5	0.001	0.5	0.0017	1	1.01	10	0.062	10	0.01	0.02	141	143	0.7	30
2291P	Balgowan Coal Sequence	7.20-7.75	6.00-8.50	8120	8210	5160	5650	304	1000	1250	1400	150	151	17	17	2370	2600	356	1000	0.1	2	0.01	5	0.001	0.5	0.0039	1	3.2	10	0.076	10	0.01	0.02	551	578	1.9	30
25P(R)	Balgowan Coal Sequence	7.35-7.85	6.00-8.50	10400	10760	7998	9108	683.4	1000	1274	1298	206.6	215.6	23.4	24	3586	3820	406.8	1000	0.1	2	0.01	5	0.001	0.5	0.002	1	3.51	10	0.127	10	0.01	0.02	230	267	0.6	30
26P(R)	Balgowan Coal Sequence	7.35-7.95	6.00-8.50	12340	12610	9414	10254	699.4	1000	1740	1780	280.8	284.55	29.2	30.55	4104	4137	959	1060.3	0.1	2	0.01	5	0.001	0.5	0.001	1	3.96	10	0.024	10	0.01	0.02	249	265	0.62	30
27(R)	Balgowan Coal Sequence	To be determined once sufficient data available																																			

Bore ID	Aquifer	pH (lab) pH units		Electrical Conductivity (EC) µS/cm		Total Dissolved Solids (TDS) mg/L		Calcium mg/L		Sodium mg/L		Magnesium mg/L		Potassium mg/L		Chloride mg/L		Sulfate mg/L		Fluoride mg/L		Aluminium (dissolved) mg/L		Arsenic (dissolved) mg/L		Copper (dissolved) mg/L		Iron (dissolved) mg/L		Manganese (dissolved) mg/L		Selenium (dissolved) mg/L		Bicarbonate mg/L		Total Nitrogen mg/L	
		PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL	PT	PL
28(R)	Balgowan Coal Sequence	To be determined once sufficient data available																																					
CSMH1Rb	Balgowan Coal Sequence	To be determined once sufficient data available																																					
GW19B	Balgowan Coal Sequence	To be determined once sufficient data available																																					
GW22C	Balgowan Coal Sequence	To be determined once sufficient data available																																					
BCS1	Balgowan Coal Sequence	To be determined once sufficient data available																																					
BCS2	Balgowan Coal Sequence	To be determined once sufficient data available																																					
GW08C	Marburg Sandstone	8.32-8.67	6.00-8.76	2482	2578	1354	4000	7	1000	518	553	0.5	0.5	2	2.35	631	700	25.2	1000	0.44	2	0.02	5	0.006	0.5	0.001	1	0.06	10	0.02	10	0.01	0.02	547	599	0.4	30
GW09C	Marburg Sandstone	7.52-8.13	6.00-8.50	1950	2141	1090	4000	47.2	1000	341.4	460	5	5.4	8	8	524	700	41.4	1000	0.1	2	0.01	5	0.001	0.5	0.001	1	0.154	10	0.018	10	0.01	0.02	253	386	0.56	30
GW11B	Marburg Sandstone	6.88-7.41	6.00-8.50	3256	3578	1896	4000	119.4	1000	430.4	460	63	72	19	22	891	917	97.2	1000	0.2	2	0.01	5	0.0236	0.5	0.0016	1	0.682	10	0.1586	10	0.01	0.02	254	288	0.1	30
M1	Marburg Sandstone	To be determined once sufficient data available																																					
M2	Marburg Sandstone	To be determined once sufficient data available																																					
M3	Marburg Sandstone	To be determined once sufficient data available																																					
130WB	Marburg Sandstone	To be determined once sufficient data available																																					
21P	Marburg Sandstone	To be determined once sufficient data available																																					
41P	Marburg Sandstone	To be determined once sufficient data available																																					
48P	Marburg Sandstone	To be determined once sufficient data available																																					
3307_WB	Rehabilitated Spoil	6.80-7.55	6.00-8.50	8750	8949	6590	7299	552.2	1000	814.4	828.8	447.2	467	18	20.75	2290	2347	1392	1462	0.5	2	0.01	5	0.002	0.5	0.0022	1	1.626	10	3.834	10	0.01	0.02	721	742	1.52	30

Notes: PT - Parameter Trigger
PL - Parameter Limit

7.1.5. Landholder Complaints

In the event that a legitimate groundwater-related complaint is received from a local landholder, groundwater monitoring (levels and quality) data will be reviewed by an appropriately qualified person who will determine if the groundwater impact investigation protocol should be initiated. Each new complaint will be compiled into a register and updated as required based on the management actions completed. The complaints register will be maintained for audit purposes.

7.2. Groundwater Impact Investigation Procedure

The groundwater impact investigation procedure will be implemented in response to an exceedance of a relevant trigger (groundwater quality or groundwater level) for any bore type, or a legitimate complaint from a landholder (groundwater related). Groundwater monitoring data set will be reviewed by an appropriately qualified specialist who will determine if further investigation is necessary. The groundwater impact investigation procedure will follow the following framework.

Trigger Exceedance Identified or Landholder Complaint Received

↓

Confirm the Breach	
Resample/Re-Test/Re-measure at the affected bore	To occur within 7 days of identification of trigger exceedance or receipt of complaint

↓

Immediate Action	
Increase Monitoring Frequency and Notify Administering Authorities (DES, DNRME and/or DAWE)	To occur within 7 days from confirmation of breach

↓

Investigation Report	
Commence Investigation into the Potential for Environmental Harm including identification of any required Contingency and Mitigation Measures	Investigation report submitted to Administering Authorities (DES, DNRME and/or DAWE) within 3 months of confirmation of breach

↓

Additional Investigations and Monitoring	
Where deemed required by the Investigation Report	Commence within 1 month of submission of the Investigation Report to the Administering Authorities (DES, DNRME and/or DAWE)

↓

Mitigation	
Implementation of Contingency and Mitigation Measures where deemed required by the Investigation Report	Within 3 months of Administering Authority (DES, DNRME and/or DAWE) approval of the Investigation Report recommending the Measures

The groundwater impact investigation procedure will apply to an exceedance of a relevant trigger for any bore type (Compliance, Early-warning Compliance, Control or Fault Monitoring).

7.2.1. Groundwater Levels

In the event that:

- a groundwater level drawdown trigger or limit breach is identified in a data set for a Compliance or Early-warning Compliance bore, including Compliance bores that are identified as Fault Monitoring bores; or
- a legitimate landholder complaint is received in relation to groundwater level drawdown or reduction in bore yield at a landholder supply bore;

Then the following impact investigation procedure will be implemented.

1) A re-measure will be conducted at the relevant bore within 7 days of the identification of the trigger breach or receipt of the landholder complaint, to confirm the breach by verifying that the data is not anomalous. Anomalous data will be identified through statistical comparison with other data from the subject bore in accordance with the methods described in DSITI (2017).
2) If the trigger breach or landholder complaint is confirmed following a resample/re-test/re-measure, the following actions will be implemented:
   a) The monitoring frequency will be increased to weekly at the relevant bore. The first follow-up measurement will occur within 7 days from confirmation of the trigger breach.
   b) the administering authorities of this GMMP (i.e. DNRME and the Department of Agriculture, Water and the Environment (DAWE), or their equivalent entities at the time) will be notified within 7 days of the monitoring date on which the groundwater level breach was confirmed.
3) Once the validity of a trigger breach or a landholder complaint has been verified, an investigation into the potential for environmental harm will be completed by an independent and appropriately qualified specialist. The investigation will include as a minimum:
   a) comparison of the results for the bore subject to the breach with those from other Compliance and Control bores;
   b) comparison to model predictions;
   c) comparison to baseline groundwater monitoring results;
   d) a review of mining activities that may be responsible for the breach;
   e) the prevailing and preceding meteorological conditions;
   f) a review of third-party groundwater use;
   g) a review of the physical integrity of the bore (if required); and
   h) assessment of the potential role of faults in the breach.

   The resulting investigation report will be sent to the administering authorities of this GMMP (i.e. DNRME and DAWE, or their equivalent entities at the time) within 3 months of receiving the monitoring results in which the trigger breach was confirmed.

4) If the investigation into the potential for environmental harm deems that further additional investigation and/or monitoring is required to determine the cause of the 'activation' of the trigger, then the recommended additional investigation and/or monitoring will be actioned within 1 month of receipt of the investigation report that identifies the need for this to occur. Additional investigations recommended may include review of the Project groundwater model (i.e. a process of continual improvement) that may in turn result in adjustment of the relevant Compliance triggers.

5) If the investigations conclusively establish that groundwater level drawdown triggers have been 'activated' as a result of mining activities and there is potential for environmental harm, contingency measures to mitigate the impact may need to be implemented as recommended by those investigations. Contingency measures may involve:

    a) a change in mining operations;

    b) a suspension of any mine related groundwater pumping from the aquifer of concern; or

    c) the enacting of make good measures for all affected landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 7.3.2**).

    If these contingency measures were deemed to be required, they will be implemented within 3 months of receipt of approval of the investigation report recommending the measures from the administering authorities of this GMMP (DNRME and DAWE, or their equivalent entities at the time). Further discussion on impact mitigation is provided in **Section 7.3**.

6) The results of the investigation into any breaches of groundwater level drawdown triggers , including all associated investigations and resulting proposed management/mitigation actions, will be documented for reporting and audit purposes and submitted to the administering authorities of this GMMP for approval (DNRME and DAWE, or their equivalent entities at the time) within 3 months of receiving the monitoring results in which the trigger breach was confirmed.

7) Where a breach of a groundwater level drawdown trigger is already being investigated, subsequent results for that parameter which similarly exceed trigger levels would contribute to that investigation but not trigger a new investigation.

7.2.2. Groundwater Quality

In the event that:

- a groundwater quality trigger or limit breach is identified in a data set for a Compliance or Early-warning Compliance bore, including Compliance bores that are identified as Fault Monitoring bores; or
- a legitimate landholder complaint is received in relation to groundwater quality change at a landholder supply bore;

Then the following impact investigation procedure will be implemented.

1) A resample/re-test will be conducted at the relevant bore within 7 days of the identification of the trigger breach or landholder complaint, to confirm the breach by verifying that the data is not anomalous. Anomalous data will be identified through statistical comparison with other data from the subject bore in accordance with the methods described in DSITI (2017).

2) If the trigger breach or landholder complaint is confirmed following a resample/re-test, the following actions will be implemented.
    a) The monitoring frequency will be increased to weekly at the relevant bore. The first follow-up measurement will occur 7 days after the confirmation of the trigger breach.
    b) The administering authorities of this GMMP (i.e. DNRME and DAWE, or their equivalent entities at the time) will be notified within 7 days of the monitoring date on which the groundwater quality breach was confirmed.
3) Once the validity of a trigger breach or a landholder complaint has been verified, an investigation into the potential for environmental harm will be completed by an independent and appropriately qualified specialist. The investigation will include as a minimum:
    a) adoption of the investigation procedure identified in ANZECC and ARMCANZ (2000);
    b) comparison of the results for the bore subject to the breach with those from other Compliance and Control bores;
    c) comparison to model predictions for groundwater flow pathways;
    d) comparison to baseline groundwater monitoring results;
    e) a review of mining activities that may be responsible for the breach;
    f) the prevailing and preceding meteorological conditions
    g) a review of third-party groundwater use;
    h) a review of the physical integrity of the bore network (i.e. when an issue is identified by anomalous monitoring results); and
    i) assessment of the potential role of faults in the breach.
4) The resulting investigation report will be sent to the administering authorities of this GMMP (i.e. DNRME and DAWE, or their equivalent entities at the time) within 3 months of receiving the monitoring results in which the trigger breach was confirmed.
5) If the investigation into the potential for environmental harm deems that further additional investigation and/or monitoring is required to determine the cause of the 'activation' of the trigger, then the recommended additional investigation and/or monitoring will be actioned within 1 month of receipt of the investigation report that identifies the need for this to occur. Additional investigations recommended may include a review of the entire Project groundwater quality database that may result in adjustment of the relevant Compliance triggers using the methodology outlined in DSITI (2017).
6) If the investigations conclusively establish that triggers have been 'activated' as a result of mining activities, contingency measures to mitigate the impact may need to be implemented as determined by those investigations. Contingency measures may involve:
    a) a change in mining operations;
    b) a suspension of any mine related groundwater pumping from the aquifer of concern; or
    c) the enacting of make good measures for all affected landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 7.3.2**).

7) If these contingency measures were deemed to be required, they will be implemented within 3 months of receipt of approval of the investigation report recommending the measures from the administering authorities of this GMMP (DNRME and DAWE, or their equivalent entities at the time). Further discussion on impact mitigation is provided in **Section 7.3**.

8) The results of the investigation into any breaches of trigger levels, including all associated investigations and resulting proposed management/mitigation actions, will be documented for reporting and audit purposes and submitted to the administering authorities of this GMMP for approval (DNRME and DAWE, or their equivalent entities at the time) within 3 months of receiving the monitoring results in which the trigger breach was confirmed.

7.3. Contingency and Mitigation

7.3.1. General

As outlined above, the Impact Investigation Procedure for both groundwater levels and groundwater quality contains a step whereby groundwater impact triggers that are exceeded and deemed to have been 'activated' as a result of mining activities, as identified in a formal investigation of the potential for environmental harm following a trigger breach, may result in the need to implement contingency measures to mitigate these impacts. Such a formal investigation would also include that which is undertaken following activation of a trigger that is deemed to be related to the behaviour of faults. Contingency measures will be identified in the report documenting the investigation of the potential for environmental harm and approved by the GMMP Administering Authorities (DNRME and DAWE) prior to implementation. Contingency measures considered in the investigation of the potential for environmental harm will be assessed and recommended on the basis of providing the best outcome for protection of the groundwater resource and its users in relation to mitigation of the impact. The contingency measures considered will include:

- a change in mining operations;
- suspension of any mine related groundwater pumping from the aquifer of concern;
- the enacting of make good measures for the affected landholder consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 7.3.2**); and
- other yet to be determined mitigation measures that are identified as a result of the specific trigger breach being investigated.

The selection of the most effective mitigation measures will be based on providing the best outcome for protection of the affected groundwater resource and/or user as determined by the investigation into the potential for environmental harm. The selection of the most effective mitigation measures therefore will only be possible following the completion of the investigation into the potential for environmental harm.

The report documenting investigation into the potential for environmental harm, including the proposed contingency measures, will be submitted to the administering authorities of this GMMP (DNRME and DAWE, or their equivalent entities at the time) for approval within 3 months of receiving the monitoring results in which the trigger breach was confirmed. Mitigation measures will be implemented within 3 months of receipt of approval of the proposed mitigation measures by the administering authorities of this GMMP (DNRME and DAWE, or their equivalent entities at the time). The process for obtaining this approval is outlined in **Section 7.2**.

7.3.2. Impacts to Third Party Groundwater Users

In the event that a formal groundwater investigation conclusively identifies that the Project's mining operations have caused a bore of a neighbouring groundwater user to have impaired capacity (as defined in the *Water Act 2000*) (affected groundwater user), to the extent that NAC does not already have a make good agreement with the affected groundwater user, NAC will attempt in 'good faith' to negotiate a make good agreement with the landowner containing suitable mitigation measures. NAC will involve an appropriately qualified specialist to assist with development of the mitigation measures. The development of suitable mitigation measures will be based on the outcomes of the appropriate scientific investigation (i.e. the investigation into the potential for environmental harm).

Possible mitigation measures that may be applied by NAC as part of the make good process include:

- the refurbishment of an existing groundwater bore;
- the installation of a new groundwater bore;
- the establishment of an alternative water supply arrangement; and/or
- the use of another mutually agreed form of mitigation.

Mitigation measures selected will be based on providing the best outcome to the affected groundwater user (landholder) and selected by agreement with that landholder. NAC will ensure the proposed mitigation measures are commensurate with the identified impaired capacity.

NAC may be required to install interim mitigation measures until the permanent mitigation measures have been developed and installed. As required, NAC will seek agreement with the affected groundwater user and pay all reasonable cost for the use of any interim mitigation measures.

If agreement cannot be reached with the affected groundwater user in relation to the proposed mitigation measures, NAC will facilitate a legal disputes resolution for the matter which may include utilising relevant processes under the *Water Act 2000*.

NAC is committed to rectifying any impaired capacity to bores that are legitimately attributed to the Project's mining operations through proper scientific evaluation, in an appropriate timeframe, using accepted and practical mitigation measures, and to the satisfaction of the affected groundwater user.

7.3.3. Offsetting Impacts to the Groundwater Resources of the Oakey Creek Alluvium and Main Range Volcanics Aquifers

As described in **Section 2.3.5**, the groundwater resources within the Study Area are prescribed under the *Water Act 2000* subordinate legislation - the *Water Regulation 2016* and several Water Plans. Under these subordinate legislations, Groundwater Management Areas (GMA's) have been declared, and within these GMA's a water licence is generally required to take underground water.

Two of the GMA's in the vicinity of the Project, the Oakey Creek GMA (covering the Oakey Creek Alluvium aquifer) and the Condamine and Balonne GMA (covering the Main Range Volcanics (Upper Condamine basalts) aquifer) are currently at maximum allocation and further entitlements are unable to be granted. Pursuant to the EPBC Approval for the project, NAC is required to implement this GMMP which is required to include mechanisms for addressing the potential impacts of the Project to groundwater resources, including details of offsets for the Oakey Creek Alluvium and Main Range Volcanics (Tertiary Basalt) Aquifers (which may comprise a retirement of part or all of an existing entitlement, or purchase and retirement of a new entitlement) and a timeframe for when the measures and offsets for impacts to groundwater resources will be implemented.

7.3.3.1. Oakey Creek Alluvium

NAC has determined that at the present time, the best outcome-based solution to offset the potential Project impacts to the Oakey Creek Alluvium is retirement of groundwater allocation entitlements from that aquifer, thus providing at minimum a net zero change in the aquifer water balance. The NHG (through NAC and APC) continues to hold 27 ML/year in formal groundwater entitlements authorised by DNRME for the Oakey Creek Alluvium as detailed in **Table 3** in **Section 2.4.1**. In comparison, the 2018 groundwater model predicts a median (most likely) take of 430 ML total estimated take of water from storage (equivalent to an average of approximately 31 ML/year) over the life of the Project from the Oakey Creek Alluvium. Therefore, it is considered that the NHG already holds sufficient entitlement to offset most of the total estimated take of water from storage over the life of the Project from the Oakey Creek Alluvium through retirement of part of the existing held allocation. Prior to commencement of the Project's mining activities, NAC will seek to purchase sufficient additional formal entitlement from the Oakey Creek Alluvium of at least 4 ML/year from surrounding landholders, in order to retire sufficient allocations. These entitlements will then be retired (handed back to DNRME) in order to mitigate/offset the take from storage from this aquifer. The entitlements will be retired no later than 6 months after the commencement of the Project's mining operations.

Should any revised groundwater model predictions developed as part of the Review and Improvement Process documented in **Section 8** indicate an increased take from this aquifer over that already offset through entitlement retirement, NAC will acquire and retire additional licensed entitlement no later than 12 months after the receipt of the updated model predictions.

In the unlikely event that the required allocation entitlements cannot be obtained, other measures will be implemented to offset the Project's impact to the Oakey Creek Alluvium. These offset measures would be implemented within 12 months of the due date for retirement of the relevant volumetric allocation licences (refer above). The offset measures would include one or a combination of the following:

a) a change in mining operations;

b) a suspension of any mine related groundwater pumping from the Oakey Creek Alluvium; or

c) the enacting of make good measures for the relevant landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 7.3.2**).

7.3.3.2. Main Range Volcanics

NAC has determined that at the present time, the best outcome-based solution to offset the potential Project impacts to the Main Range Volcanics is retirement of groundwater allocation entitlements from that aquifer, thus providing at minimum a net zero change in the aquifer water balance. The NHG (through NAC and APC) also continues to hold 202 ML/year in formal groundwater entitlements authorised by DNRME for the Main Range Volcanics as detailed in **Table 3** in **Section 2.4.1**, whilst anticipated future usage for Mine potable supply purposes is less than 20 ML/year as described in **Section 2.4.1**. In comparison, the 2018 groundwater model predicts a median (most likely) take of 1,276 ML of water from storage (equivalent to an average of approximately 91 ML/year) over the life of the Project from the Main Range Volcanics. Therefore, it is considered that the NHG already holds sufficient entitlement to offset the total estimated take of water from storage over the life of the Project from the Main Range Volcanics through retirement of part of the existing held allocation. Part of the NHG's entitlements will be retired (handed back to DNRME) in order to mitigate/offset the take from storage from this aquifer. The entitlements will be retired no later than 6 months after the commencement of the Project's mining operations.

Should any revised groundwater model predictions developed as part of the Review and Improvement Process documented in **Section 8** indicate an increased take from this aquifer over that already offset through entitlement retirement, NAC will retire additional licensed entitlement no later than 12 months after the receipt of the updated model predictions.

In the unlikely event that the required allocation entitlements cannot be sought, other measures will be implemented to offset the Project's impact to the Main Range Volcanics. These offset measures would be implemented within 12 months of the due date for retirement of the relevant volumetric allocation licences (refer above). The offset measures would include one or a combination of the following:

a) a change in mining operations;

b) a suspension of any mine related groundwater pumping from the Main Range Volcanics; or

c) the enacting of make good measures for the relevant landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 7.3.2**).

7.4. Groundwater Complaints Management Process

Groundwater complaints that are believed to be attributed to the operation of the Mine should be immediately reported to NAC. Groundwater complaints may be reported verbally by telephone (1 800 882 142 or Oakey Community Office: 07 4691 3445) or in writing using e-mail (community@newhopegroup.com.au) or letter (New Acland Coal Pty Ltd, GPO Box 2440, Brisbane, Qld, 4001). NAC has provided its near neighbours with general and special 24 hour contact numbers. NAC will continue this practice for the duration of the Project.

The general details of the groundwater complaint need to be provided at the time of reporting the complaint to NAC. NAC will make all reasonable efforts to ensure the reported groundwater complaint is managed in a timely and appropriate manner. NAC's on-site Environmental Team is responsible for environmental complaints management at the Mine.

NAC will record the details of the groundwater complaint in the Mine's complaint database (register) and review this information. As required, NAC will re-contact the complainant about the groundwater complaint to obtain all the necessary details to decide the next course of action. Depending on the severity of the groundwater complaint, NAC as a courtesy may also advise the Toowoomba Office of the DES about the matter. As required, the NHG's Corporate Environmental Team may assist with management of the groundwater complaint.

NAC's investigation of the groundwater complaint is designed to establish the legitimacy of the complaint, and if legitimate, whether the Mine is directly or indirectly responsible for the complaint. If current evidence or further scientific investigation establishes NAC is responsible for the groundwater complaint, NAC will advise the complainant, the Toowoomba Office of the DES or DNRME (as appropriate) and follow the mitigation strategy outlined in **Section 7.3** of this Plan. If current evidence or further scientific investigation establishes NAC is not responsible for the groundwater complaint, NAC will advise the complainant in a timely manner, and depending on circumstances, the Toowoomba Office of the DES or DNRME (as appropriate).

At the cessation of the complaint investigation process, NAC will record all the relevant details about the groundwater complaint in the Mine's complaint database, including all management actions undertaken, the final outcomes of the complaint investigation process, the details of any required follow-up or on-going management actions, and whether the complaint is 'closed off' to the satisfaction of the complainant. NAC maintains the Mine's complaint database for issue analysis, regulatory and audit purposes.

Importantly, NAC is committed to working with its near neighbours to resolve genuine issues as they arise in relation to the operation of the Mine.

8. Review and Improvement Process

As required, NAC may update or revise this GMMP based on the outcomes of the annual review process outlined in this Section. The DES, DNRME and/or DAWE (or their future equivalent entities) will be consulted in relation to any significant changes to this GMMP and as necessary will be re-issued any new versions of the document in accordance with the CG's imposed conditions, the conditions in the EA, the AWL approval and/or the EPBC approval.

8.1. Groundwater Impact Prediction, Validation and Review (Model Update)

During the life of the Project, data collected through the groundwater monitoring program will be used to update and refine the Project's groundwater model and its predictions.

8.1.1. Model Update Process

Table 14 presents the proposed schedule for groundwater impact prediction, validation and review. The results of any groundwater model verification and refinement will be documented and presented to DNRME (regulatory authority under the *Water Act 2000*) and DAWE (regulatory authority under the *EPBC Act 1999*), or their equivalent entities at the time.

Table 14 Schedule for Groundwater Impact Prediction, Validation and Review

Model Revision	Timing
Initial Review	At the conclusion of the revised monitoring network installation program (review completed in 2017 and subsequently updated in 2018)
2nd Review	After one (1) year of any box cut excavation for the Project
3rd and subsequent Reviews	Every three (3) years or if deemed necessary under the Groundwater Impact Investigation Procedure as described in **Section 6.2**

The groundwater impact prediction, validation and review process will include:

- review of the hydrogeological conceptualisation used in the previous model;
- an update of the predicted impacts;
- revised water balance model;
- review of assumptions used in the previous model including recharge and boundary conditions/parameters;
- an assessment of any impacts that might have occurred due to flooding events;
- an assessment into the role of faults in relation to impact predictions including their behaviour in terms of being conduits or barriers for groundwater flow (see **Section 8.3.2**);
- predictions of changes in groundwater levels for a range of model scenarios (i.e. sensitivity and uncertainty testing);
- information about any changes made since the previous model, including data changes;
- a report outlining the justification for the refined model and the outputs of the refined model; and

- an evaluation of the accuracy of the predicted changes in groundwater levels and recommended actions to improve the accuracy of model predictions.

The report outlining the findings and any recommendations from the model update process will be completed by an appropriately qualified person and submitted to the GMMP administering authorities (DES, DNRME and/or DAWE, or their equivalent entities at the time) for approval no later than 3 months after the completion of the review.

8.1.2. Review of the GMMP

Revised groundwater level drawdown predictions resulting from the model review process may create a discrepancy between the updated model predictions and the groundwater level drawdown triggers established in this GMMP (refer **Section 7.1.2**).

The model update process will therefore also include a review of the GMMP that incorporates an assessment of the requirement to update the drawdown triggers set out in this GMMP. Should this assessment find that the triggers require revision, this GMMP will then be updated accordingly.

Similarly, the estimated take of groundwater from the Oakey Creek Alluvium and Main Range Volcanics aquifers as outlined in **Section 7.3.3** may be revised as a result of the model update process. The review of the GMMP will include assessment of the requirement to update the offsets for this take, and any change to the offset requirements or offset strategy would be documented in this GMMP accordingly.

During the GMMP review, should revised impact predictions resulting from the model update process (95th percentile drawdown predictions) extend further than previous modelled extents, this will result in:

- further investigation into the cause of this extent change;
- consideration of expansion of the GMMP monitoring network to reduce uncertainty; and
- re-consideration of the appropriate location of Control and Early-warning Compliance bores.

It is recognised that the Project lies within the easternmost part of the Surat Cumulative Management Area (Surat CMA), administered by the Queensland Government Office of Groundwater Impact Assessment (OGIA). It is also recognised that coal mines have been brought into OGIA's assessment for the Surat CMA. The GMMP review will include any requirements for modification of the GMMP and its groundwater monitoring network as recommended/mandated by OGIA to NAC.

Should it be identified in the GMMP review that the GMMP requires update as a result of the model update process, the GMMP update will be completed by an appropriately qualified person and submitted to the administering authorities (DES, DNRME and/or DAWE, or their equivalent entities at the time) for approval no later than 3 months after the completion of the model update.

8.2. Annual Reviews

Notwithstanding the Project groundwater model validation and review process outlined in **Section 8.1** and the three-yearly GMMP review process required by the CG's imposed condition 11 as detailed in **Section 8.3**, NAC will also conduct an annual review of the environmental performance of this GMMP. The annual review will:

- include a comprehensive review of the monitoring results and complaints records for the Project over the year, including a comparison of these results against the:
    - + relevant statutory requirements, limits or performance measures/criteria/triggers,

  + monitoring results of previous years, and
  + relevance to the Project's EA, AWL and EPBC approval.

- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- compare monitoring data with baseline data and undertake a statistical trend and outlier analysis in accordance with the procedures identified in DSITI (2017);
- discuss any trends in the monitoring data over the life of the Project;
- identify any discrepancies between both the 50th and 95th percentile predicted impacts and actual estimated impacts of the Project, and analyse the potential cause of any significant discrepancies (i.e. validate the model).
- describe mitigation measures that have or are being implemented to address exceedances of any groundwater impact triggers; and
- review the condition and extent of the groundwater monitoring network in the context of meeting its objectives.

The annual reviews will be undertaken by an appropriately qualified and experienced professional with a report provided on the outcome of the review to the administering authority, with the first annual review completed within 12 months from the issuing of the Project's EA and ML required for the Project.

8.3. Three Yearly Reviews

8.3.1. General

As described in **Section 8.1.2** the GMMP review process will be undertaken by NAC at three yearly intervals as required by the CG's imposed condition 11 in conjunction with the Project groundwater model validation and review process outlined in **Section 8.1**. In addition to the requirements of the Annual Review outlined in **Section 8.2** above, the Three Yearly Review will also include:

- an assessment of the outcome of the groundwater management and monitoring program against the objectives in the Project's EA;
- hydrograph analysis for paired monitoring sites in response to stresses (e.g. mining, recharge events, pumping) as a means to assess aquifer connectivity. If no clear stresses are observable at the time of the 3-yearly review then a recommendation may be made to conduct pumping tests to provide adequate stressed aquifer data to assess aquifer connectivity;
- a specific review of the results of the fault monitoring program identified in **Section 4.3.6**, including an assessment of the adequacy of the program and identification of any requirements to expand the fault monitoring network or enact additional investigations into the hydrogeologic function of faults (see **Section 8.3.2**);
- a review of the adequacy of the monitoring locations, frequencies and groundwater quality triggers specified in the Project's EA with respect to any updated groundwater impact predictions; and
- a review of the adequacy of the groundwater monitoring program with respect to any updated groundwater impact predictions, including for the post-closure phase with a particular focus on the Manning Vale East void that is currently predicted to have a small losing flux to groundwater. This process would involve comparison of any revised impact predictions to the previous impact predictions (focussing on the 95th percentile predictions), and also comparison to the existing monitoring network, to determine if the monitoring network remains appropriate or if consideration of

expansion of the monitoring network is warranted, including re-consideration of the appropriate location of Control and Early-warning bores.

The three yearly reviews will be undertaken by an appropriately qualified and experienced professional with a report provided on the outcome of the review to the administering authorities of the GMMP (DES, DNRME and DAWE, or their equivalent entities at the time) within 2 years from the issuing of the Project's EA and ML/s required for the Project; and then no later than 1 July every 3 years following.

8.3.2. Review of Fault Monitoring

The three yearly review will include a specific review of the results of the fault monitoring program identified in **Section 4.3.6**. The review will include:

- assessment of the fault monitoring data with the aim of further characterising the role of faulting within the hydrogeologic system and whether faults function as barriers or conduits for groundwater flow;
- assessment of the adequacy of the program for identifying whether faults function as barriers or conduits for groundwater flow;
- review of the triggers associated with the fault monitoring bores so that they continue to allow for early warning of greater than predicted impacts occurring;
- identification of any requirements to expand the fault monitoring network to further characterise whether faults function as barriers or conduits for groundwater flow; and
- identification of requirements to enact additional investigations into the hydrogeologic function of faults, including provision of design of those investigations.

The review will focus on comparison of the groundwater level data and groundwater quality data between bores on either side of the fault using both hydrograph and statistical analysis of water level and water quality data. Should the faults not continue to function as partial barriers to groundwater flow as currently conceptualised (see **Section 2.3.4**), it would be expected that similarities in the ongoing monitoring data response will be observed from bores on either side of the fault, as well as clear departure from model predictions.

Additional investigations that will be conducted as part of the Fault Monitoring Program review are as follows.

- Geophysical Investigations:
    + Downhole geophysics database review.

      This investigation will focus on a review of the NAC resource exploration drillhole and downhole geophysics databases to identify where drillholes have intersected faults. The geophysical signature of the fault zones will then be characterised with the aim of identifying fault related features that may influence the groundwater flow system, such as the density of the rock formation within the fault zone as compared to above and below the fault zone. The MDL_01 fault zone at the Project site has previously been successfully identified and characterised using this method in one location as documented in Appendix C of SLR, 2018a (**Appendix A**).
    + Ground based geophysical surveys.

      As documented in Appendix C of SLR, 2018a (**Appendix A**), ground based geophysical surveys, such as micro-gravity, have been previously successfully used to identify and characterise the MDL_01 fault zone in the southwest corner of the Project site. This type of investigation will be expanded to include other areas of the Project site and surrounds to further characterise the MDL_01 fault zone, and potentially other faults.

- Drilling and Testing:
    + As documented in Appendix C of SLR, 2018a (**Appendix A**), a groundwater bore drilling and pumping test investigation program has been previously successfully used to identify and characterise the MDL_01 fault zone in the southwest corner of the Project site, including providing conclusive evidence that the MDL_01 fault acts as a barrier to groundwater flow in this location over the duration of the testing program. The program installed a pumping bore on one side of the fault, and a series of monitoring bores on the same and opposite sides of the fault. The pumping test involved extraction of groundwater from the pumping bore and groundwater level observations indicated significantly different aquifer responses on either side of the fault (i.e., drawdown responses were much smaller in observation bores located on the opposite side of the fault compared to those located on the same side of the fault as the pumping bore). This investigation will be repeated for other areas of the Project site and surrounds to further characterise the MDL_01 fault zone.

8.4. Network Maintenance

Over the lifespan of the Project (approximately 16 years of working) and the post closure monitoring period, it is inevitable that groundwater monitoring bores will become unserviceable and need to be replaced. Furthermore, there are several Operational monitoring bores (namely 113Pb, 112P, 111PGC_Upper and 111PGC_Lower) that are located in close proximity to mine pits that may become disturbed by mining activities in latter stages of the Project, and as a result, may require replacement. The identification of bore replacement requirements would be considered in the Annual Review process detailed in **Section 8.2**.

NAC will proactively maintain the groundwater monitoring network, replacing bores as necessary, ensuring that the methods of construction, maintenance, management and decommissioning of bores is undertaken in a manner that prevents or minimises impacts to the environment and provides appropriate integrity of the bores to obtain accurate monitoring.

In the event that monitoring bores require replacement or additional monitoring bores are deemed required to supplement the existing network, NAC will ensure that bore installation will:

- occur under the supervision of a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters; and
- be constructed in accordance with methods prescribed in the latest edition of the Minimum Construction Requirements for Water Bores in Australia by an appropriately qualified and licensed water bore driller.

9. References

DES, 2017. Guideline. Mining. Model mining conditions. Queensland Department of Environment and Science (DES), Queensland Government, Brisbane.

DNRME, 2017. Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland - WSS/2016/3189 – (Version 1.02 - 19/12/2017), Queensland Department of Natural Resources, Mines and Energy (DNRME), Queensland Government, Brisbane.

DSITI, 2017. Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane.

Geochemical Scientific, 2020 Bore Network Integrity and Implications Assessment, prepared for the New Acland Coal Pty Ltd by Geochemical Scientific Pty Ltd.

Middlemis H and Peeters LJM, 2018. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

National Environmental Protection Council, 2013. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Amendment 1, 2013) (Amendment 1 2013 NEPM).

OGIA, 2016. Hydrogeological conceptualisation report for the Surat Cumulative Management Area. Report prepared by the Office of Groundwater Impact Assessment, of the Department of Natural Resources and Mines.

SLR, 2015. New Acland Stage 3 Project Baseline Assessment Program. Report prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

SLR, 2018a. New Acland Stage 3 Project 2017-2018 Groundwater Model Update. Conceptual Hydrogeological Model. Report prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

SLR, 2018b. New Acland Stage 3 Project 2017-2018 Groundwater Model Update. Numerical Model Report. Prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

SLR, 2020a. New Acland Coal Mine EA Groundwater Monitoring Bore 18P Assessment. Prepared for New Acland Coal Pty Ltd by SLR Consulting Australia Pty Ltd.

SLR, 2020b. NAC Monitoring Bore Integrity Review. Prepared for Clayton Utz by SLR Consulting Australia Pty Ltd.